Bringing a global time reference to any time critical center through telecom optical fiber infrastructure

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Seven Solutions

About us

Seven Solutions S.L. is a privately held leading company in accurate sub-nanosecond time transfer and frequency distribution for reliable industrial and scientific applications. With more than ten years of expertise in different sectors such as avionics, telecommunications, Smart-Grid, space, military and scientific facilities as particle accelerators and radio-telescopes.

Seven Solutions has more than 7 years of expertise accurately synchronizing distributed instrumentation facilities and datacenters with White Rabbit approach.

Summary

- Introduction
- Evolution of PTP: High Accuracy Profile
- Time distribution in the datacenter
- Time distribution inter-datacenter
- Timing solutions
- Conclusion

Introduction
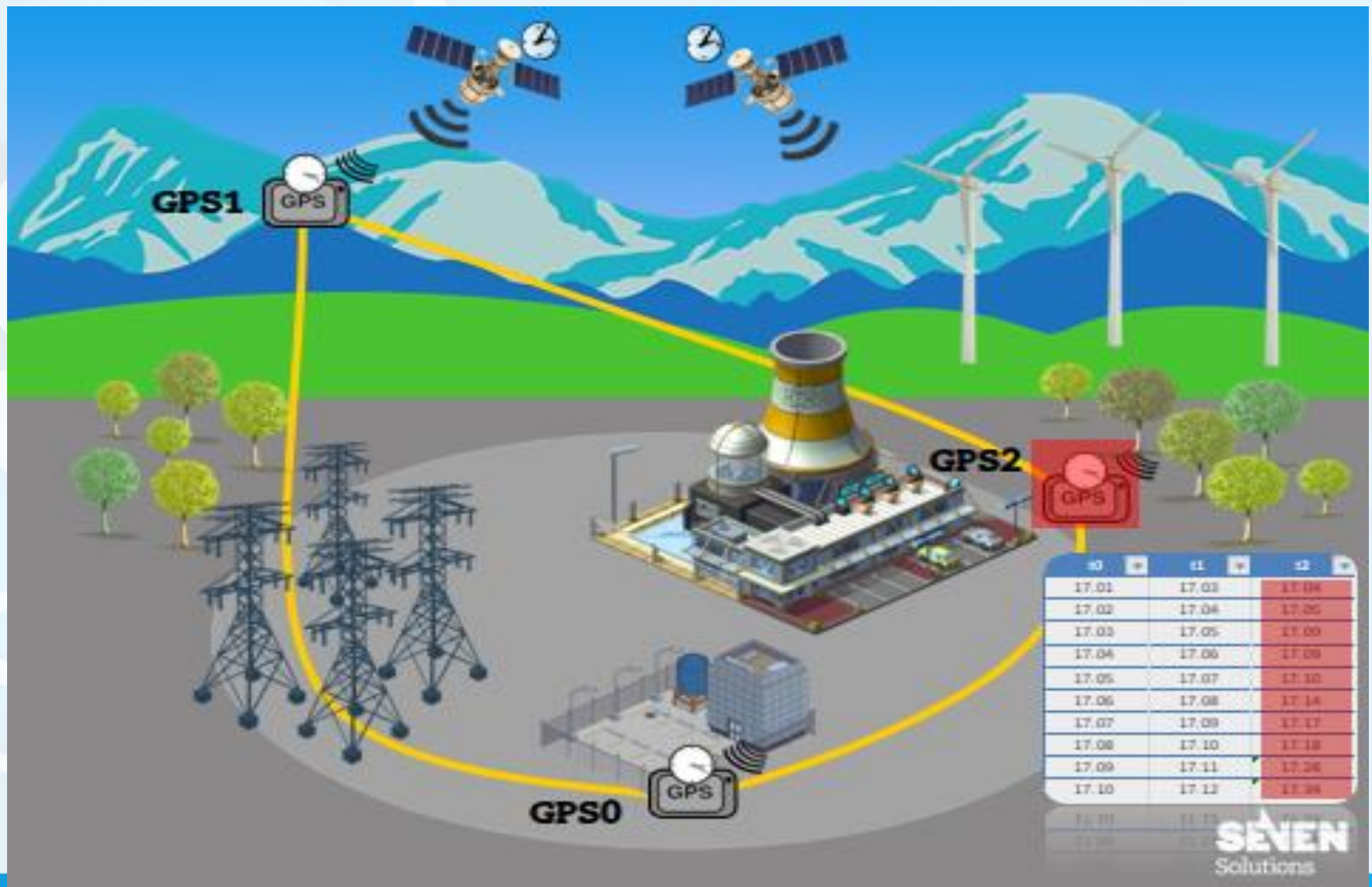
Introduction

Challenge and general approach:

- GNSS + PTP
- GNSS + Atomic clock + PTP (very rare)

Issues:

- Jamming/Spoofing
- Not scalable: It degrades significantly with distance and hops
- Difficult calibration
- High cost
- Etc...

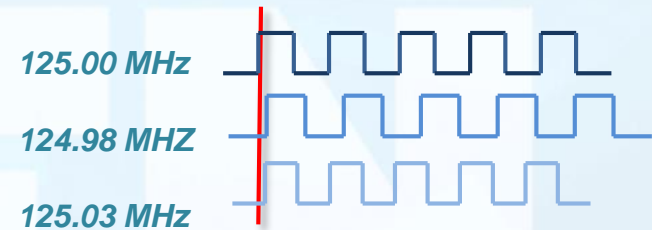# Evolution of PTP: High Accuracy Profile

An extension of Ethernet

- Synchronization: **Sync-E & PTP (IEEE-1588v2)**
- Accurate timestamps
- Accounts for asymmetries on the link
- Dynamic calibration
- Thousand of nodes
- Distance range over 80 km
- Robustness & redundancy
- Self-calibration over long distances

Evolution of PTP: High Accuracy Profile

How White Rabbit works
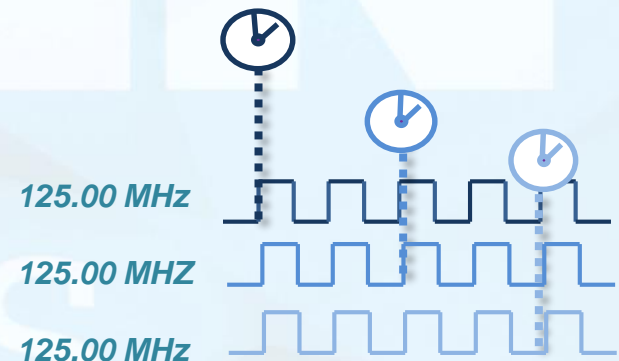
Synchronization: **Sync-E & PTP (IEEE-1588v2)**

Small differences in the node/switch individual clocks.

125.00 MHz

124.98 MHZ

125.03 MHz

Sync-E

Common notion of frequency!!

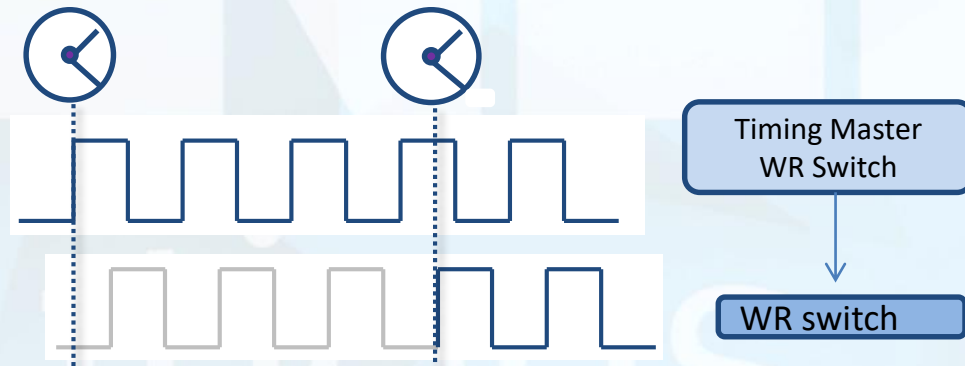Syntonization via SYNC-E

125.00 MHz

125.00 MHZ

125.00 MHz

Evolution of PTP: High Accuracy Profile

OFFSET ADJUSTEMENT WITH ENHANCED PTP

Synchronization: **Sync-E & PTP (IEEE-1588v2)**

Temperature and distance affect! → DDMTD


Timing Master WR Switch

WR switch

Capable of measuring time differences between two digital clock signals with very fine resolution (sub-picosecond).

Evolution of PTP: High Accuracy Profile

- Born at CERN as White Rabbit (WR) Protocol

- Same links for data and timing

- Sub-nanosecond accuracy synchronization

- Thoroughly tested: CERN, GSI, KM3NeT, … and also at different National Metrology Institutes.

- Ongoing process of standardization:
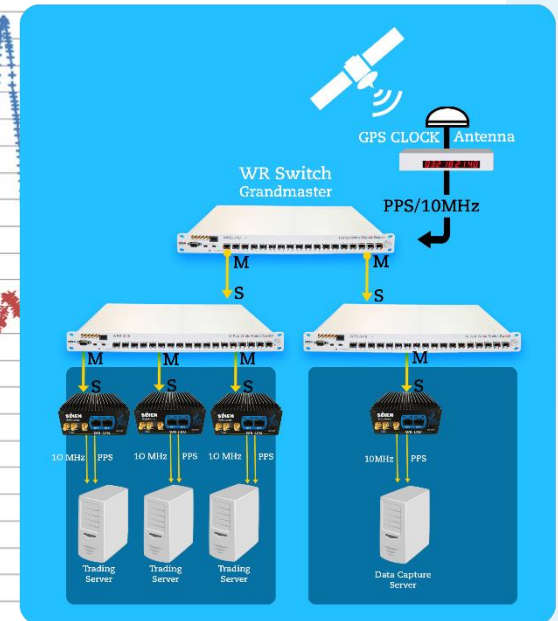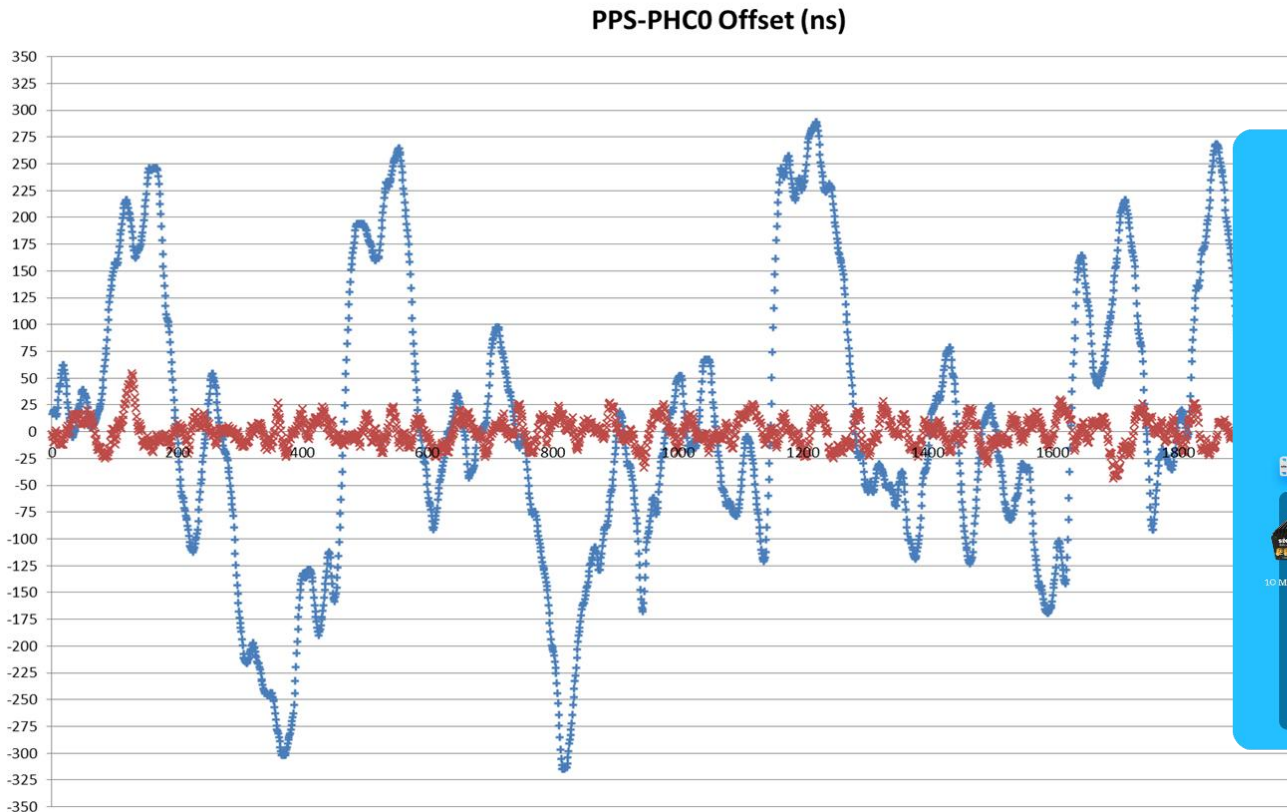 - High Accuracy profile of IEEE-1588v3

Time distribution in the datacenter
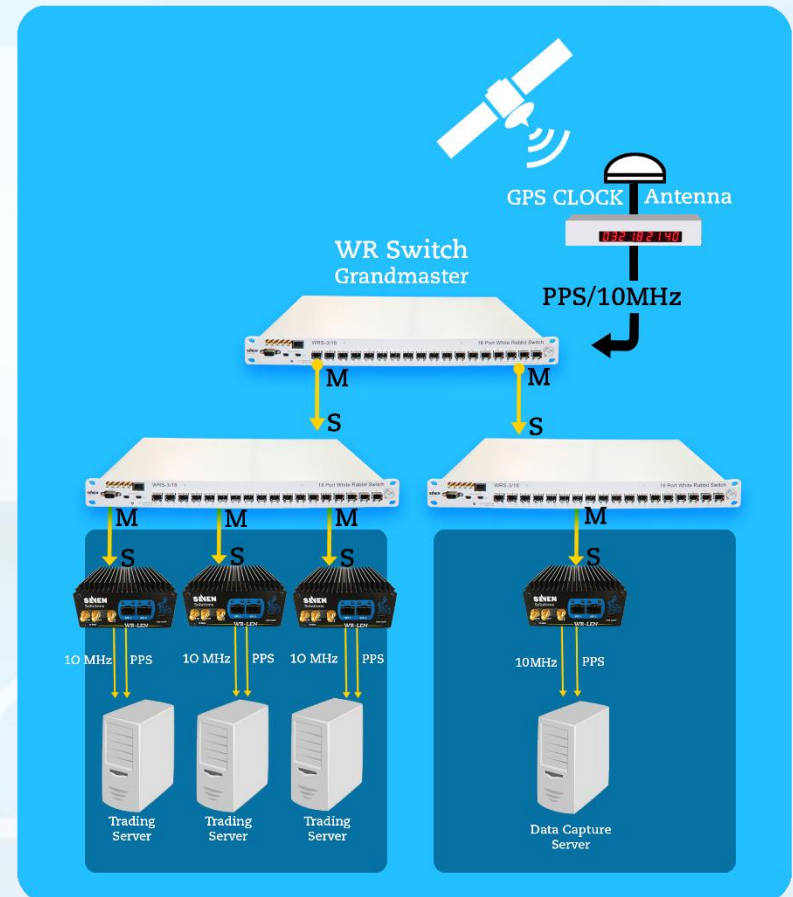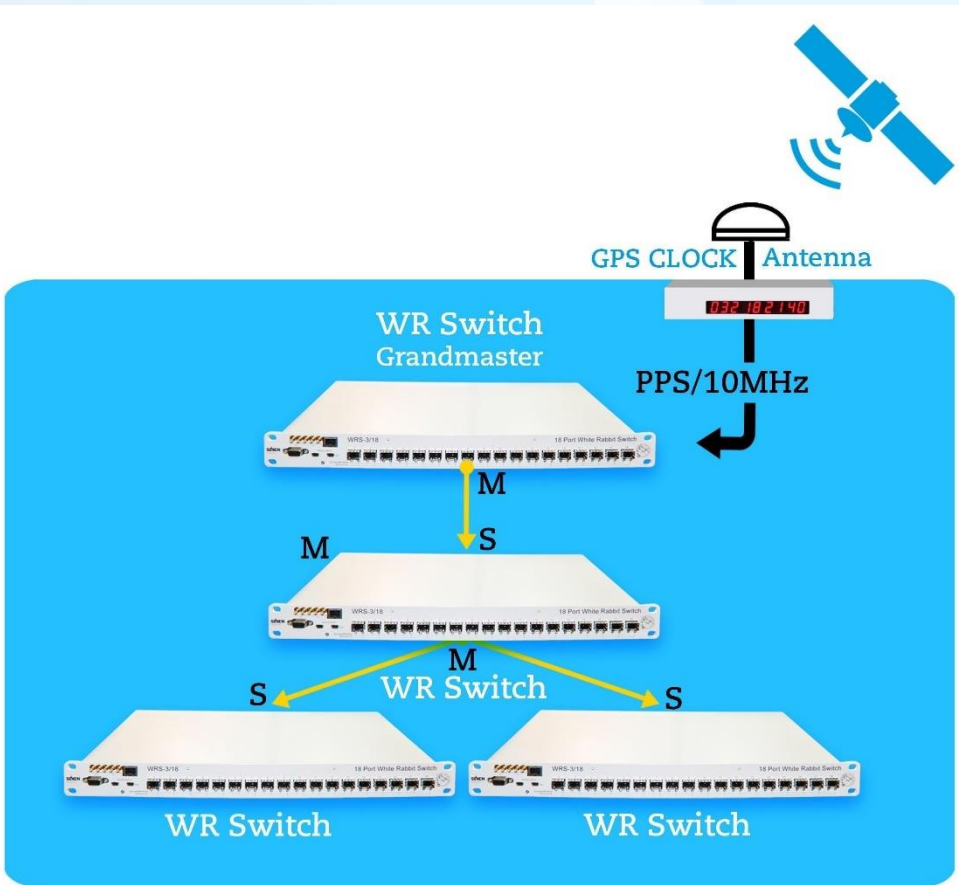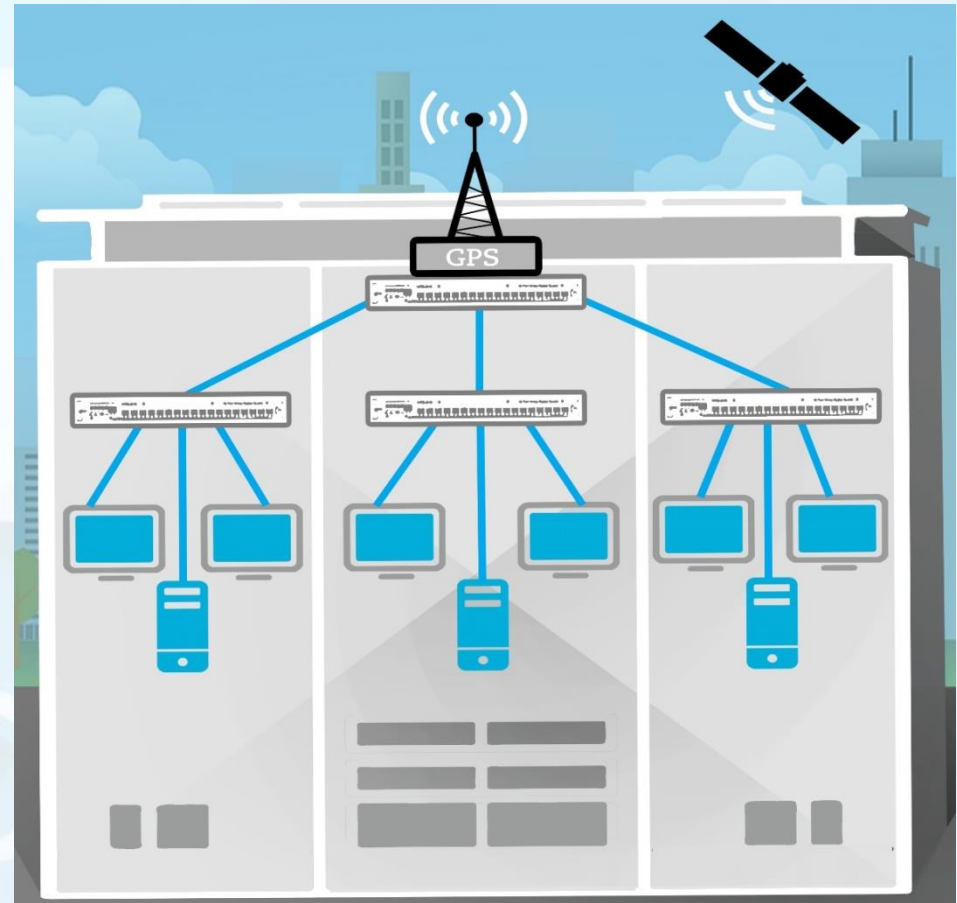
Time distribution in the datacenter

PPS Ref. Oscilator -> PPS WR Switch 3rd Level

Time distribution in the datacenter
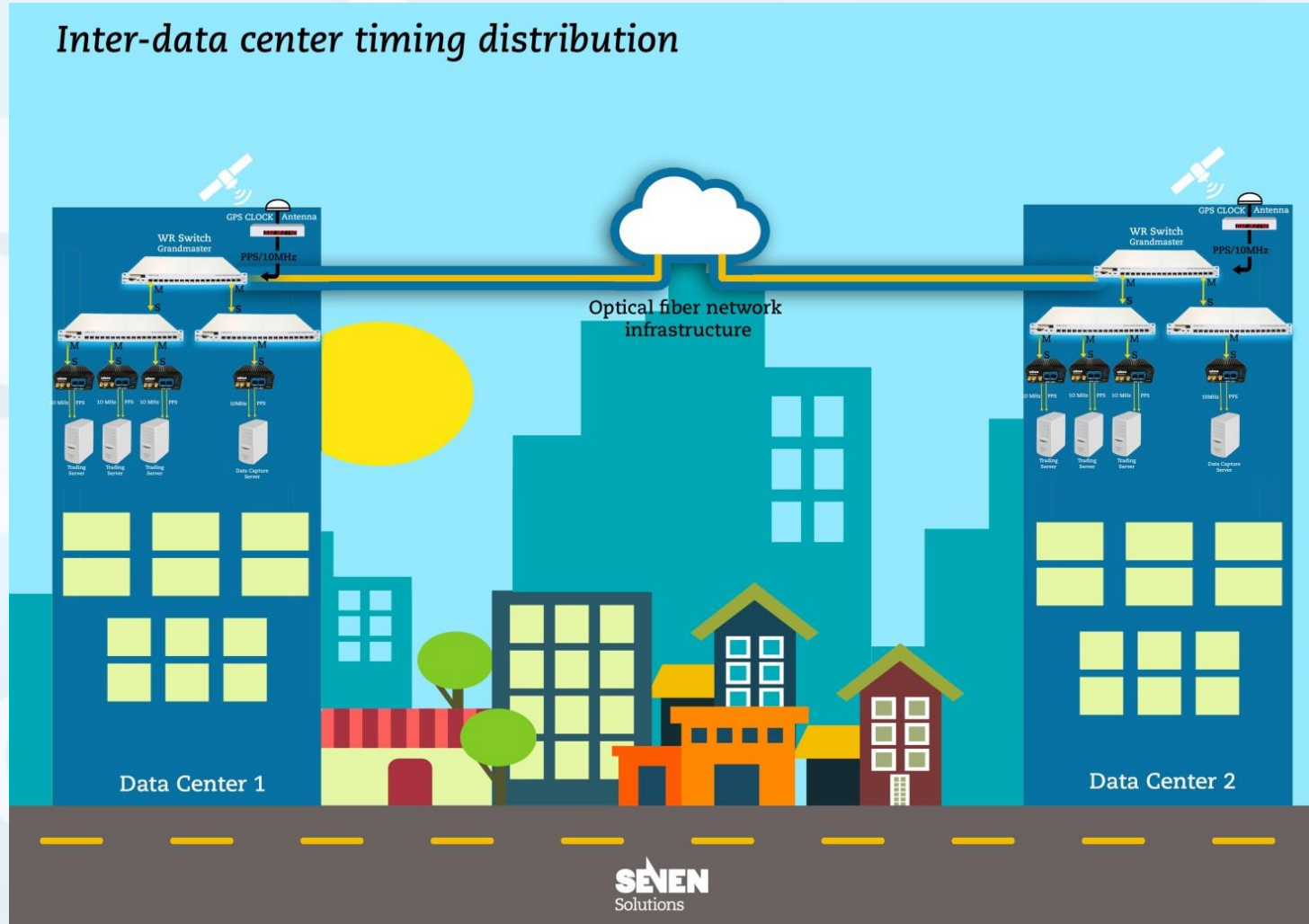

PPS-PHC0 Offset (ns)
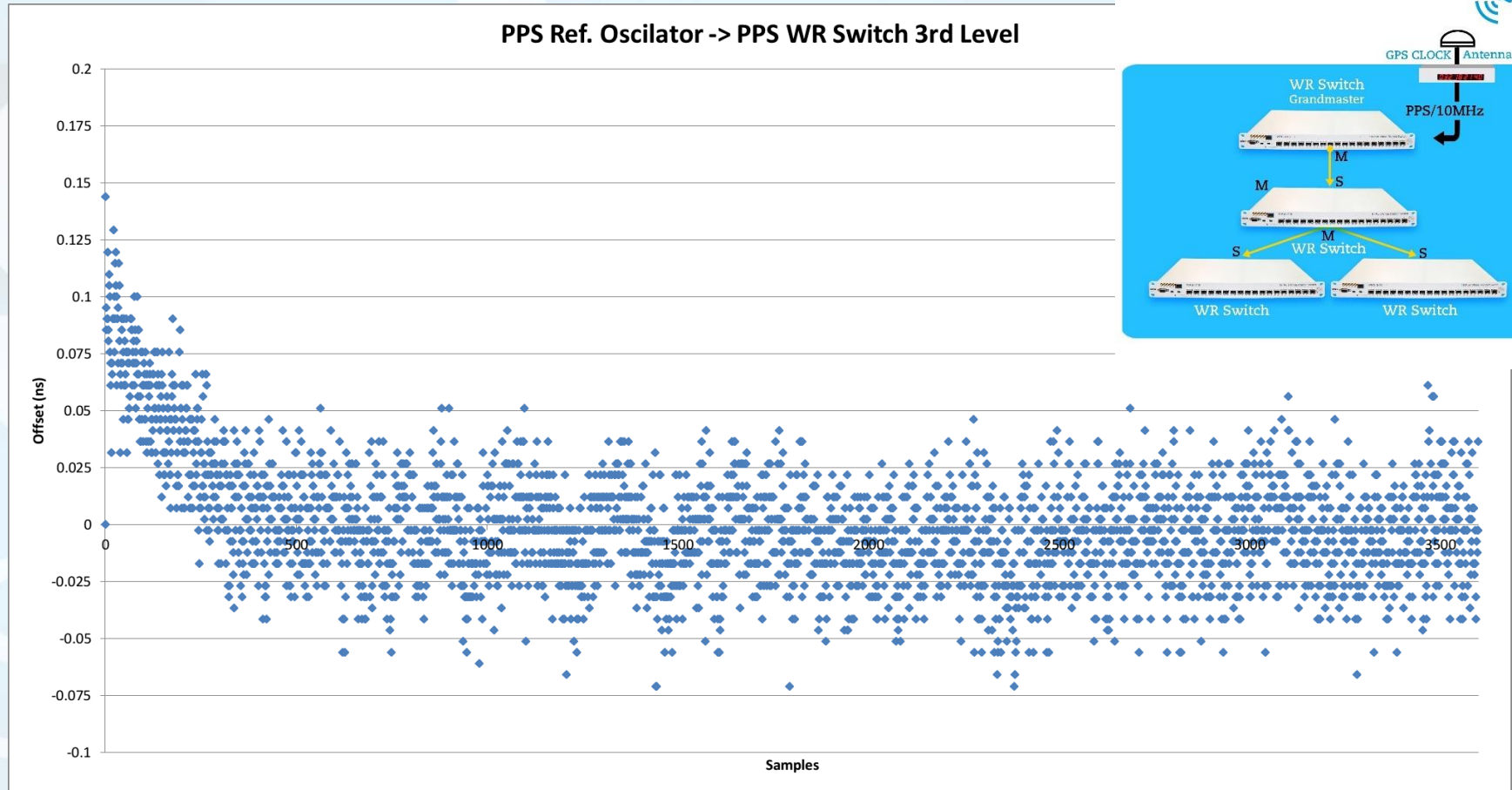
Time distribution in the datacenter

- Accurate time distribution over the whole:
    - Building
    - Datacenter
    - Large facilities
- Sub-ns accuracy
- **Easy deployment** (dynamic calibration)
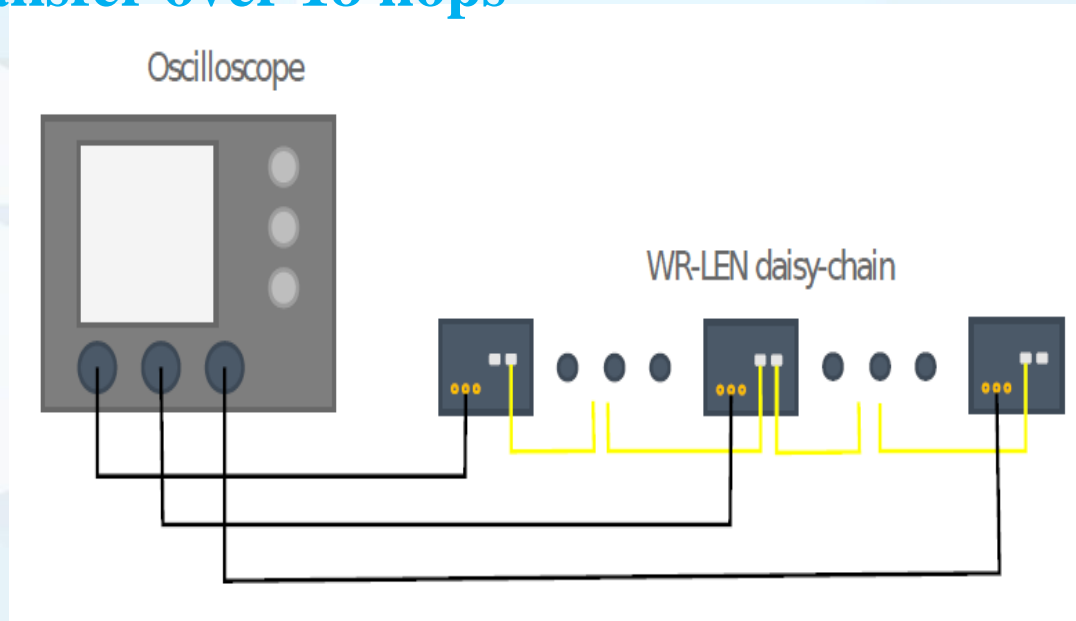- Redundancy of GPS receivers is possible

Time distribution inter-datacenter
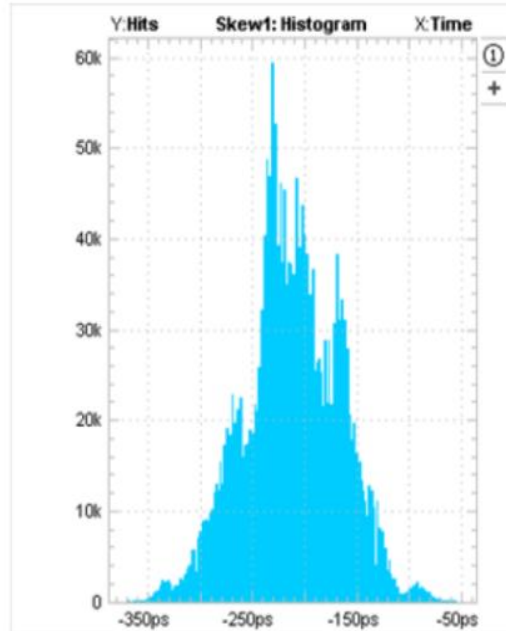
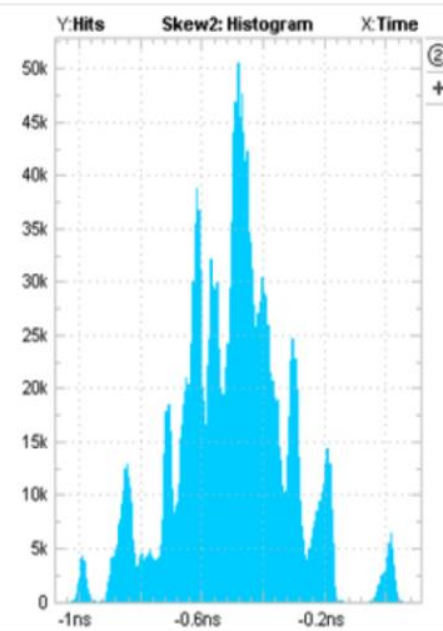# Time distribution inter-datacenter

Time transfer over 18 hops

Synchronization results along the Dasy Chain.

- Experiment with 90% of bandwidth utilization.
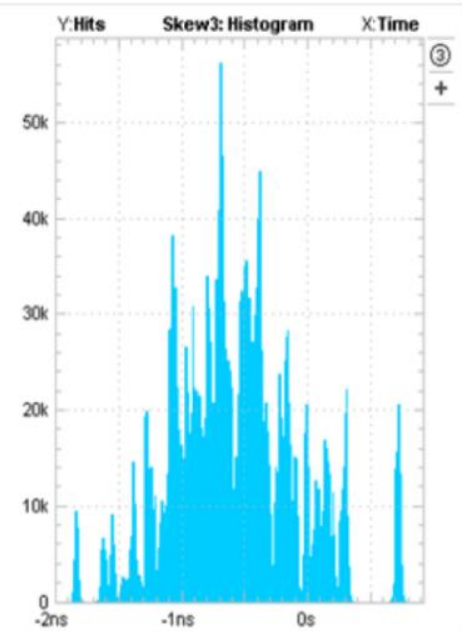- Using default device configuration (non parameter tuning).

Time distribution inter-datacenter

10th node   15th node   18th node

Description	Mean	**RMS**	Peak-to-Peak
Skew Master to 10th node	-212.51 ps	45.65 ps	312.50 ps
Skew Master to 15th node	-500.66 ps	174.50 ps	1.07 ns
Skew Master to 18th node	-573.45 ps	490.17 ps	2.65 ns

Timing solutions

Easy To Integrate

Scalable

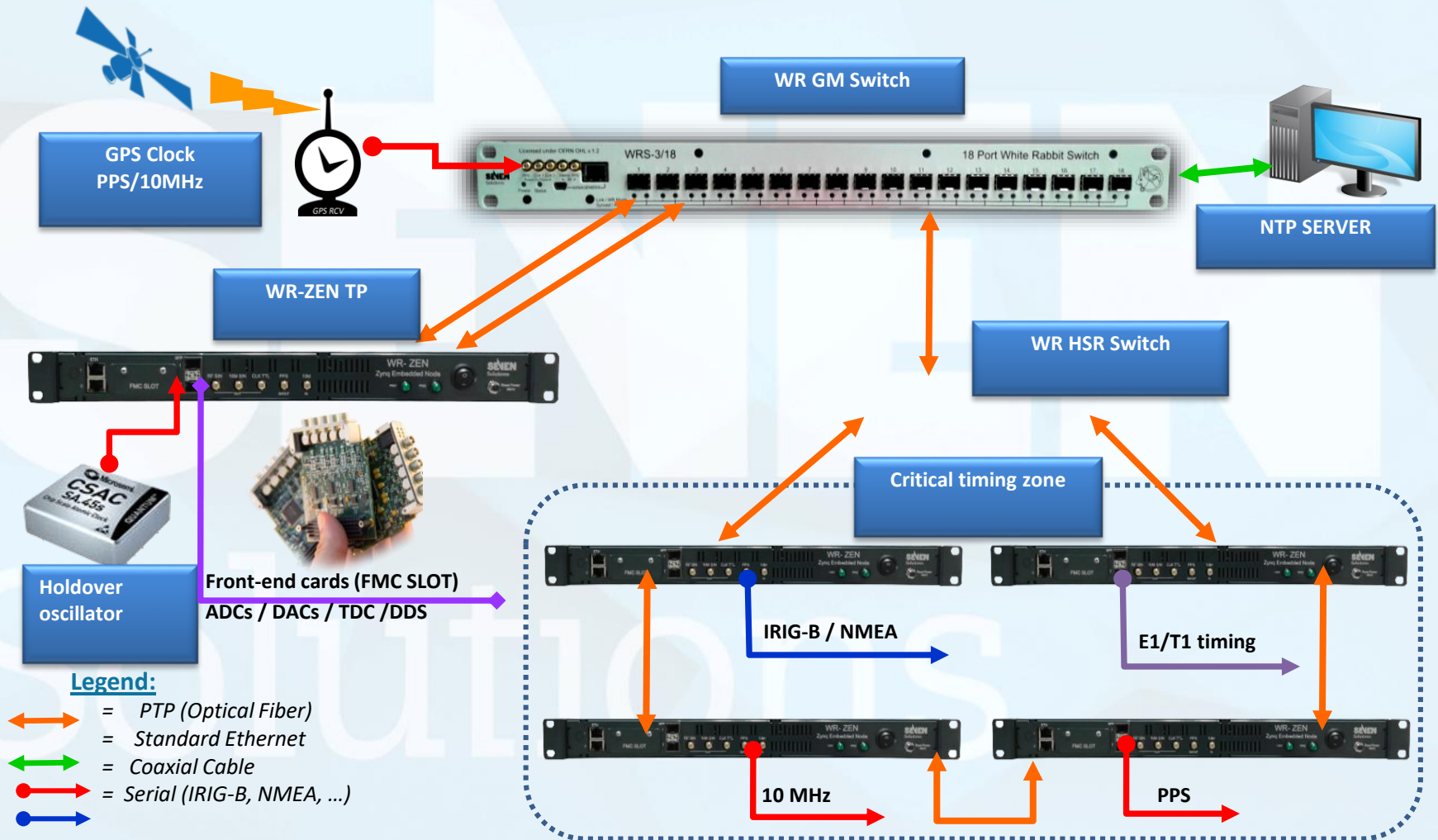Highly Accurate

Dependable

Cost-Effective

Facilitates New Services

- Key products: WR Switch, WR-ZEN TP, WR-LEN

- Standard input/output signals: 10 MHz, PPS

- Widely adopted protocols: NTP, PTPv2, IRIG-B

- Different topologies: Tree, daisy-chain

- Operation as: Grand Master, Master or Slave

Timing solutions

Conclusion

We have been more than 7 years, developing and White Rabbit and deploying it for ultra-accurately synchronizing distributed instrumentation and datacenters.

White Rabbit provides: Ultra-accurate synchronization, scalability and deterministic timing.

Our experiment shows that an efficient integration in the datacenter is required for taking full advantage of ultra-accurate time distribution solutions.

Scalability and long distance capability allow synchronizing also different datacenters.

SEVEN
Solutions

When every nanosecond counts

Thank you for your attention!

www.sevensols.com