Five Best Practices for Deploying and Monitoring a virtual Primary Reference Time Clock (vPRTC) Network

Best Practice 3

Configuring the TimeProvider® 4100 High Performance Boundary Clocks (HPBC) at Each vPRTC Node

MICROCHIP

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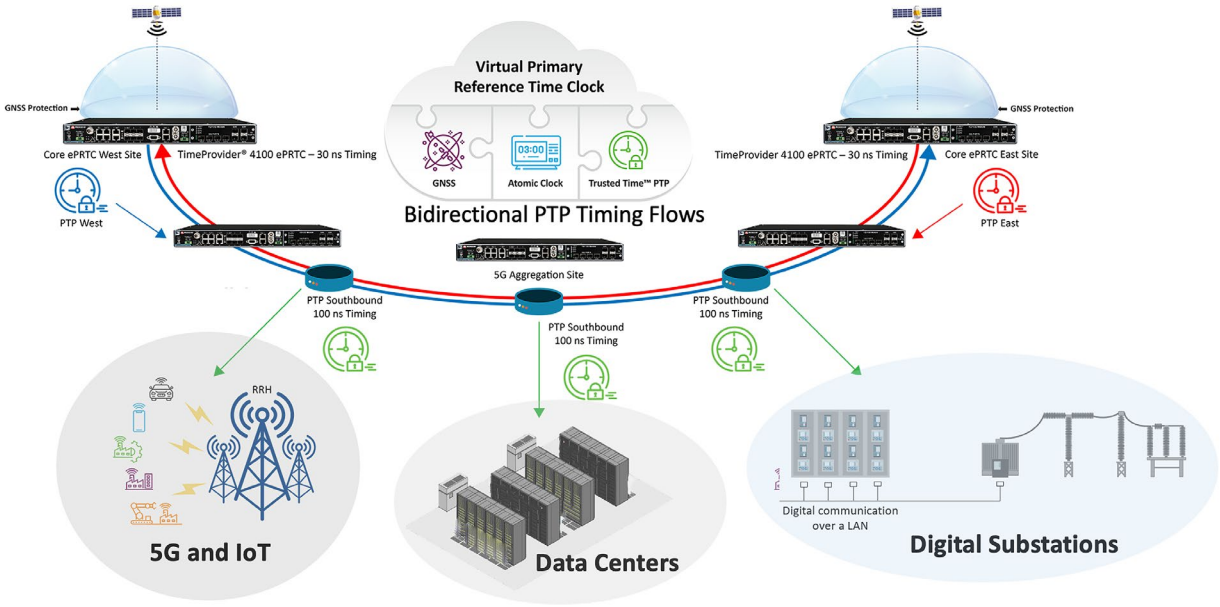
Introduction

The virtual Primary Reference Time Clock (vPRTC) is a highly secure and resilient network-based timing architecture that has been developed to meet the expanding needs of modern critical infrastructures including 5G, transportation, data centers, and power utilities.

The resilient architecture alleviates dependency on satellite-based timing sources such as Global Navigation Satellite Systems (GNSS) by placing autonomous time scale grade atomic clocks in enhanced Primary Reference Time Clock (ePRTC) area timing-hub sites at the core of a fiber-based terrestrial timing distribution network. Secure core-timing sites and fiber distribution are 100% in control of the network operator, and immune to potential jamming or spoofing cyber-attacks on satellite-based timing solutions.

Figure 1. Virtual Primary Reference Time Clock Architecture Providing Resilient Timing for Critical Infrastructure Operators



This paper presents the third, out of five, key best-practices derived from millions of cumulative hours of operation of the vPRTC timing architecture accross multiple industries.

Best Practice 3: Configuring the TimeProvider® 4100 High Performance Boundary Clocks (HPBC) at Each vPRTC Node

The TimeProvider® 4100 system is a sophisticated network clocking element with the ability to transfer timing with extraordinary levels of precision and can be configured in different operational modes: ePRTC, PRTC-A, PRTC-B, Gateway Clock, and as a HPBC designed for the optical layer. In HPBC mode, it can meet or exceed ITU-T G.8273.2 Class D specifications with a typical error budget of 2 ns per HPBC hop.

When making a comparison between traditional boundary clocks and the vPRTC HPBCs, traditional boundary clocks are unidirectional, have a single clock domain, and a very basic de-jitter function. They are designed to have a single input and no ability to make measurements between multiple references. Whereas the HPBC clocking element has multiple PTP input clients and dual clock domains per port. With full bi-directional functionality, the system accepts PTP input from different directions (“East Site” and “West Site”) simultaneously. HPBCs monitor the incoming clocks and can select the most stable highest quality input. HPBCs also run a global Best Master Clock Algorithm (BMCA) function that enables fast switchover between PTP inputs as necessary. Figure 1-3 shows the West Site, East Site, and HPBC Hop configuration. Table 1-3 explains factors that contribute to configuring the TimeProvider 4100 HPBC at each vPRTC node.

Figure 1-3. vPRTC with West Site, East Site, and HPBC Hop Configuration

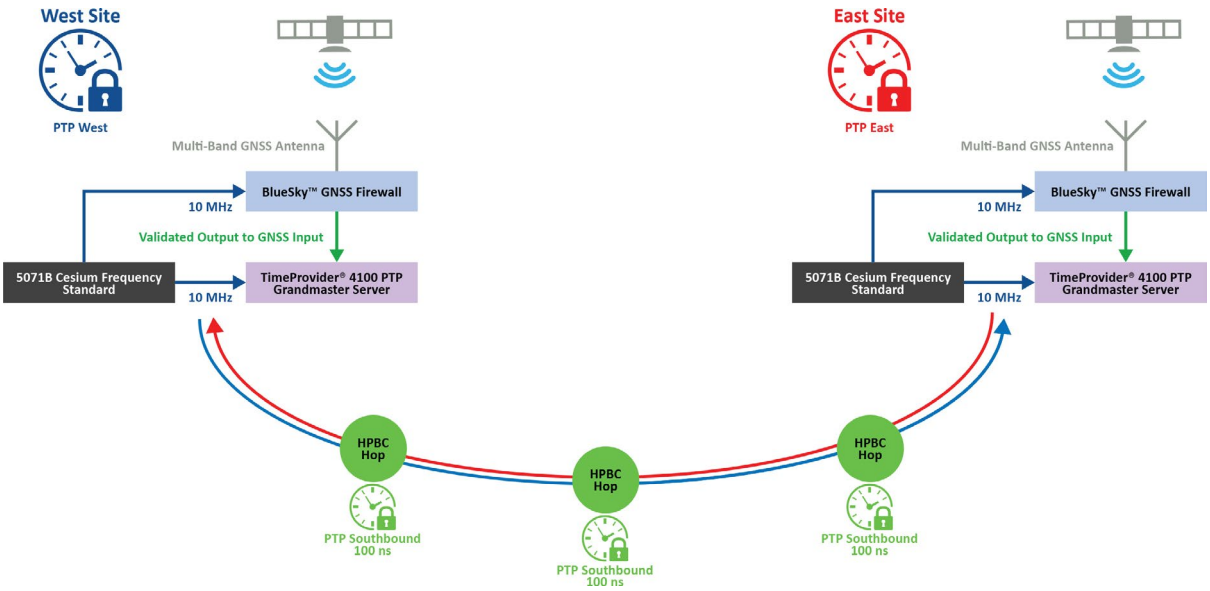


Table 1-3. Best Practices for Configuring the TimeProvider® 4100 HPBC at Each vPRTC Node

Factor	Recommended Best Practice
Hop count	Up to 15 HPBC hops. Max error contribution for planning (15 hops x 2 ns per hop = ±30 ns) max.
PTP Profile	G-8275.1 Full on path support.
Primary ePRTC Site Protection	Designate one ePRTC site to be the “primary” and the other to be the “secondary” site. • All HPBC clocks follow the same ePRTC site as “primary”. • If the “primary” ePRTC signals an issue, all HPBC clocks in the chain will automatically switch to the “secondary” ePRTC site. • If there is a fiber cut along the chain, all HPBC clocks east of the cut will lock to the east ePRTC site and similar for the west side of the cut.
Continuous monitoring	The HPBC continuously measures and compares the offset from both the east and west ePRTC sites to assure PRTC stability of the entire chain, and to enable easy diagnostics of any timing issues along the chain in either direction.
TimePictra® Synchronization Management	It is recommended to monitor and manage all TimeProvider® 4100 HPBC clocks in the chain using the TimePictra® management system.

The TimePictra® synchronization management system provides concise monitoring screens to instantly detect and alert the operator to any alarm conditions. Customizable monitoring dashboard screens provide alarm status and a visual mapping of the HPBC chain with all links east and west showing lock and performance status conditions.

Summary

Design the vPRTC network so that each TimeProvider® 4100 High Performance Boundary Clock receives 2 high accuracy Universal Coordinate Time (UTC) traceable timing feeds.