orolia Group

Beyond the Frontier

ALT-PNT PROJECT TEST RESULTS REVIEW

May 2022

OROLIA PROPRIETARY

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INTRO TECHNOLOGY

Features

- Sub-ns synchronization accuracy
- Network resiliency
- Scalability and long distance
- Interoperability
- UTC traceability
- Monitoring and Management
- Cybersecurity

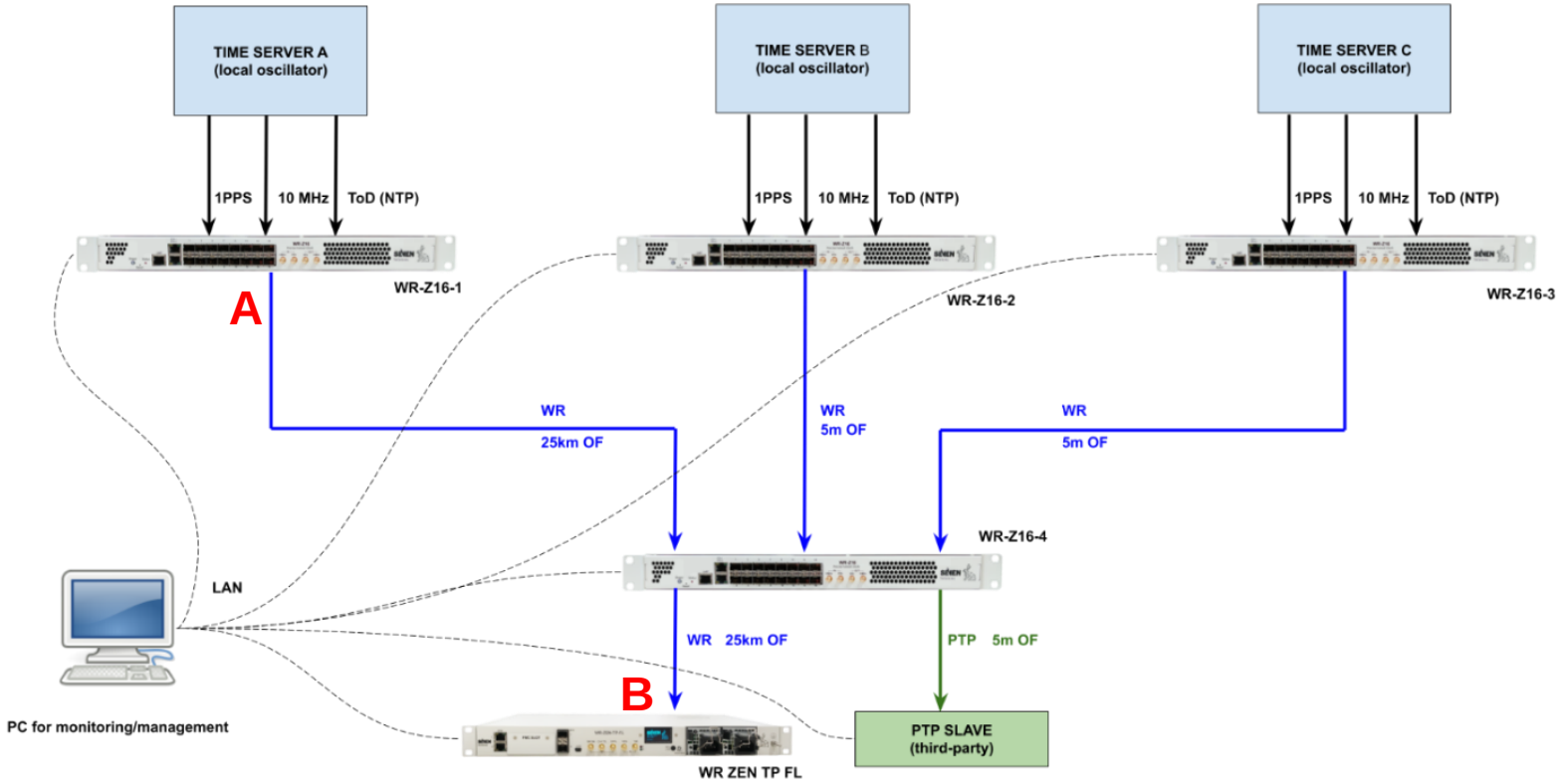
INTRO TESTS

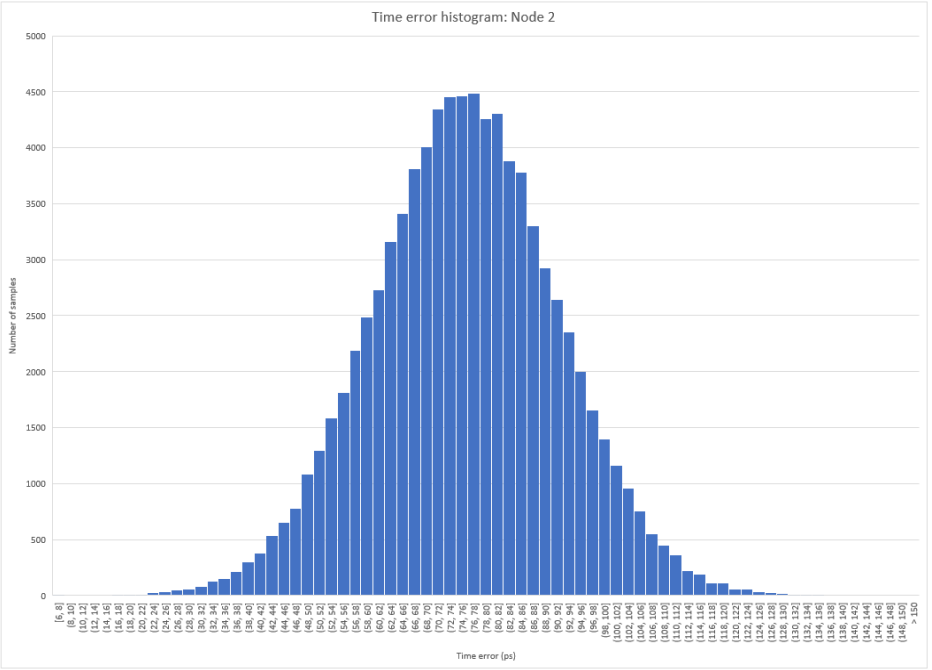
Accuracy (average)	**73.13 ps**
Jitter (standard deviation)	14.15 ps
Peak to peak error (24 hours)	141 ps

Goals

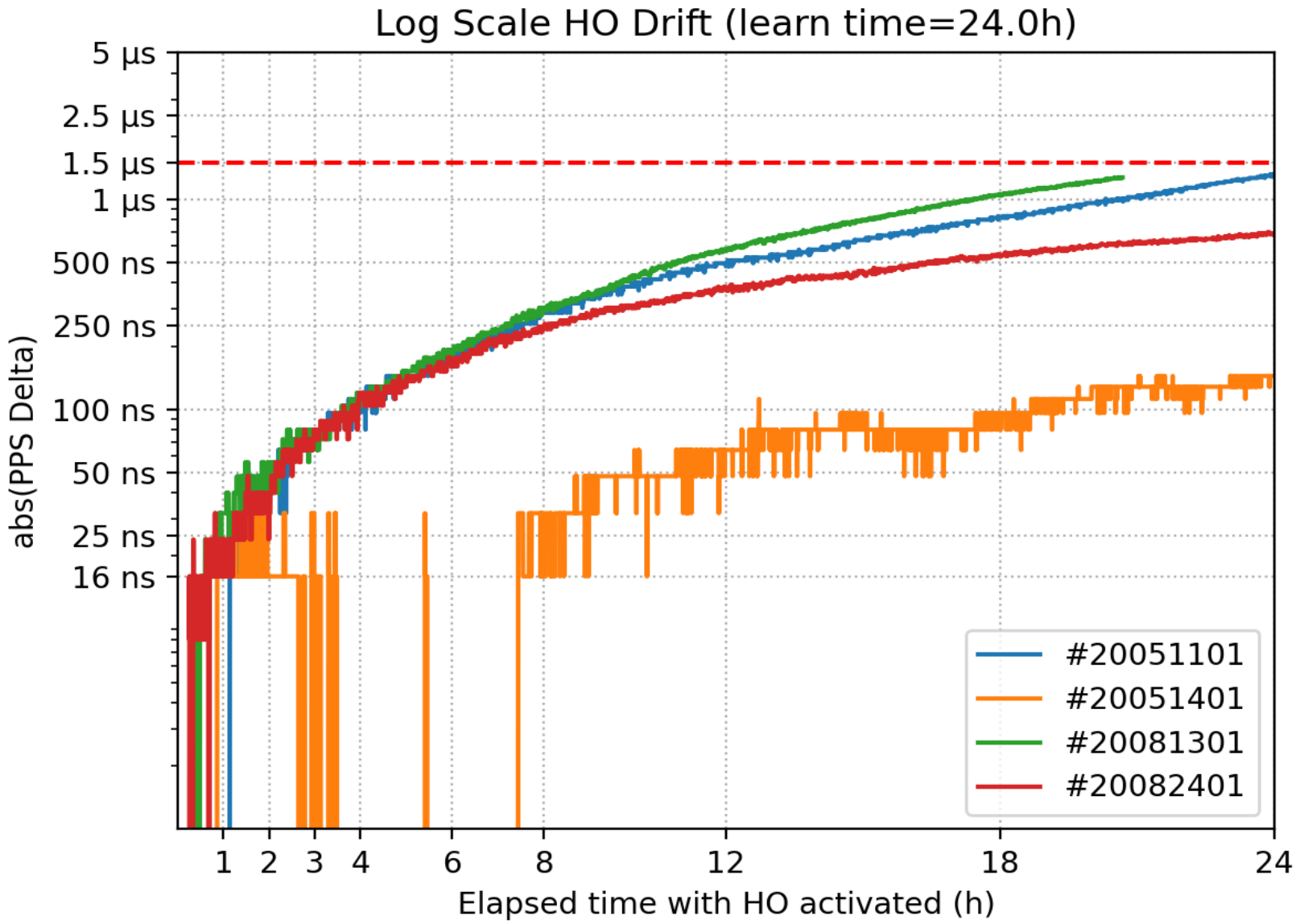
Demonstrate technology capabilities regarding:

- High-accurate time transfer (WR)
- Network resiliency
- PTP interoperability with third party devices
- Monitoring

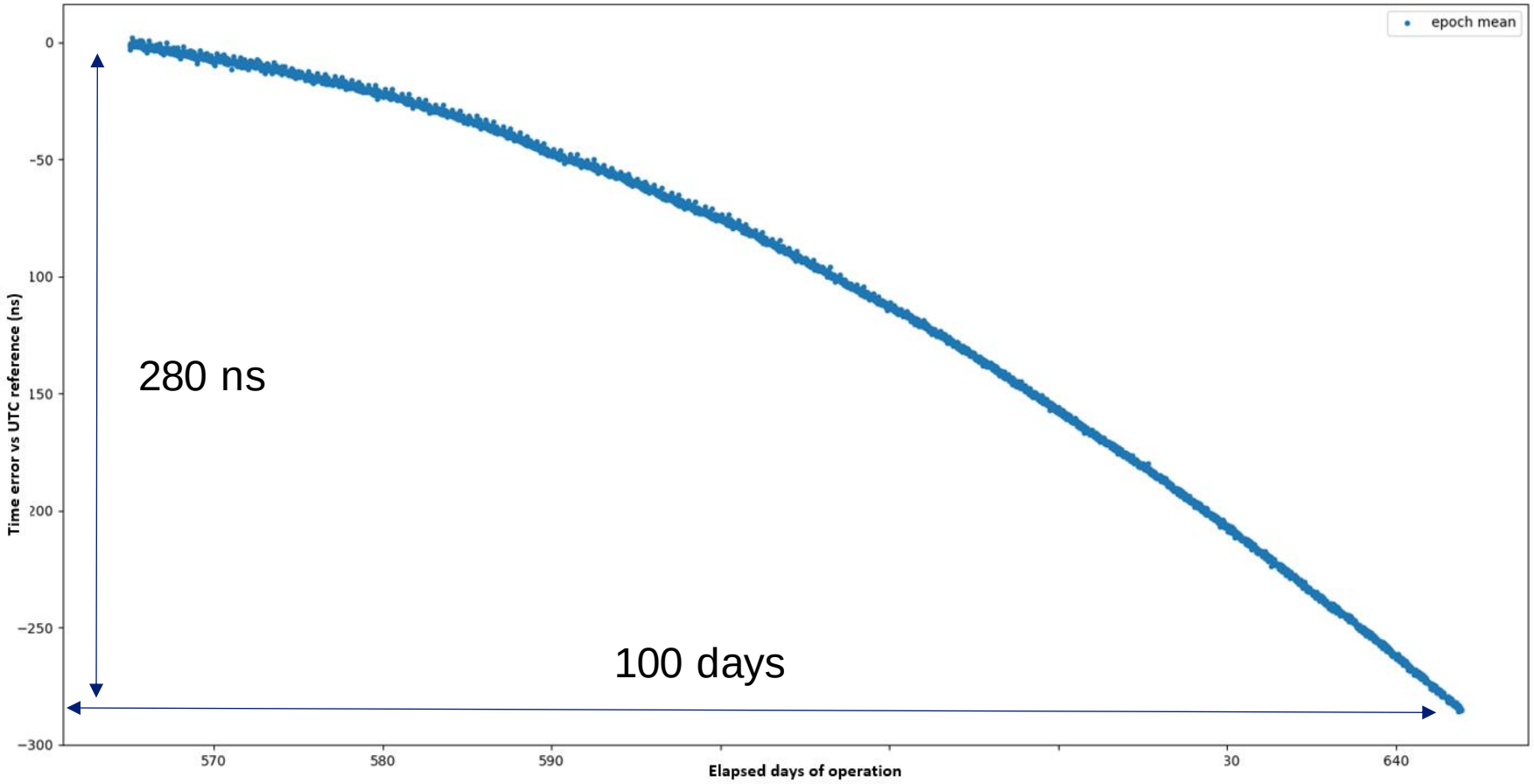




TEST RESULTS: HOLDOVER PERFORMANCE



TEST RESULTS: MEDIUM-TERM TIME STABILITY



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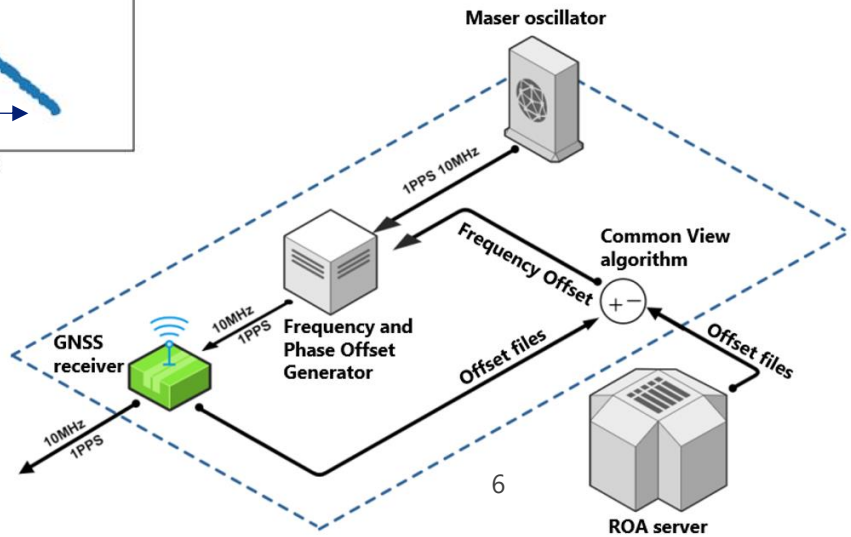


TEST RESULTS: MONITORING

Home

Tag: device_type Value: WRZ

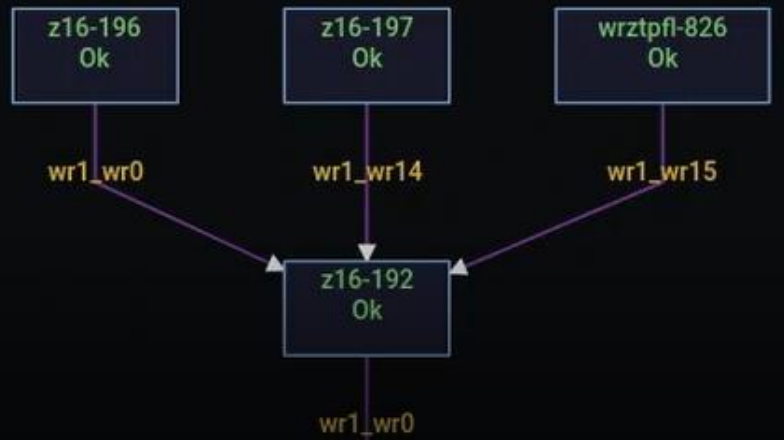
Device Overview

Hostname	Serial Number	Firmware Version	Preset	System Status	Timing Status	Act. Reference	Act. Reference Stat	Act. Reference cod	Hops
z16-197	S01_197	v3.2.0.4-LJ	GM ext GNSS	Ok	Ok	GM: Front-panel	Locked	10000	0
z16-196	S01_196	v3.2.0.4-LJ	GM ext GNSS	Ok	Ok	GM: Front-panel	Locked	10000	0
wrztpfl-826	S04_826	v3.2	GM ext GNSS	Ok	Ok	GM: Front-panel	Locked	10000	Unknown
z16-192	S01_192	v3.2.0.4-LJ	Custom	Ok	Ok	BC: WR @ wr0	Locked (TRACK_PH...	20001	0
z16-193	S01_193	v3.2.0.4-LJ	BC wr0 slave	Ok	Ok	BC: WR @ wr0	Locked (TRACK_PH...	20001	1

Alerts

Time	IP	Level	Description
2021-11-24 22:37:00	192.168.1.100	Warning	The device has timing issue(s)
2021-11-25 03:22:30	192.168.1.100	Warning	The device has system issue(s)
2021-11-24 14:20:30	192.168.1.100	Warning	CPU usage is too high
2021-11-24 15:48:00	192.168.1.101	Warning	The device has timing issue(s)
2021-11-24 15:47:30	192.168.1.101	Error	The device has timing issue(s)
2021-11-24 12:00:30	192.168.1.101	Error	Low available memory (RAM)
2021-11-24 16:53:30	192.168.1.102	Warning	The device has timing issue(s)
2021-11-25 08:48:00	192.168.1.102	Warning	Unknown error

Network Topology



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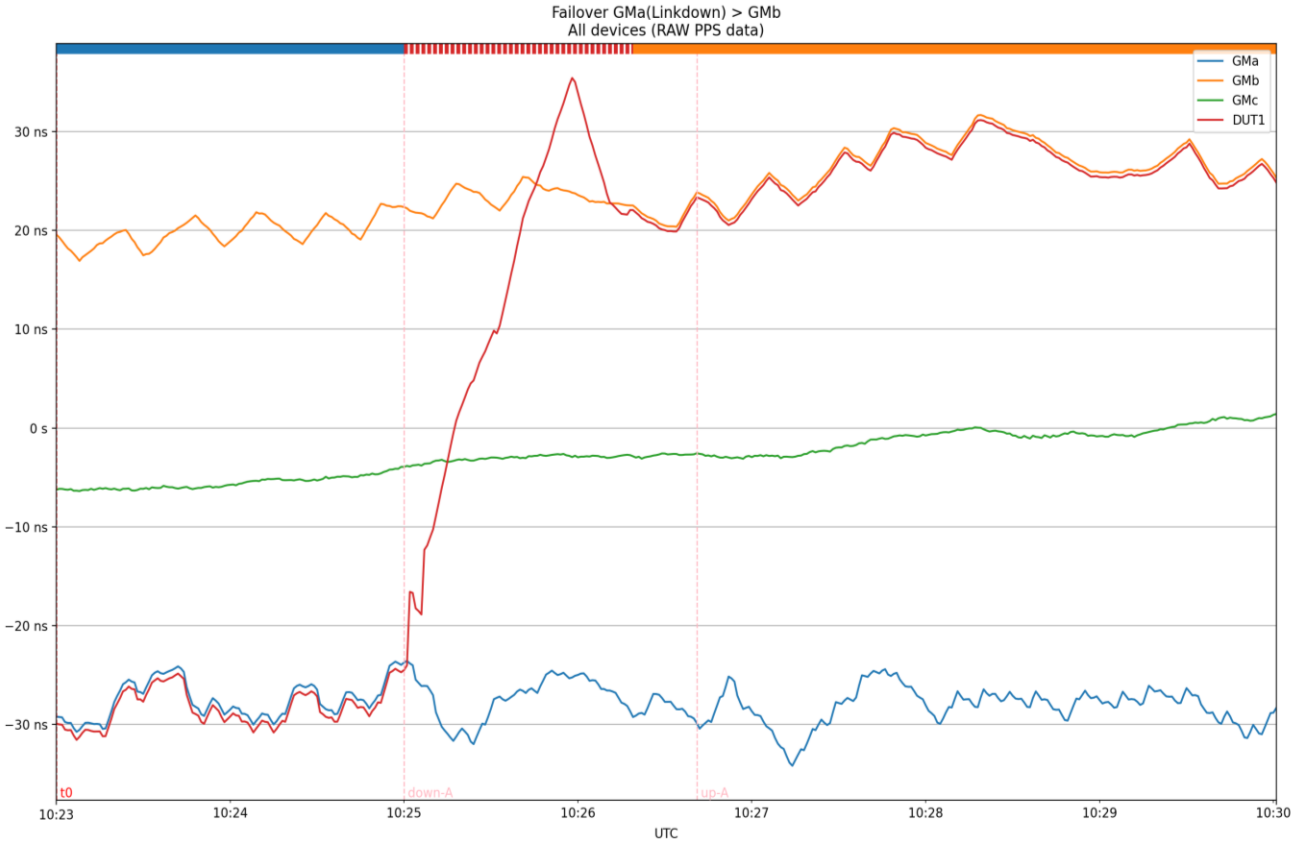
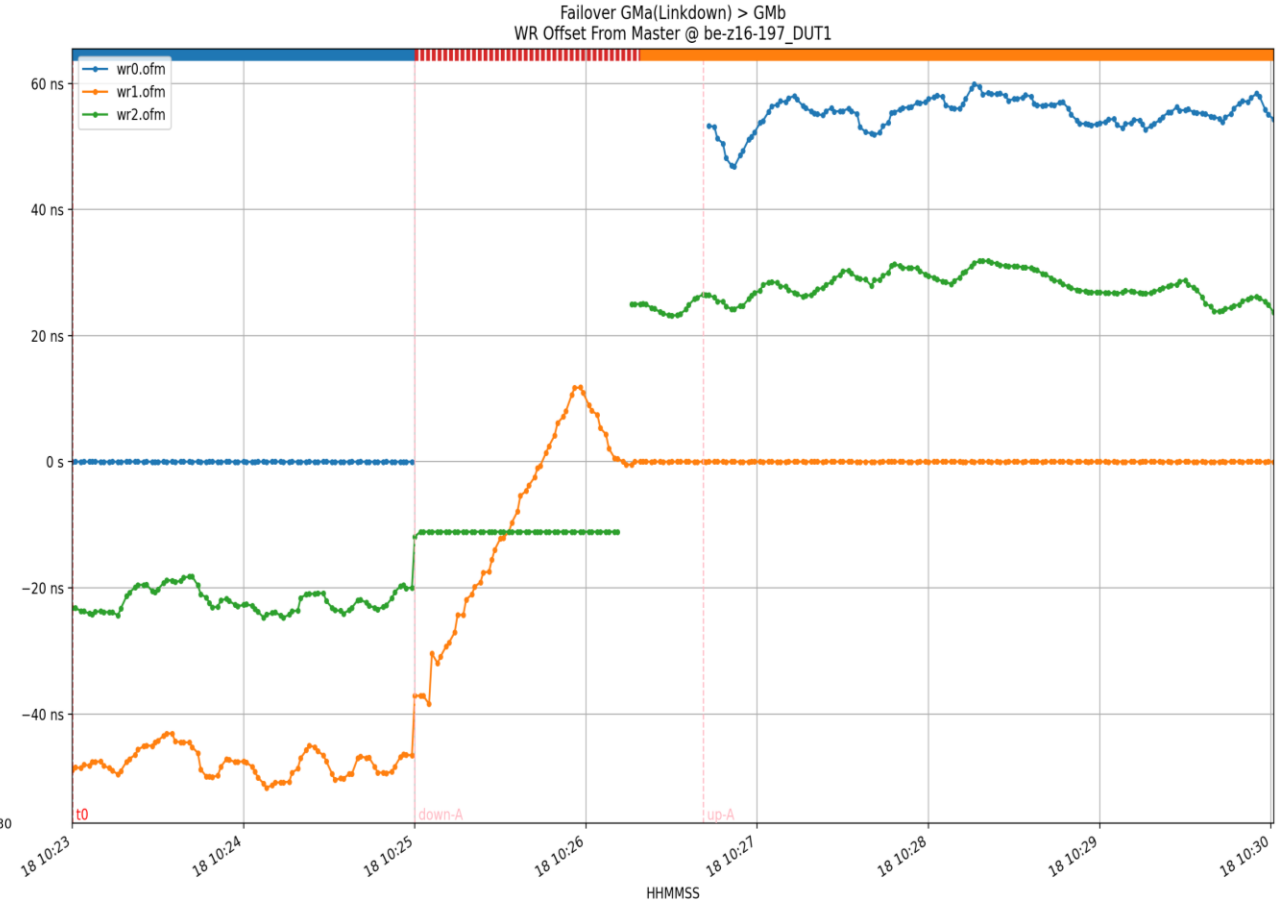
TEST RESULTS: FAILOVER (LINK DOWN @ GM_A)

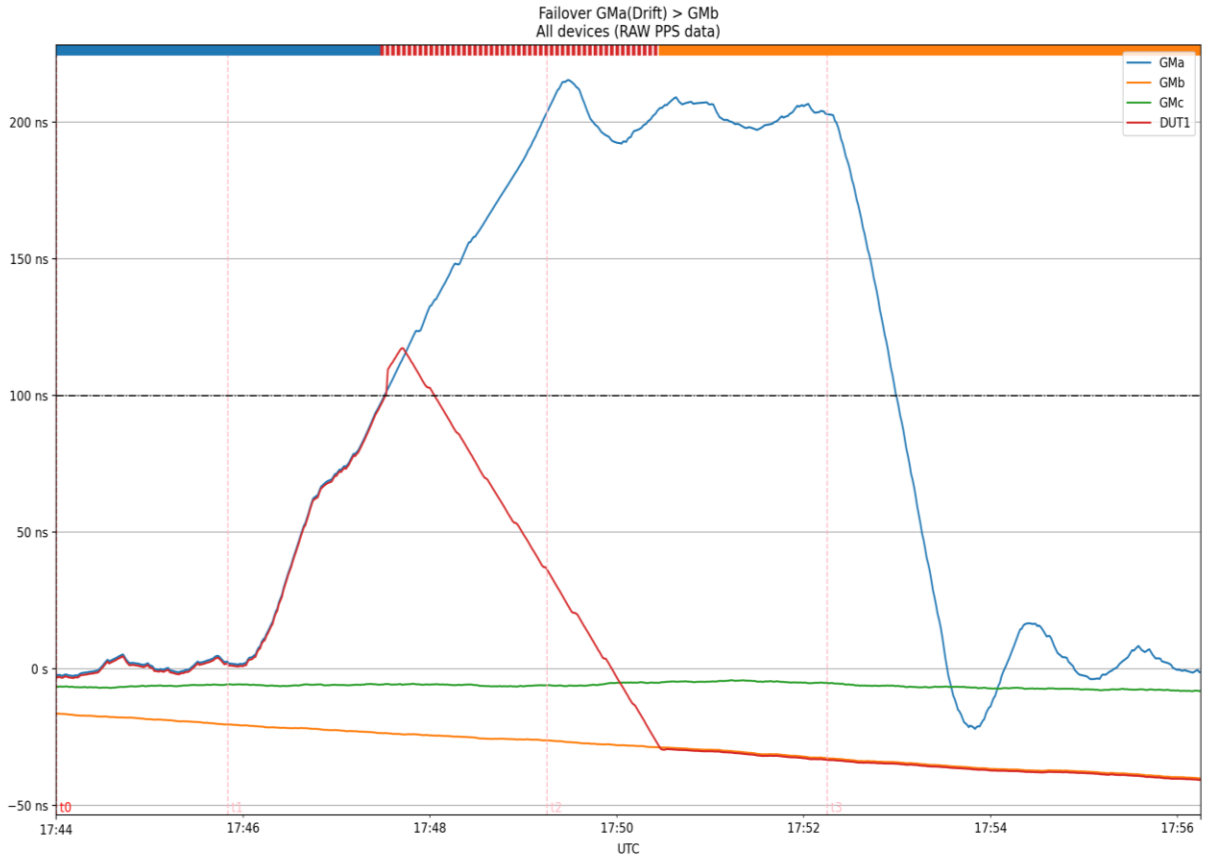


External lab measurement

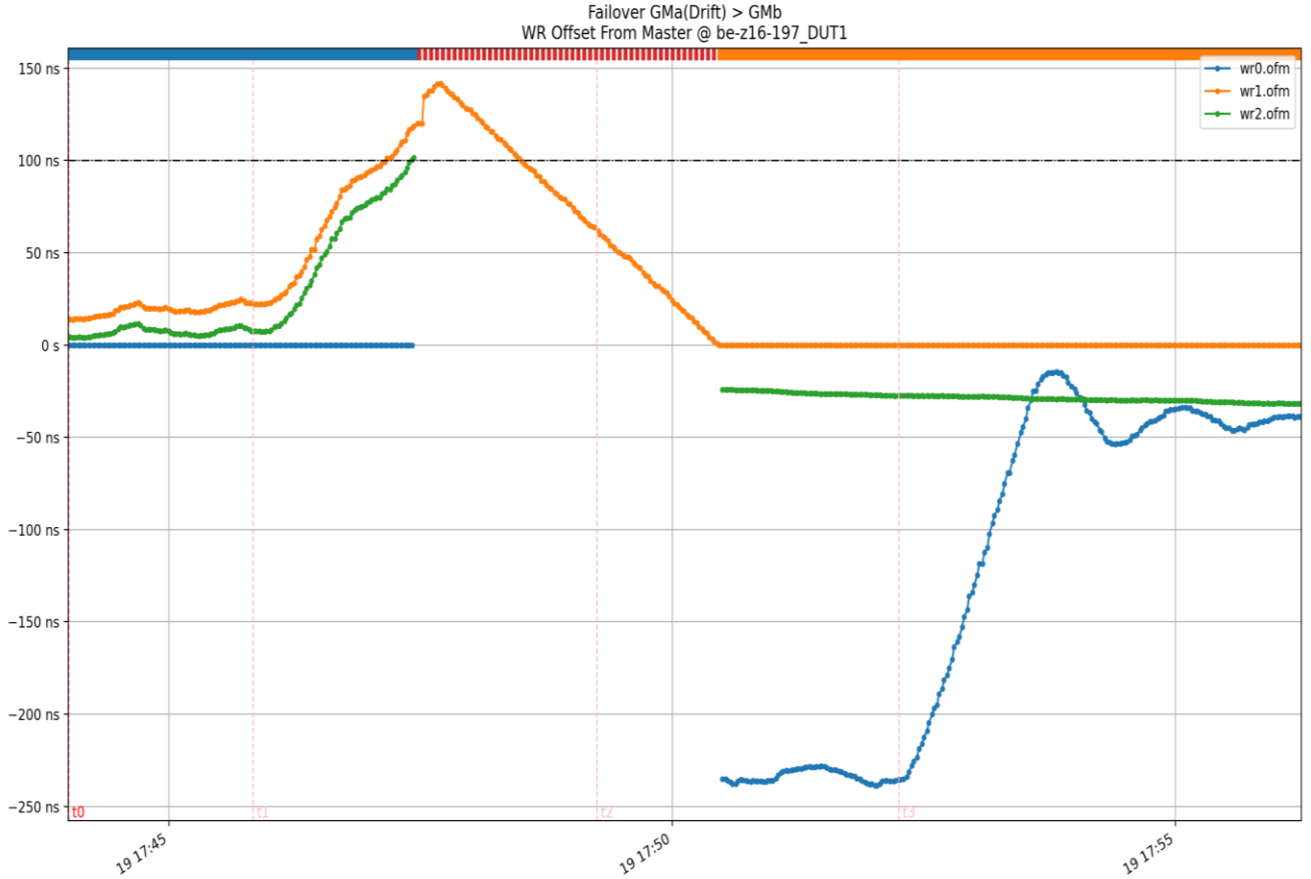


Measuring at the device under test (DUT)

TEST RESULTS: FAILOVER (DRIFT DETECTION @ GM_A)

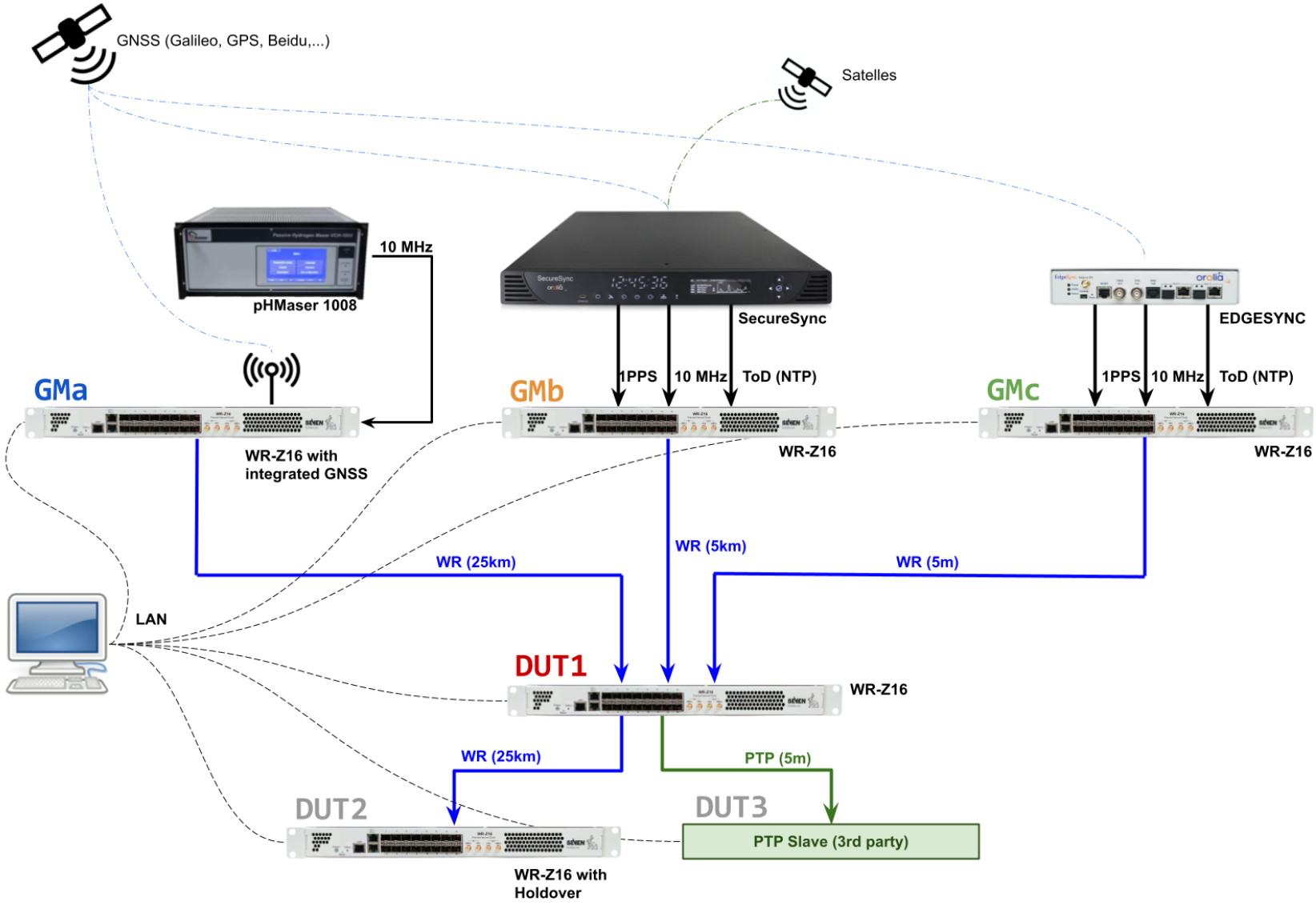


External lab measurement



Measuring at the device under test (DUT)

A RESILIENT ARCHITECTURE



RESILIENT ARCHITECTURE AGAINST ATTACK/FAILURES

- Device based resiliency
  - Resiliency to Jamming (GNSS denied scenario):
    - External passive hydrogen maser (PHM) or local holdover (DOXCO, mRO)
    - SecureSync can track STL (Satelles) if GNSS L1/E1 bands are jammed
  - Resiliency to Spoofing:
    - OSNMA allows spoofing detection
    - STL is fully encrypted to protect against spoofing
- Network based resiliency
  - WR (time transfer) allows measuring and comparing distributed GNSS spread at tens of km. Our approach allows switching from one timing source to the other in case the majority differs from actual timing source (voting scheme as trust metric).

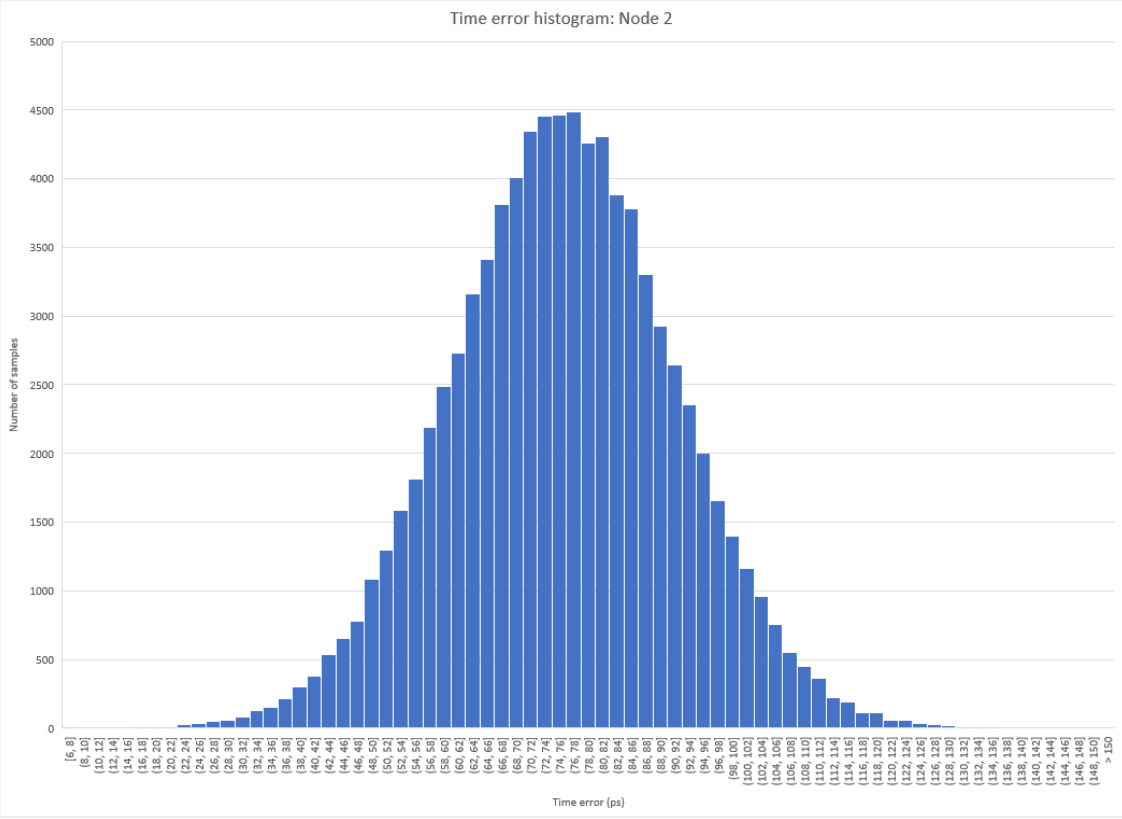
→ Resilient^{2}PNT=(Device Resiliency x Network Resiliency)

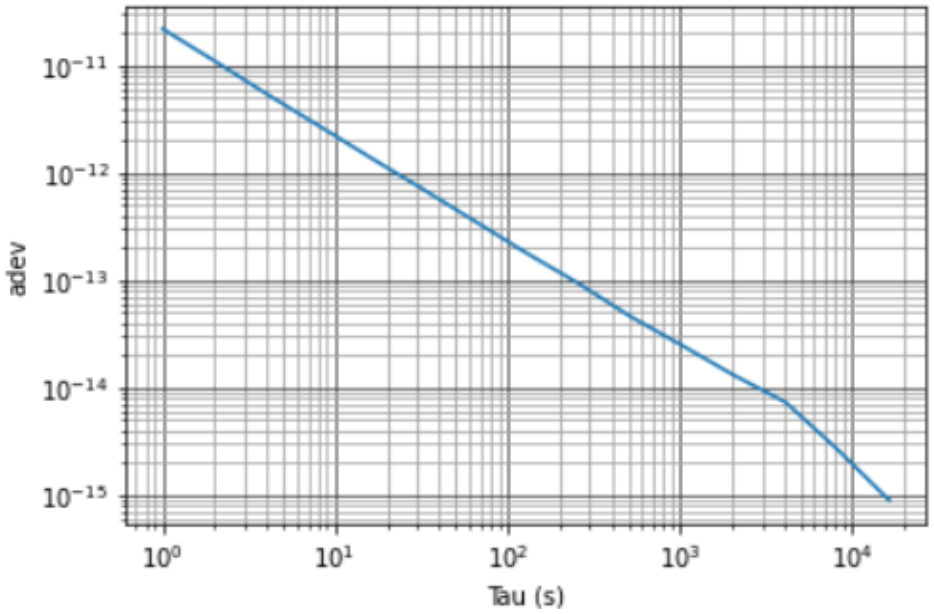
Test ID	Test name	Duration	Measure	Metrics	Objective	Site	Results summary
T1	System verification	<2h	-	Fail/pass	Setup the DUTs and verify correct and normal operation the White Rabbit network	JRC	System was properly verified by Seven Solutions team by accesing the equipment remotely.
T2M	Short term sync stability vs clock reference	24h	1PPS	TE, ADEV, MTIE	Showing short-term timing distribution performance tracking the reference of a clock provided by 7S	JRC	The tests results show sub-ns accuracy time transfer in 2hops with 50km end to end link length: - peak-to-peak time error<90ps - jitter <17ps - ADEV: 2e-11@1s, 2e-12@10s, 2e-13@100s, 2e-14@1000s, 1e-15@10000 - MTIE: 7,8e-11@1s, 1,02e-10@10s, 1,17e-10@100s, 1,17e-10@1000s, 1,41e-10@10000
T2N	Short term sync stability in HO vs UTC reference	24h	1PPS	TE vs UTC ref.	Showing short-term timing distribution performance in Holdover mode based on UTC reference	JRC	The test results shown a holdover performance lower than 1.5us/24h after 24h of learning time locked to a GNSS. * due to reasons pending to investigate, the performance measured in JRC was worse than in 7Sols installations using same equipment.
T3	Medium term time stability	>30 days	1PPS	TE vs UTC ref.	Showing medium-term time transfer performance based on UTC reference	7S	The test results shown a time error below 280ns after 80 days of operation of a maser time reference working in free running mode.
T4M	Network monitoring	<2h	descriptive	descriptive	Showing monitoring capabilities of the 7Sols WR system	JRC	The demo was succesfully completed by showing the monitoring and management capabilities of the solution, based on both the web interface and the centralized monitoring system installed on JRC management PC.
T4N	Failover scenario A	<2h	descriptive	descriptive	Showing resiliency capabilities of the 7Sols WR system for failover scenario A: loss of GNSS reference	JRC	The automatic failover was succesfully completed showing a maximum time error during the switching lower than 25ns on each iteration, for both stratum 2 and 3 devices.
T4O	Failover scenario B	<2h	descriptive	descriptive	Showing resiliency capabilities of the 7Sols WR system for failover scenario B: failure in optical fiber link	JRC	The automatic failover was succesfully completed showing a maximum time error during the switching lower than 25ns on each iteration, for both stratum 2 and 3 devices.
T4P	Failover scenario C	<4h	descriptive	descriptive	Showing resiliency capabilities of the 7Sols WR system for failover scenario C: slow frequency drift	7S	The automatic failover was succesfully completed after detection of a faulty time source due to a frequency drift (>100ns) using a voting system based on 3 independent time sources.
T4Q	Interoperability	<2h	descriptive	descriptive	Showing interoperability with other timing protocols capabilities of the	JRC	The inteoperability of the devices was demostrated by showing the correct PTP G.8275.1 synchronization between 7Sols devices and a Meinberg

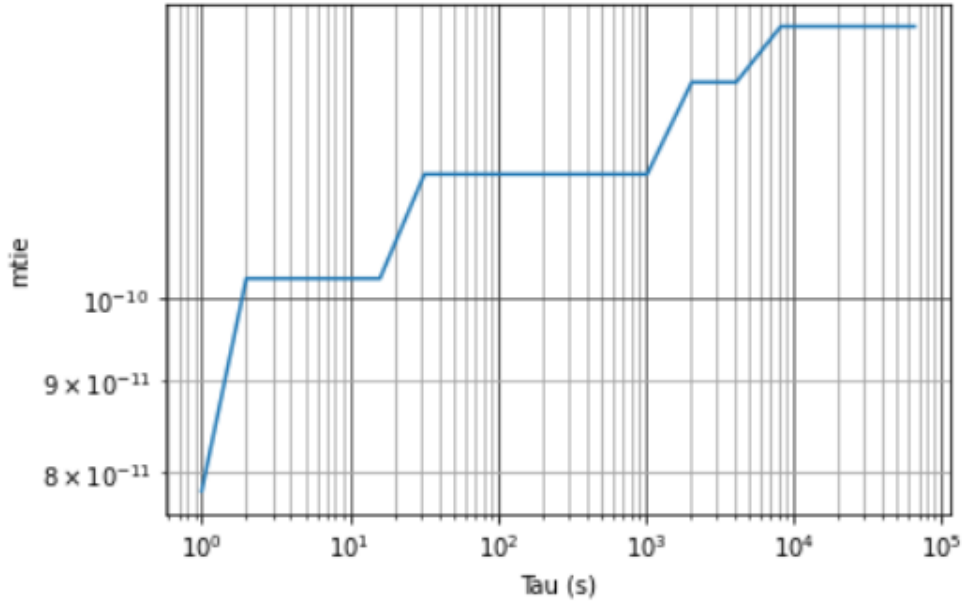
Q&A

TEST RESULTS: SHORT TERM TIME STABILITY

Accuracy (average)	**73.25 ps**
Jitter (standard deviation)	16.12 ps
Peak to peak error	89.39 ps







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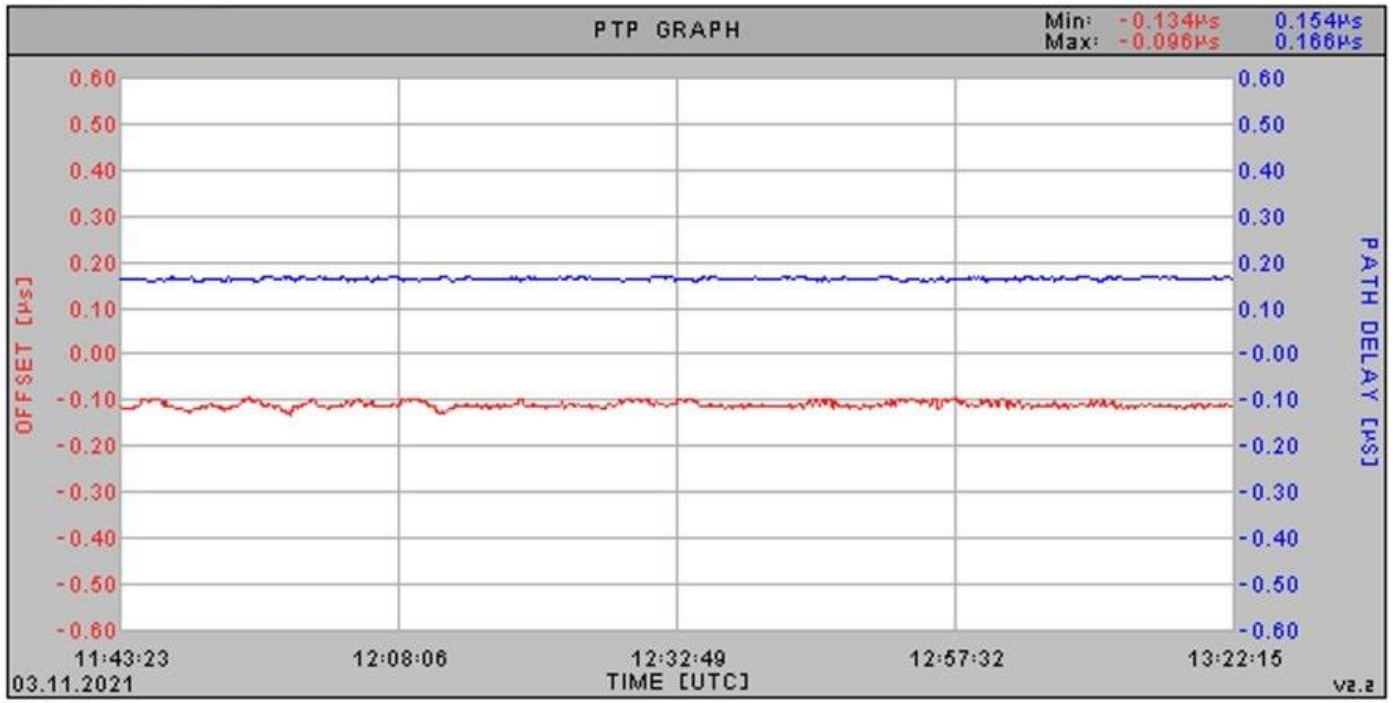
TEST RESULTS: INTEROPERABILITY

PTP V2 Statistics

Statistics



INTRO TESTS

Goals

Demonstrate technology capabilities regarding:

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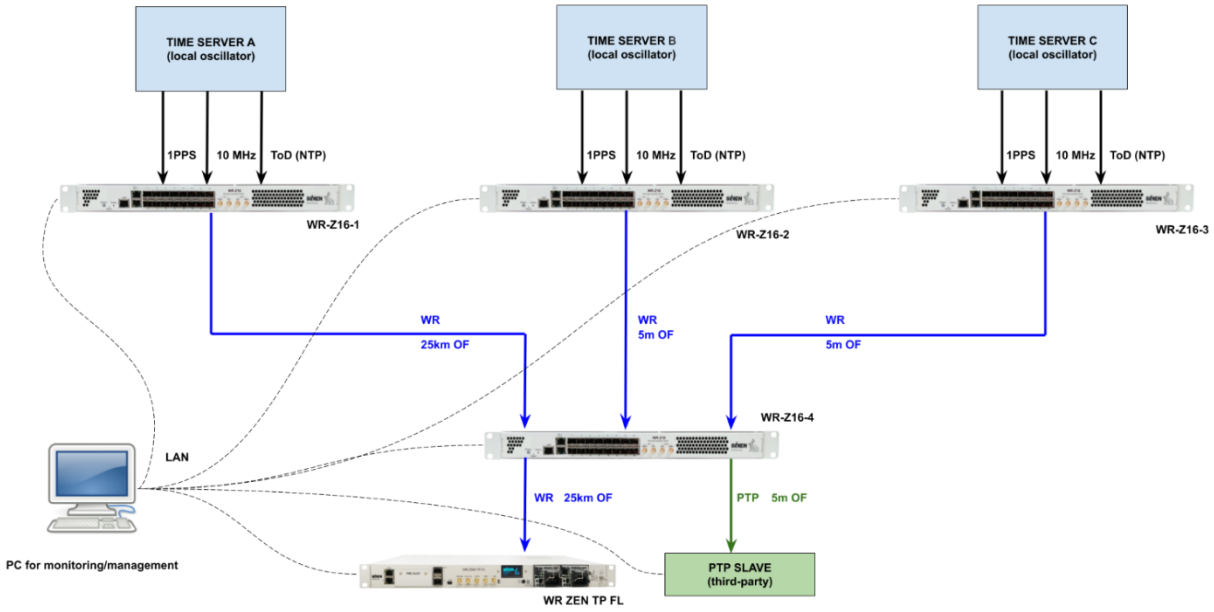

Test ID	Test name	Duration	Measurements	Metrics	Objective	Location
T1	System verification	<2h (estimated)	-	Fail/pass	Setup the DUTs and verify correct operation	JRC
T2M	Short term sync stability vs clock reference	24h	1PPS, 10MHz	TE, ADEV, MTIE vs clock ref.	Showing short-term time and frequency distribution performance tracking the reference of a clock provided by 7S	JRC
T2N (optional)	Short term sync stability in HO vs UTC reference	24h	1PPS, 10 MHz	TE vs UTC ref.	Showing short-term frequency distribution performance in Holdover based on UTC reference	JRC
T3	Medium term time stability	14 days	1PPS	TE, ADEV, MTIE vs UTC ref.	Showing medium-term time transfer performance based on UTC reference	7S
T4M	Network monitoring	<2h (estimated)	descriptive	descriptive	Showing monitoring capabilities of the solution	JRC
T4N	Failover scenario A	<2h (estimated)	descriptive	descriptive	Showing resiliency capabilities of the solution for failover scenario A: loss of GNSS reference	JRC
T4O	Failover scenario B	<2h (estimated)	descriptive	descriptive	Showing resiliency capabilities of the solution for failover scenario B: failure in optical fiber link	JRC
T4P	Failover scenario C	<4h (estimated)	descriptive	descriptive	Showing resiliency capabilities of the solution for failover scenario C: slow frequency drift	7S
T4Q	Interoperability	<2h (estimated)	descriptive	descriptive	Showing interoperability with other timing protocols capabilities of the solution	JRC