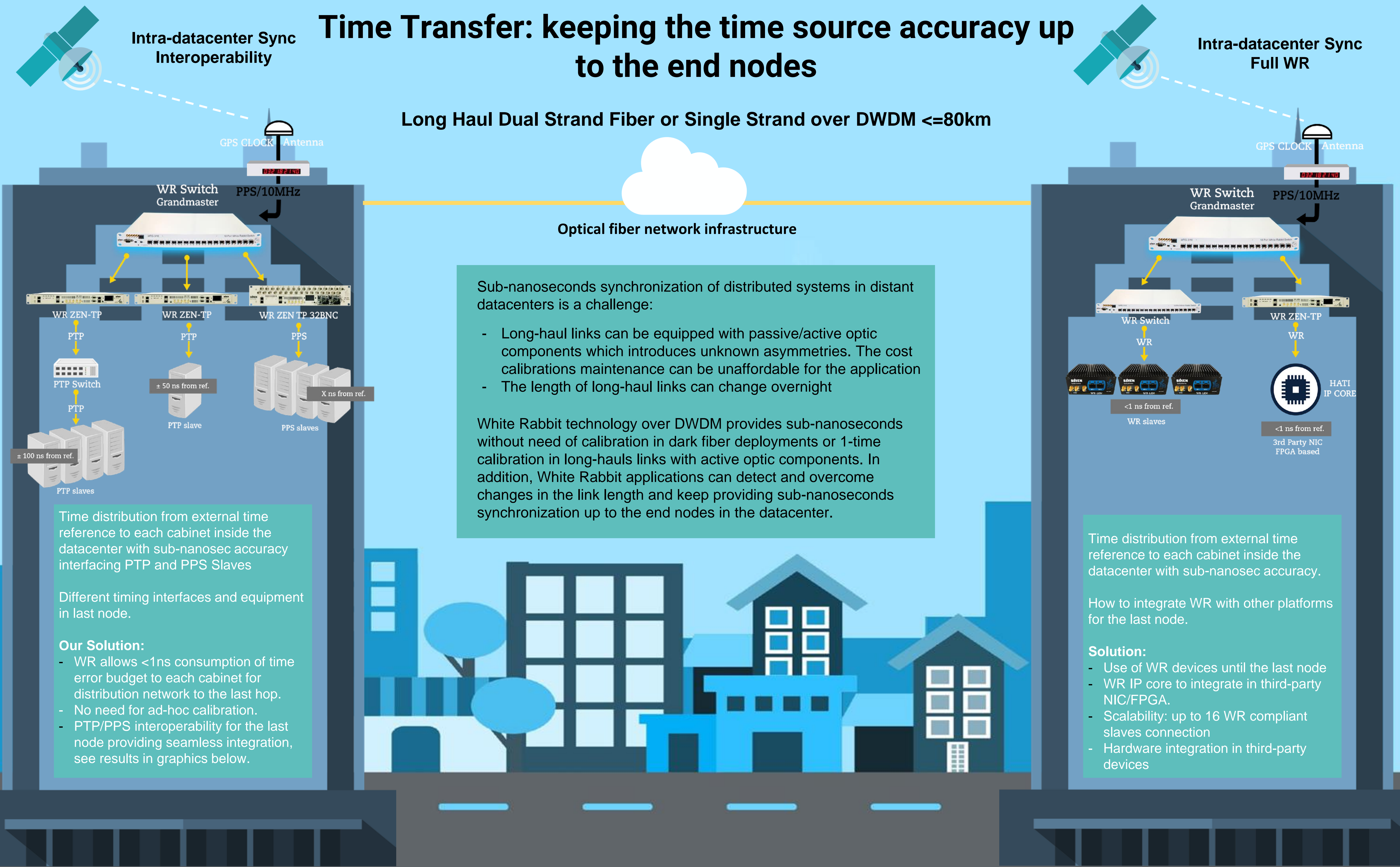


# Time Transfer: keeping the time source accuracy up to the end nodes



Long Haul Dual Strand Fiber or Single Strand over DWDM <=80km

Optical fiber network infrastructure

Sub-nanoseconds synchronization of distributed systems in distant datacenters is a challenge:

- Long-haul links can be equipped with passive/active optic components which introduces unknown asymmetries. The cost calibrations maintenance can be unaffordable for the application
- The length of long-haul links can change overnight

White Rabbit technology over DWDM provides sub-nanoseconds without need of calibration in dark fiber deployments or 1-time calibration in long-hauls links with active optic components. In addition, White Rabbit applications can detect and overcome changes in the link length and keep providing sub-nanoseconds synchronization up to the end nodes in the datacenter.

Time distribution from external time reference to each cabinet inside the datacenter with sub-nanosec accuracy interfacing PTP and PPS Slaves

Different timing interfaces and equipment in last node.

**Our Solution:**

- WR allows <1ns consumption of time error budget to each cabinet for distribution network to the last hop.
- No need for ad-hoc calibration.
- PTP/PPS interoperability for the last node providing seamless integration, see results in graphics below.

Time distribution from external time reference to each cabinet inside the datacenter with sub-nanosec accuracy.

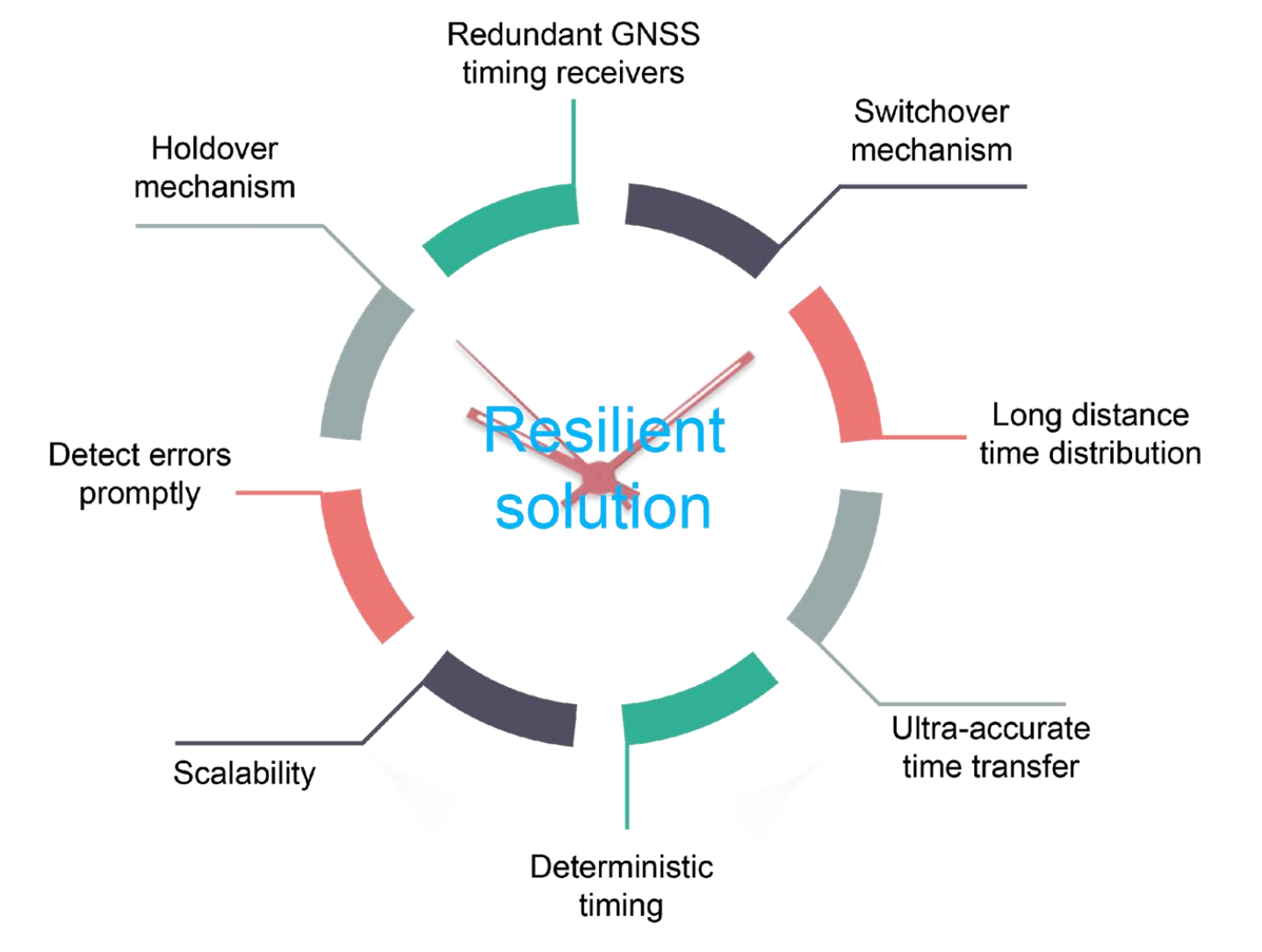
How to integrate WR with other platforms for the last node.

**Solution:**

- Use of WR devices until the last node
- WR IP core to integrate in third-party NIC/FPGA.
- Scalability: up to 16 WR compliant slaves connection
- Hardware integration in third-party devices

## White Rabbit Platforms

- Sub-nanosecond deterministic time
- Up to thousands of nodes
- Link length up to 80 km
- PTPv2, NTP, Sync-E
- Holdover systems (1.5us/day)
- Network Robustness & Link Redundancy
- 1-time calibration and/or dynamic calibration

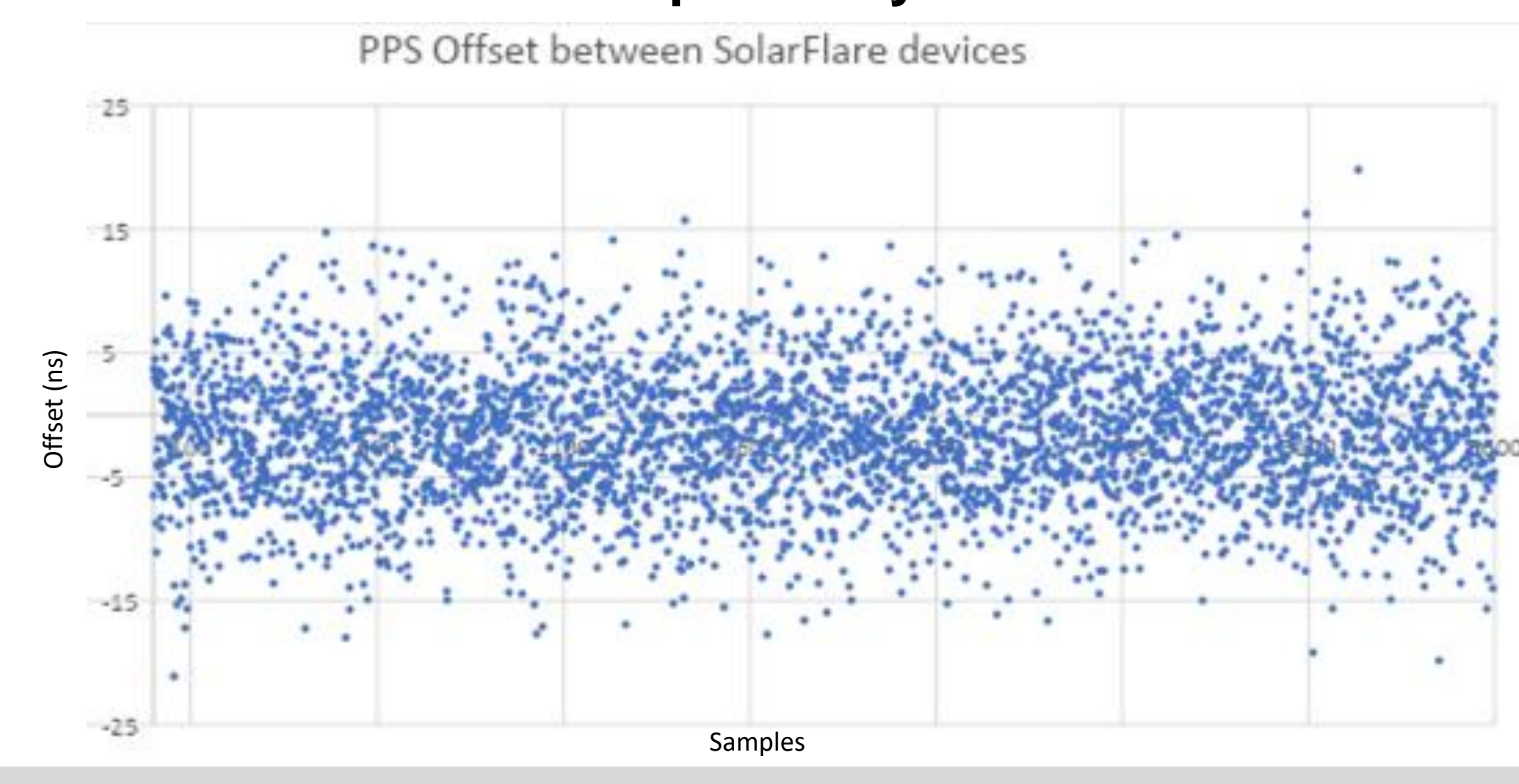


## JAMMING AND SPOOFING PROTECTION

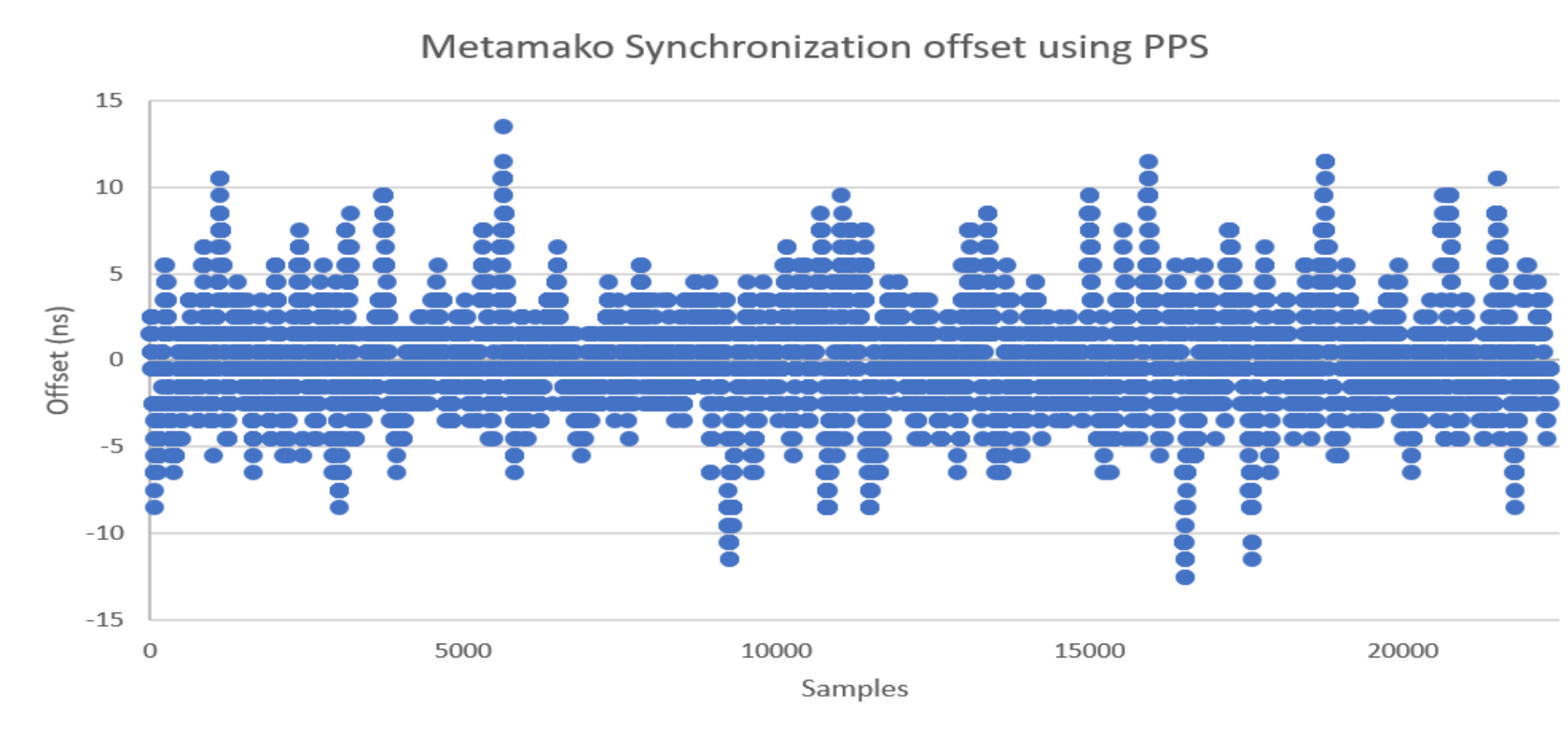
A single local GNSS antenna represents an important risk. Jamming and spoofing on it can cause significant disruption and a safety threat:

- White Rabbit can be used to diversify the time reception.
- Deploy two or more GNSS antennas and interconnect them through a WR link with sub-nanosecond accuracy.
- Jamming/spoofing a two antennas in different locations is much harder.
- Possibility to connect to a National Metrology Institute for UTC reference alternatively to GNSS.

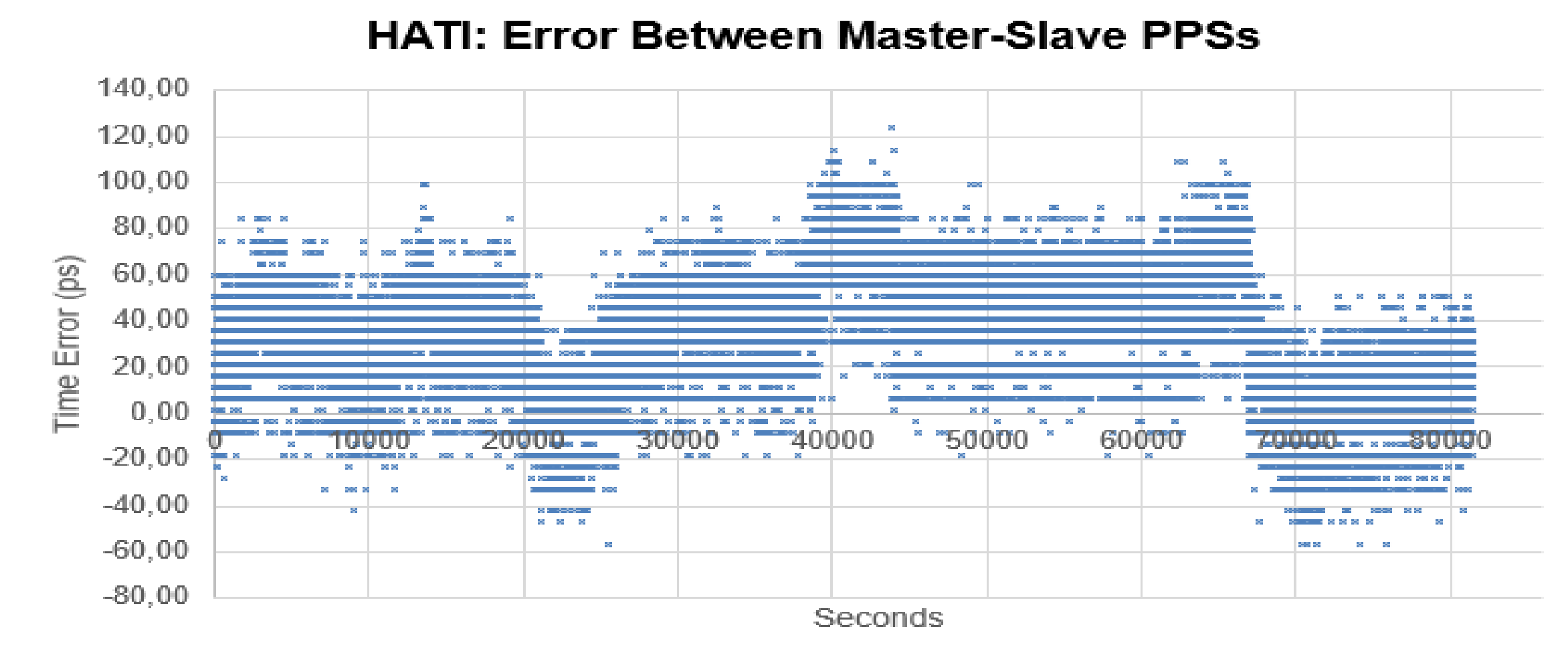
### PTP interoperability test:



### PPS interoperability test



### VHDL IP Core HATI



- Direct connection to PTP Slave (± 50 ns accuracy) or multiple PTP slave
- 3rd Party PTP Devices: Solarflare, Metamako, Oregano, Endace, Napatech.

- Up to 32 PPS slaves connected with coaxial cables up to 10 meters
- 3rd Party PPS Devices: Solarflare, Metamako, Meinberg...

- WR-PTP time using FPGA (Xilinx) IP Core
- Enables 3rd NICs to be WR compliant Standard 1/10GbE
- Timestamp Tx and Rx packets within picoseconds resolution
- Tens of WRSlaves on 3rd party platforms synced in Sub-ns range