



TIMING THE INDUSTRY

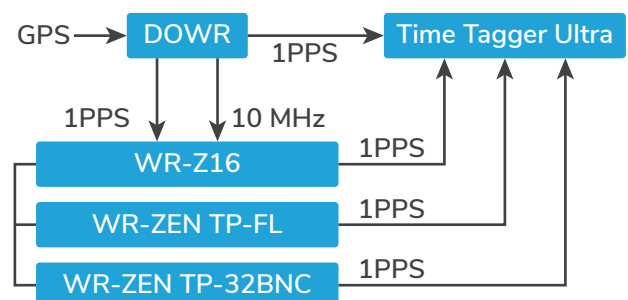
INTRODUCTION

Latest advances in science, telecom, finance, defense, broadcast, and smart grid require synchronization with sub-nanosecond accuracy and picosecond precision. White Rabbit networks, made to meet these demanding specs, in turn, challenge the instruments that measure the synchronization quality in real time.

Time Tagger Ultra by Swabian Instruments is an ideal candidate to test the performance of precision time protocols because of its best-in-class picosecond resolution and on-the-fly processing capabilities. In this white paper, we use a single Time Tagger Ultra to characterize a multi-node time-transfer network composed of Seven Solutions' products.

SETUP

DOWR receives a GPS reference and provides it to the White Rabbit grandmaster WR-Z16 via a one-pulse-per-second, 1PPS, signal and a 10 MHz signal. WR-Z16 distributes this external time reference to the network nodes of the WR-ZEN TP family: FL and 32BNC. Time Tagger Ultra monitors the 1PPS outputs of all the network components.



MEASUREMENT

The Time Tagger Ultra continuously time-tagged the 1PPS signals from the Seven Solutions' devices over 24 hours. These time tags provided the time error, that is, the distribution of individual time differences between each pair of pulses. **Figure 1** shows a time error histogram for each node in the WR network with the GPS signal from DOWR taken as a reference. **Figure 2** shows the time error histograms for two WR nodes with the WR-Z16 grandmaster as a reference.

RESULTS

Figure 1 confirms that the specified sub-nanosecond time error with respect to the GPS reference is preserved on each node of the White Rabbit network. **Figure 2** shows the time transfer capabilities and stability of the White Rabbit technology itself, because this measurement involved only the 1PPS signals distributed within the WR network.

These results not only confirm the time accuracy and precision of the White Rabbit protocol, but also highlight the multiple advantages offered by the Time Tagger Ultra for synchronization monitoring. Namely, the device provides a very high time resolution of just a few picoseconds, a friendly user interface, real-time measurement capabilities, and remote control. The systems with up to 144 channels are especially helpful in testing multi-layer networks.

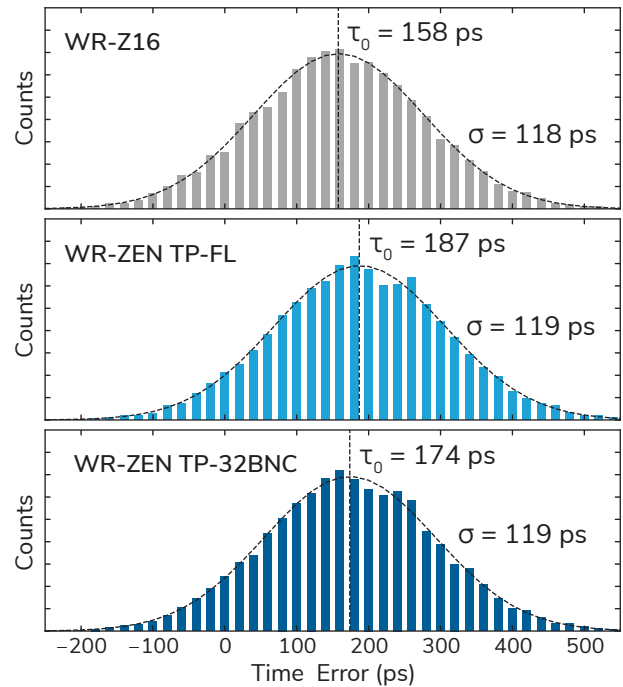


Figure 1. Time error histograms for every network node with respect to the GPS time reference of DOWR. The mean τ_0 and the width σ of each histogram show the synchronization accuracy and precision, respectively.

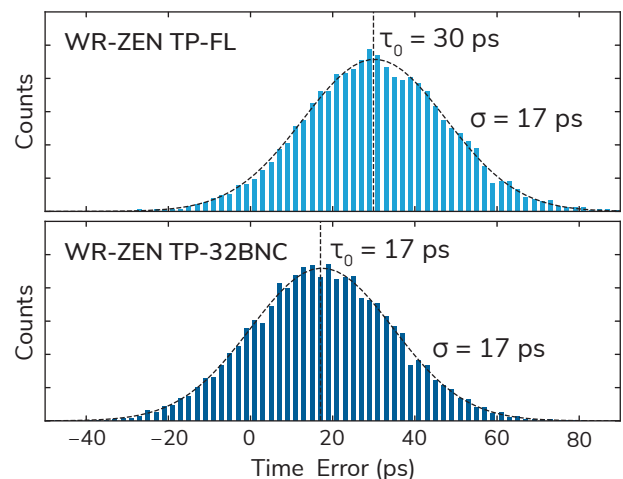


Figure 2. Time error histograms for WR-ZEN TP-FL and TP-32BNC network nodes with respect to the WR time reference of WR-Z16. The mean τ_0 and the width σ show the synchronization accuracy and precision, respectively.

Swabian Instruments GmbH is a test and measurement company based in Stuttgart, Germany. We develop digital data acquisition and signal generation systems that are easy to use, performant, and packed with useful features. Our flagship Time Tagger series empowers groundbreaking projects in event counting, such as quality control for time distribution protocols and frequency stability analysis. www.swabianinstruments.com

Seven Solutions S.L. is a privately held company with more than ten years of expertise in embedded system design, including electronics, firmware, and software. We offer best-in-class turn-key systems, as well as customized solutions for timing applications. We are leaders in accurate sub-nanosecond time transfer and frequency distribution based on White Rabbit technology and derived standards. www.sevensols.com
