Timing the Industry

Introduction

As the industry evolves, more and more applications with very demanding requirements for time and frequency synchronization are emerging. Examples of this need appear in many sectors such as transport, aeronautical, financial, health and telecommunications.

Many of these applications not only need a reliable, stable, and precise time reference to time stamp the different events that they need to monitor, but they must also distribute this main time source among all the devices that need to be synchronized and monitored with the highest possible precision and accuracy. To do this, therefore, two types of equipment are needed: a clock reference and a device capable of distributing time.

The following demonstrator will try to study the complementarity of these two types of equipment, studying their interoperability and the synchronization performance which is possible to achieve.

Set-up

The set-up used for the test (**Figure 1**) consists of the following equipment:

Mobatime

- PTP Grandmaster clock DTS 4160.
- GNSS antenna.

Seven Solutions

- Time fan-out WR Z16.
- Time provider WR-ZEN TP-FL

Additional equipment

- Keysight Frequency counter 53230A.

The connection and synchronization between the PTP Grandmaster and the Time fan-out will be carried out by means of the 10 MHz and 1 PPS signals coming from the time source and the time distribution to the rest of the network devices could be done by WR Z16 through the standard PTP IEEE 1588-2019 HA based on White Rabbit protocol over fibre optic links.

Since the time distribution performance of this protocol is not degraded by the number of hops present in the network, a representative measure of the synchronization that will be offered throughout the topology can be done comparing by a frequency counter the 1 PPS signal provided by the time source (PTP Grandmaster clock DTS 4160) and the first distribution device (Time fan-out WR Z16) as shown in **figure 1**.

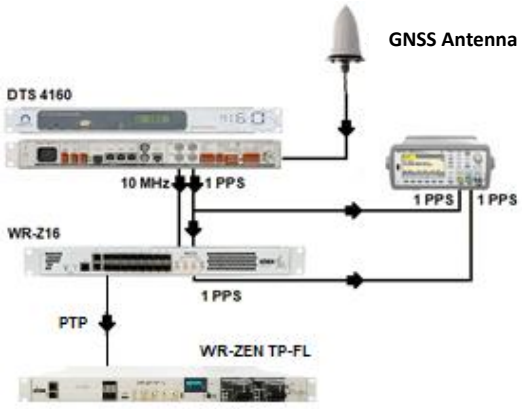

Figure 1: Set-up for the test

Results

The following plot (**Figure 2**) shows the result obtained by measuring and comparing the 1 PPS signals from the time source and the first distribution equipment during approximately a day and a half.

As it can be seen, the synchronization accuracy achieved in this setup is in the range of 400 ps. Thanks to the PTP IEEE

1588-2019 HA capabilities, the sub-ns accuracy is guaranteed in the rest of the nodes of the network.

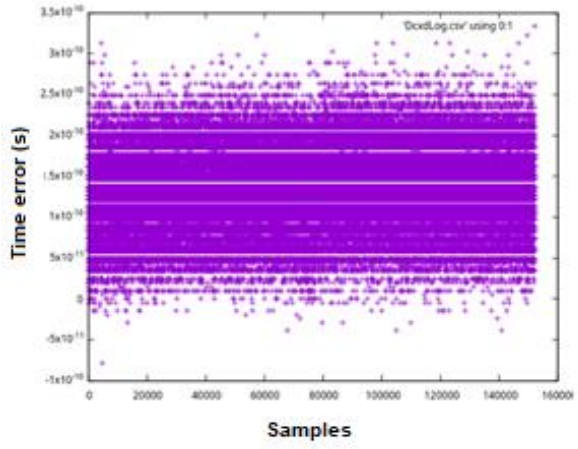

Figure 2: Time error measurements

The next plot (**Figure 3**) shows the histogram of the time error measurements:

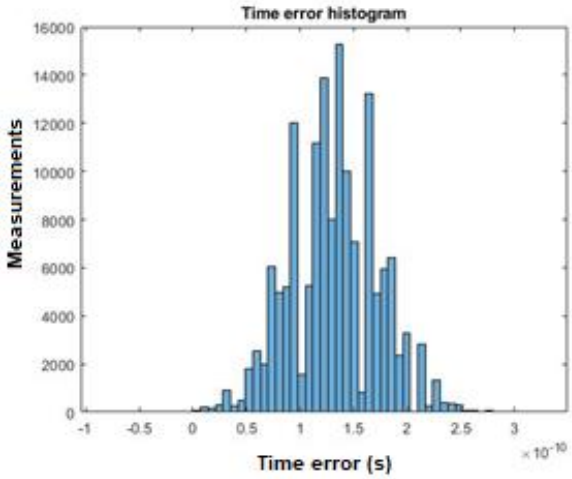

Figure 3: Time error histogram

This graph shows that during most part of the time, the time error measured is around 100-150ps.

The **table I** contains the most relevant parameters calculated directly from the raw data.

Accuracy (ps)	Jitter (ps)	Peak2Peak (ps)
132	41	400

Table I: Relevant parameters

Conclusions

As the results detailed in the previous section show, the compatibility and complementarity of Mobatime's PTP Grandmaster clock DTS 4160 and the Time fan-out WR Z16 developed by Seven Solutions is total, achieving a time synchronization accuracy between them of 132 ps in average and a jitter of 41ps, that meet the most demanding requirements of industrial applications.

This fact, added to the non-degradation in the performance that the PTP IEEE 1588-2019 HA protocol presents in terms of time and frequency distribution to the following hops, along with the rest of additional services that both devices can provide (cybersecurity, resilience, monitoring, etc.) mean that the synergies created using both devices have to be taken into consideration when facing the design or deployment of an industrial application.

About Mobatime

MOBATIME is the world's leading center of expertise for clock systems, time distribution, time reference systems and time synchronization. All of its devices and components are developed and produced in Switzerland by the family-owned company Moser-Baer AG, which was founded in 1938. Today they are over 400 people and operating all over the world. Several thousand of their products are in use and achieving top performance. Special requirements need high-level technological expertise and adapted or newly developed components and time systems.
www.mobatime.com

About Seven Solutions

Seven Solutions S.L. is a privately held company with high expertise in embedded systems and leading accurate sub-nanosecond time transfer and frequency

distribution for reliable aerospace and defense, industrial and scientific applications. With more than ten years of expertise in embedded systems design (electronics, firmware, embedded software), we offer the best-in class full turn-key solutions as well as customized solutions for timing applications. We are leaders in time and frequency distribution solutions based on White-Rabbit technology and derived standards (IEEE-1588-2019-HA). www.sevensols.com