

# Ultra-Accurate Timing in the Visibility Network at Datacenters



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- Visibility network
  - Monitorize your network status.
  - Evaluate the network performance.
  - Performance log.
  - Improve the network design.
  - Deutsche Börse use case: better analyzing their trading activity, latencies and algorithms performance. Important because of transparency purposes and enhanced infrastructure.





## White Rabbit technology

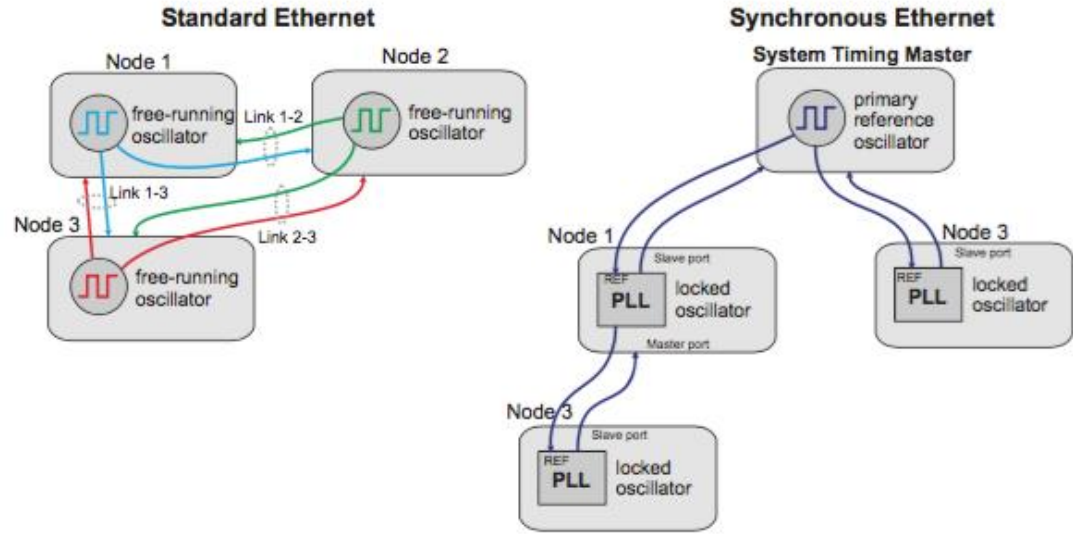
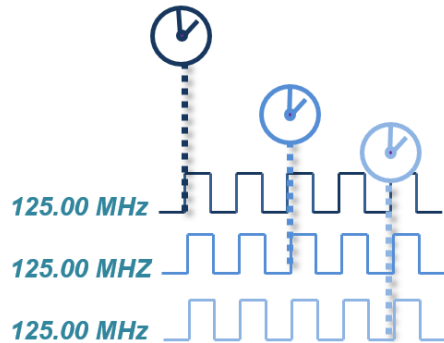
**White Rabbit (WR)** is a technology born at CERN which achieves sub-nanosecond accuracy in Ethernet based networks. It allows easy deployments of scalable and reliable networks with high accuracy synchronization requirements.

- 10 years of expertise synchronizing large scientific facilities with WR:
  - CERN, GSI, Fermilab, ...



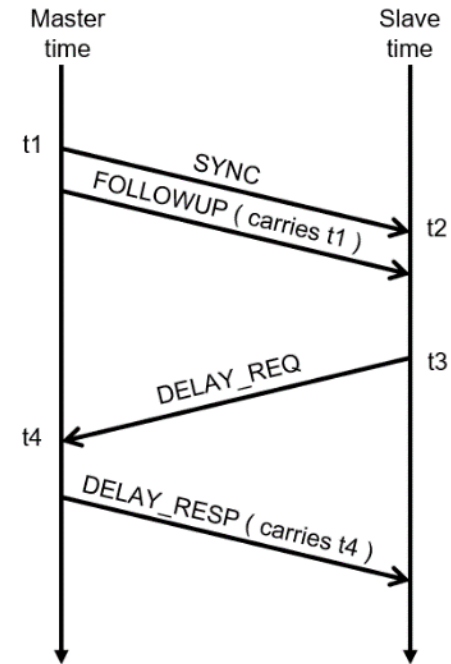
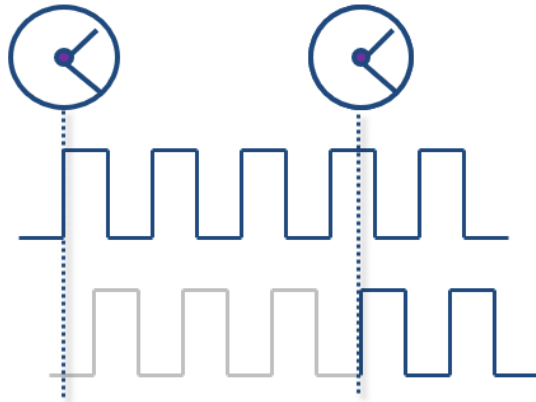
- Validated by National Metrology Institutes: NIST, NPL, PTB, OP, VSL, ROA, VTT, RISE, ...
- New PTP High Accuracy profile to be released early 2019 will be intensively based on the pre-standard approach White Rabbit.
- More than 7 years of expertise on the White Rabbit technology. Main White Rabbit technology developers. Original WRS hardware designers.

- Based on optical Gigabit Ethernet networks
  - Network syntonization
    - Synchronous Ethernet

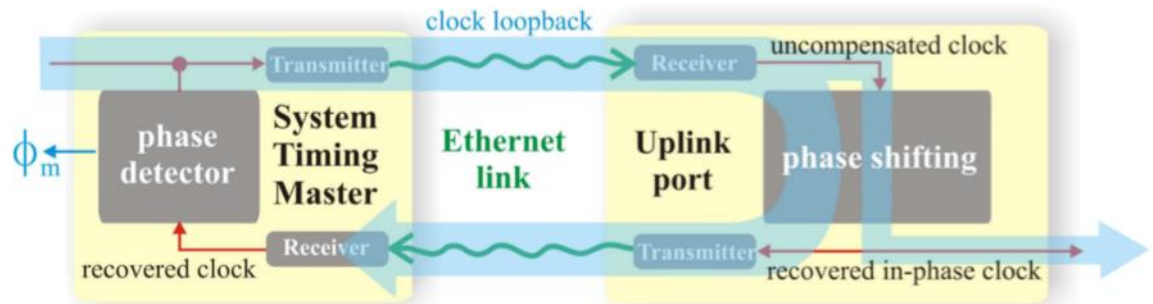


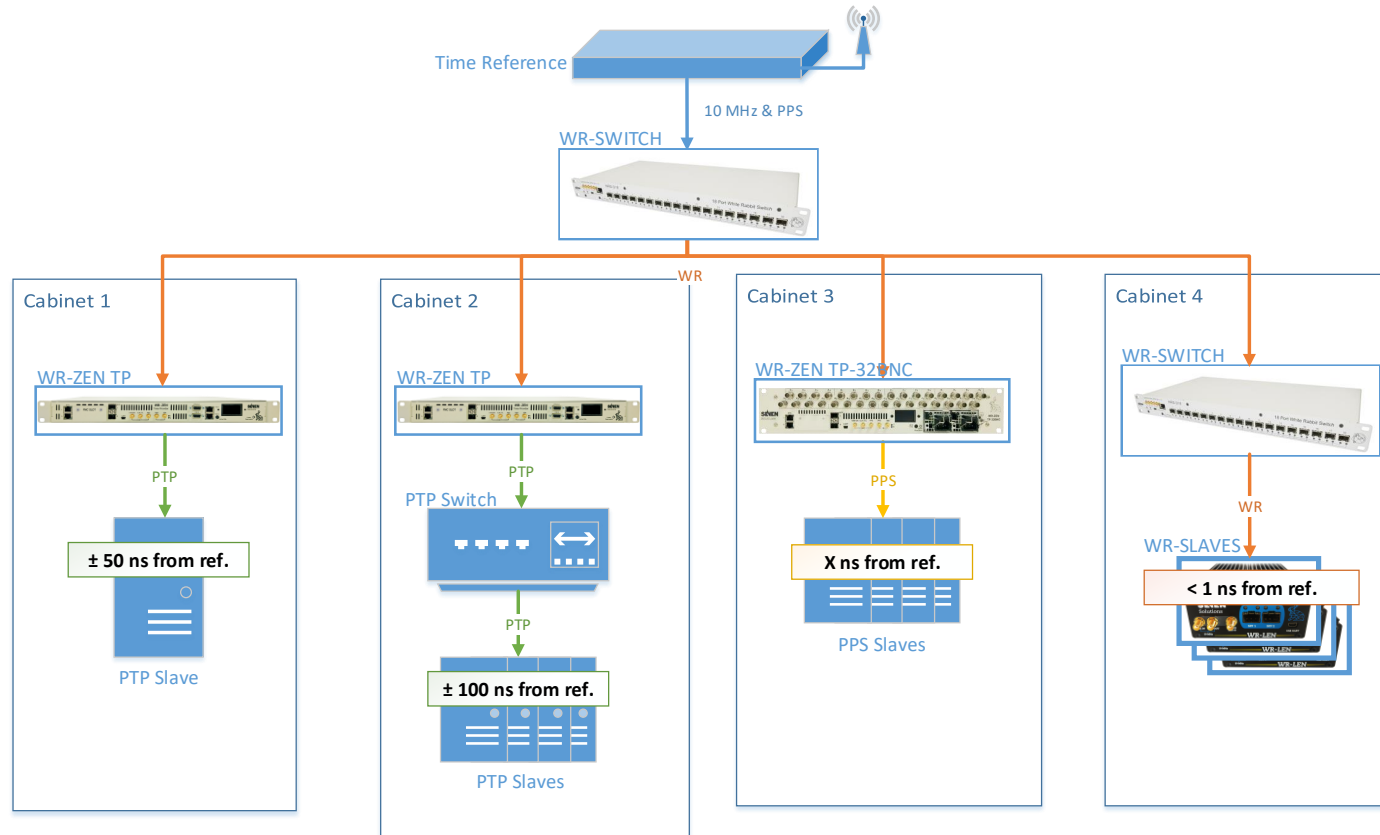


- Based on optical Gigabit Ethernet networks
  - Network synchronization
    - Precision Time Protocol (IEEE 1588v2)



- Based on optical Gigabit Ethernet networks
  - Additional mechanisms
    - Digital Dual-Mixer Time Difference
    - Hardware timestamps
    - Dynamic link asymmetry compensation
    - Pre-calibration



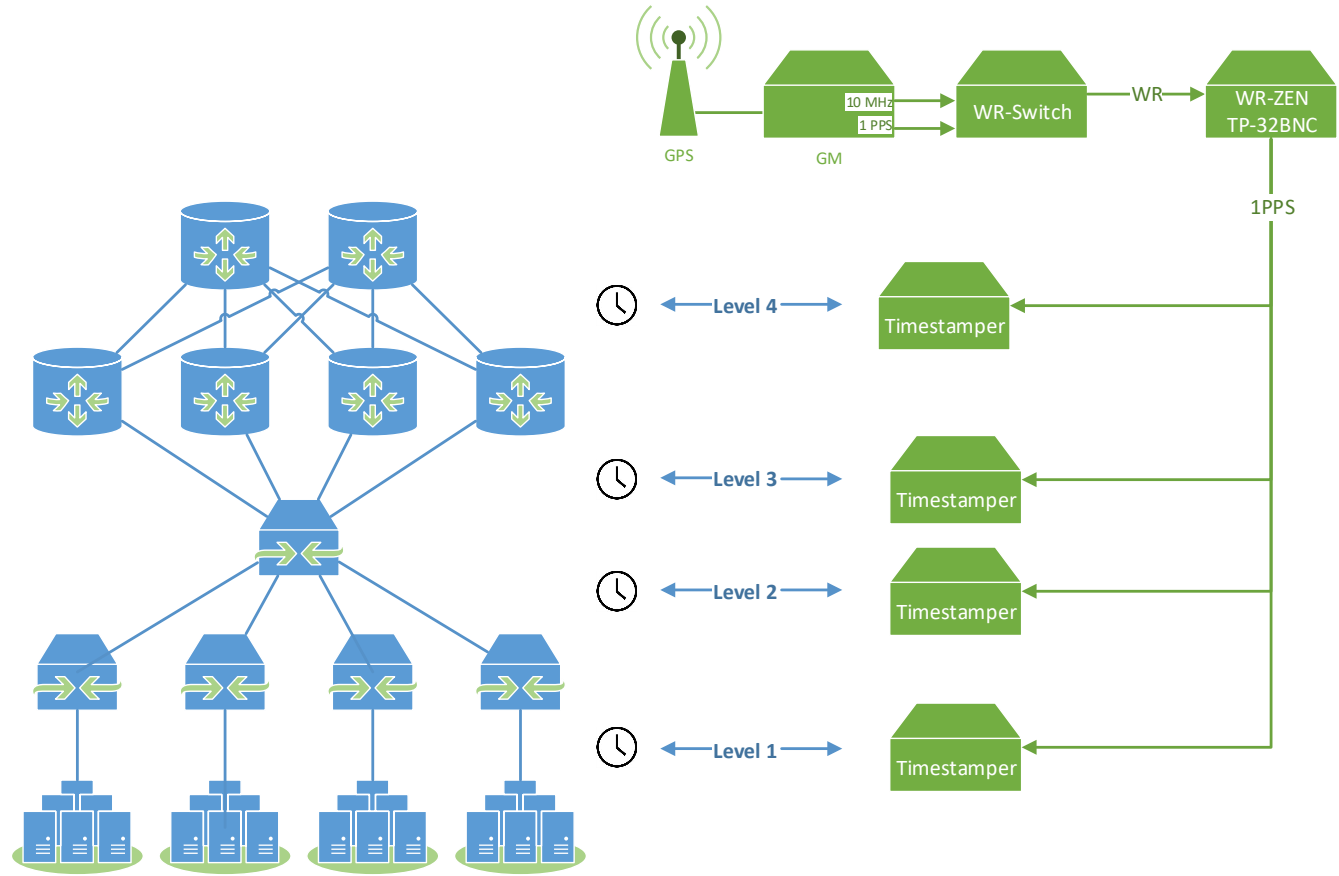




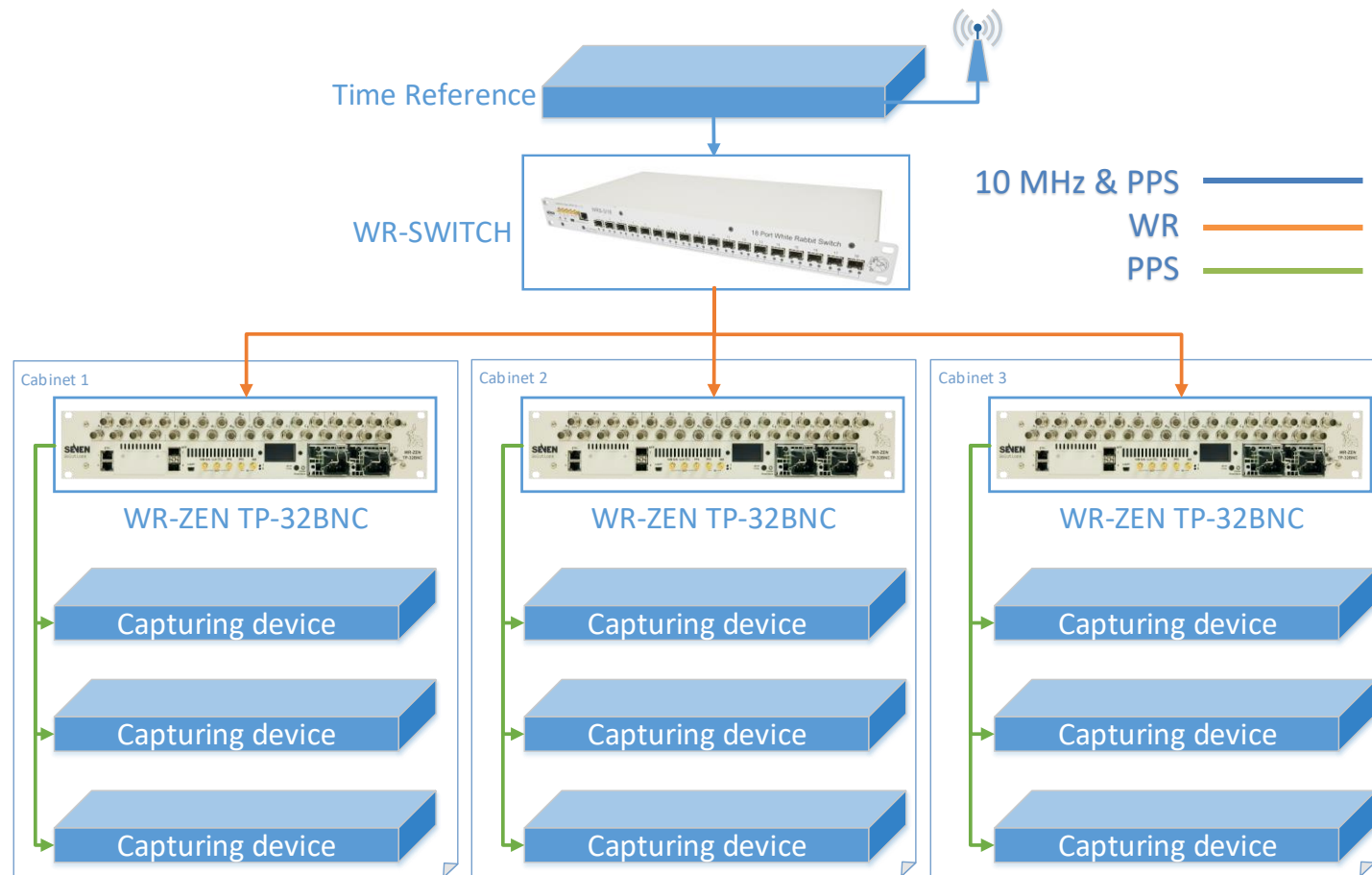
- Sub-nanosecond distribution to each cabinet
- Expend  $< 1\text{ns}$  of time error budget to each cabinet
- Choice of interoperability for last hop:
  - 1 last PTP hop ( $\pm 50\text{ ns}$  from the reference)
  - 2 last PTP hops ( $\pm 100\text{ ns}$  from the reference)
  - 1 PPS hop (sync accuracy depending on clock performance of the slave)
  - WR until the end node ( $< 1\text{ns}$  from the reference)

- WR to PTP and PTP to WR conversion
- PTP supported profiles:
  - IEEE 1588-2008
  - ITU G.8265.1 Telecom profile
  - ITU G.8275.1 Telecom profile
  - IEEE C37.238 Power profile
  - More to come...

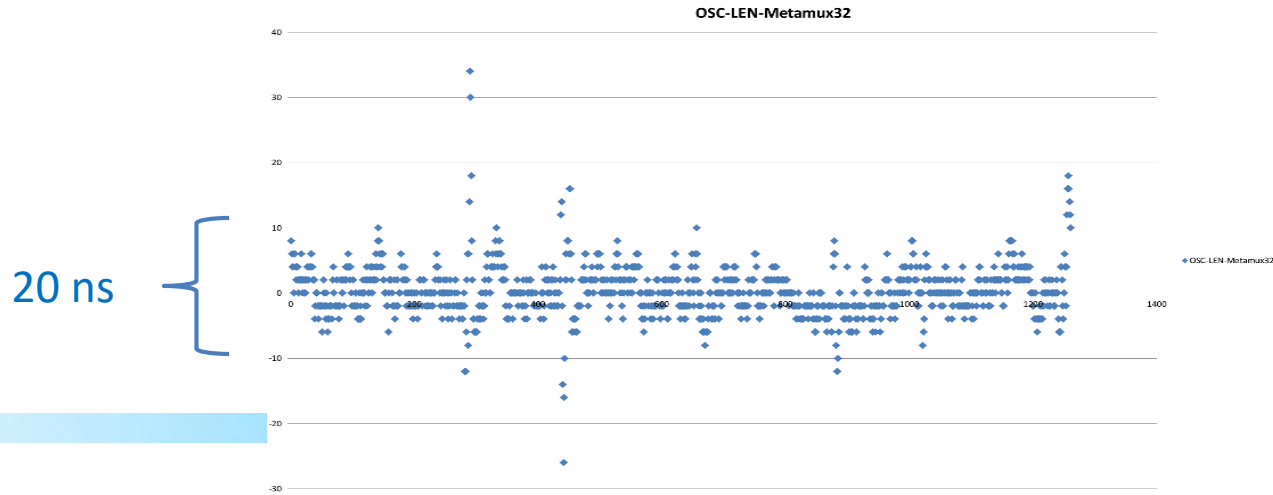
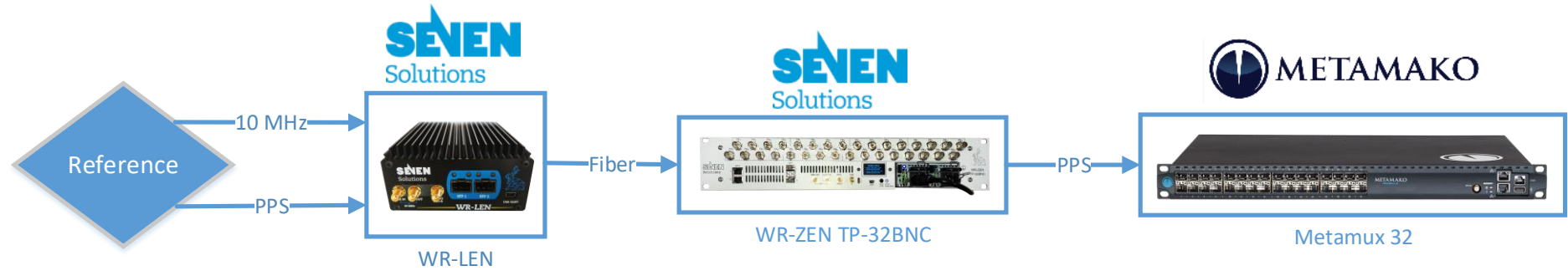
- Deutsche Börse has studied and integrated WR technology using Seven Solutions' products to synchronize their packet capture and timestamping devices across the entire datacenter with unprecedented precision.
- Tap every link
- Timestamp every packet
- A detailed live map of the network can be obtained for analysis
- Validated in the finance sector by the German stock exchange (Deutsche Börse).



- Multi-cabinet time transfer expander
- Deliver accurate and precise PPS to every capturing device
- All capturing devices synchronized

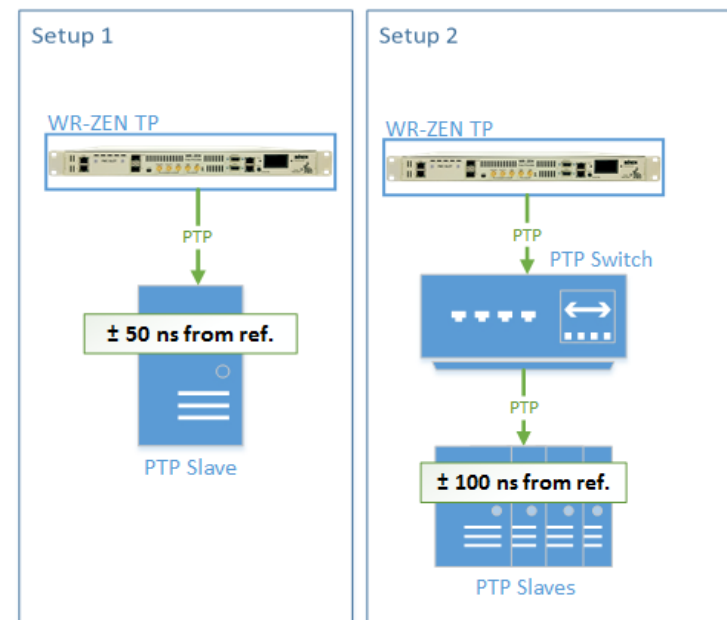


- MetaMako test (PPS connection)

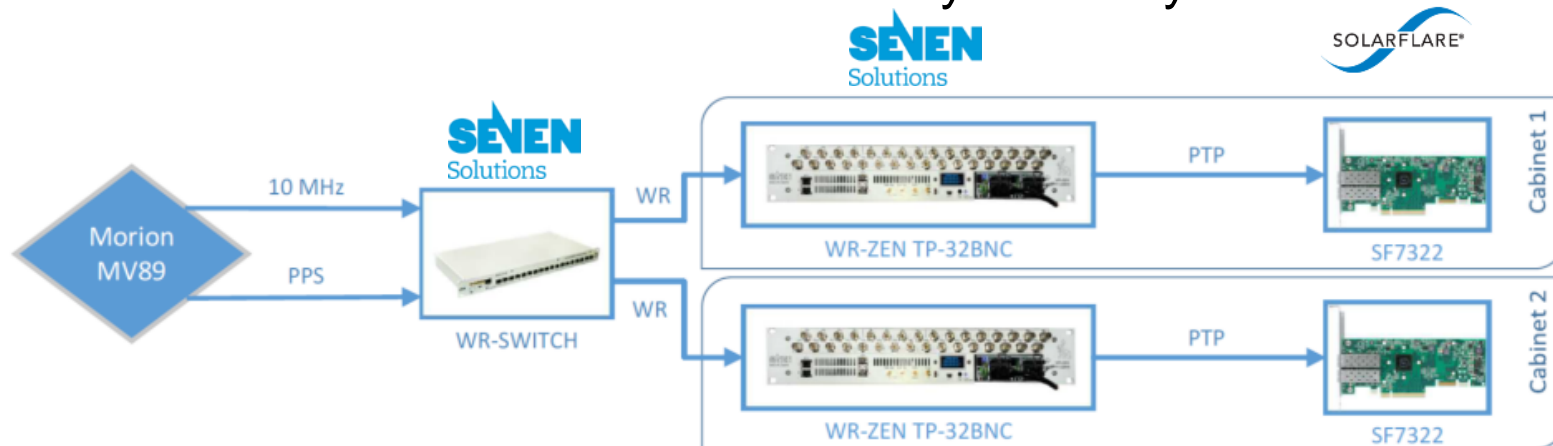




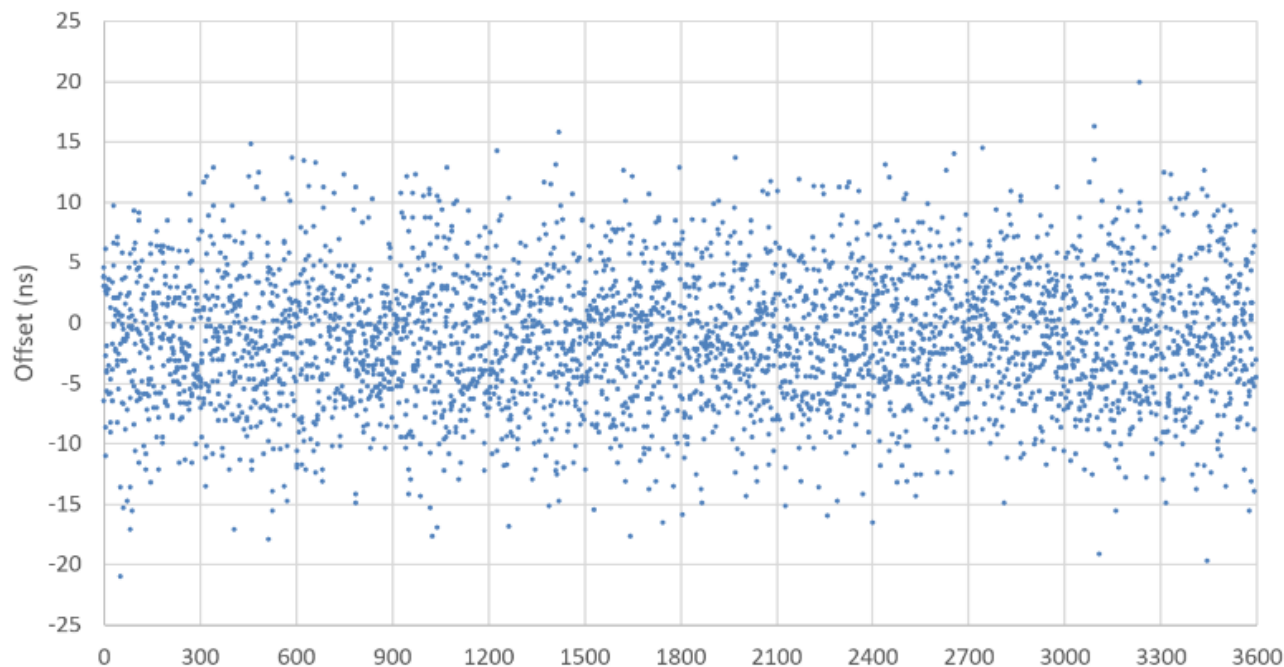
- Intra-datacenter time distribution
  - PTP interoperability using WR-ZEN TP devices.
  - Setup 1: Direct connection to PTP Slave ( $\pm 50$  ns accuracy).
  - Setup 2: Multiple PTP slave connection using a PTP switch ( $\pm 100$  ns accuracy).
  - Tested devices: Solarflare, Metamako, Oregano, Endace, Napatech.



- Tests in our lab:
  - PPS offset between SolarFlare 7322 devices has been monitored during 15 hours
  - No calibration on the PTP link
  - WR links are self-calibrated dynamically

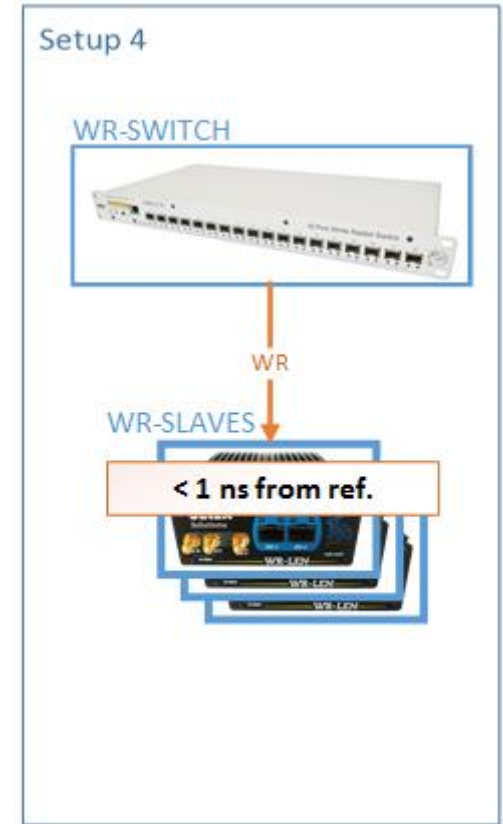


PPS Offset between SolarFlare devices

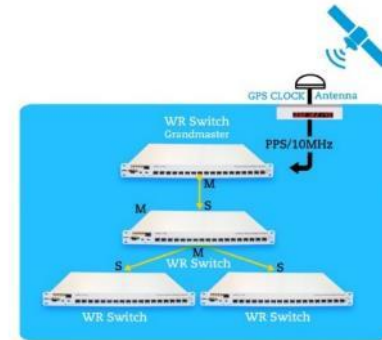


| Measure            | Value     |
|--------------------|-----------|
| Max                | 19,80 ns  |
| Min                | -25,14 ns |
| Peak to peak       | 44,94 ns  |
| Standard deviation | 5,39 ns   |

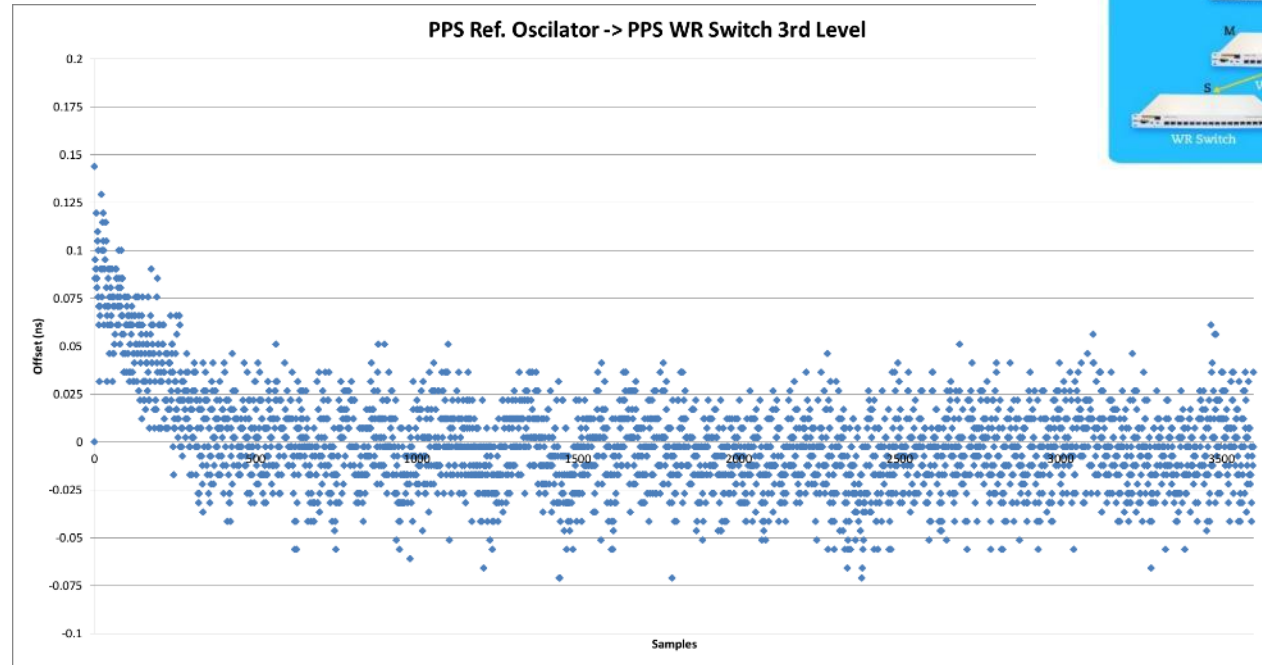
- Intra-datacenter time distribution
  - WR-PTP time distribution
  - Setup 4: Up to 16 WR compliant slaves connection.
  - Sub-nanosecond accuracy over tens of daisy-chained slaves.
  - Mandatory WR compliant slave devices.



- White Rabbit switch tests



200 ps







**When every nanosecond counts**