Substation Solution Brief

Substation Timing Synchronization Using IEEE-1588 Power Profile

Summary

Cisco, a leading vendor of secure IP networks to electric power utilities for substation connectivity and Wide Area Networking, invites vendors of IEEE-1588 timing source devices as well as the end-device vendors that implement the 1588 "Power Profile", to validate clock distribution and synchronization over Cisco networks and certify interoperability with Cisco Connected Grid products in the substation, to build customer confidence in the joint solution with the "Cisco Compatible" certification and logo.

To get started, join the Cisco Developer Network for Connected Energy (CDN/CE):

http://developer.cisco.com/web/partner/getstart

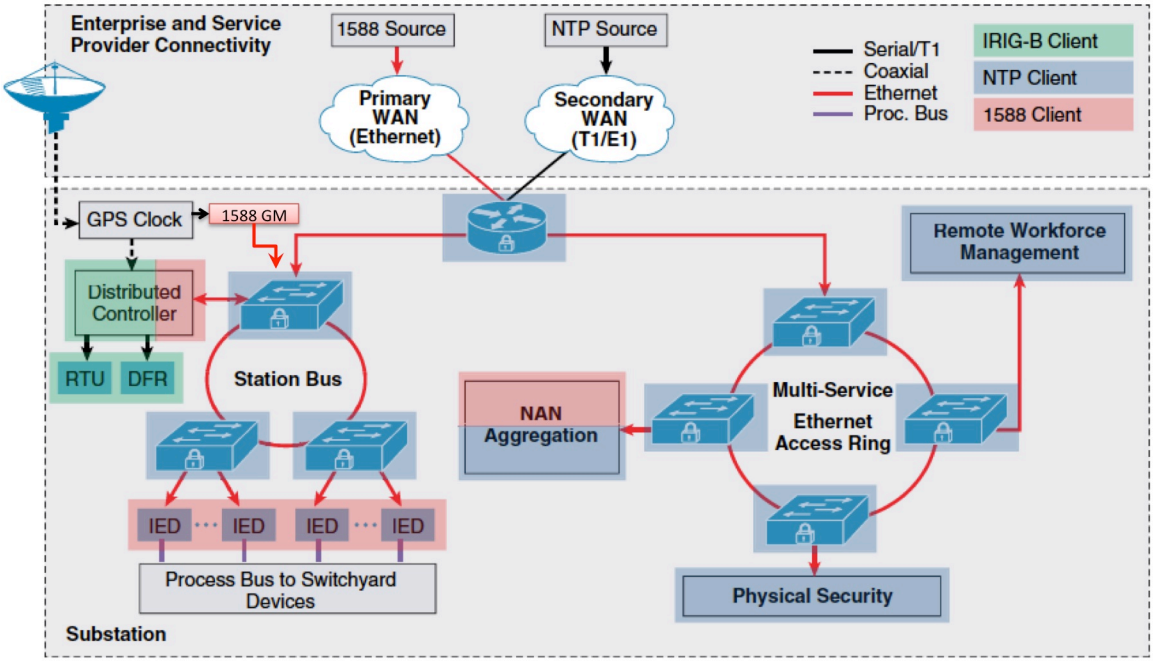

Figure 1 Substation Timing Distribution

Background

Precise timing synchronization is required in a substation to ensure that measuring devices connected to the grid have accurate clocks. Accuracy of the clocks is measured relative to a national standard, and can vary from order of milliseconds to microseconds, depending on the application. Some examples of measuring devices

that require precise timing synchronization are Fault Recorders, Sequence of Events Recorders, and Phase Measurement Units.

Preferred methods of time synchronization of clocks in the substation include the Inter Range Instrumentation Group (IRIG) approach, IP network accessible master clocks using the Network Time Protocol (NTP), which provides accuracy in the 1-millisecond range, and the IEEE 1588 Precision Time Protocol (PTP), which provides accuracy in the 1-microsecond range. See Figure 1. In particular, the recently approved "Power Profile" of the 1588 standard is specifically targeted at the utility substation.

Solution Description

The IEEE 1588 standard defines a hierarchical set of clocks maintained by the use of the PTP. In each timing domain, there is one or more Grand Master (GM) clock source usually synchronized to a GPS clock. See Figure 2.

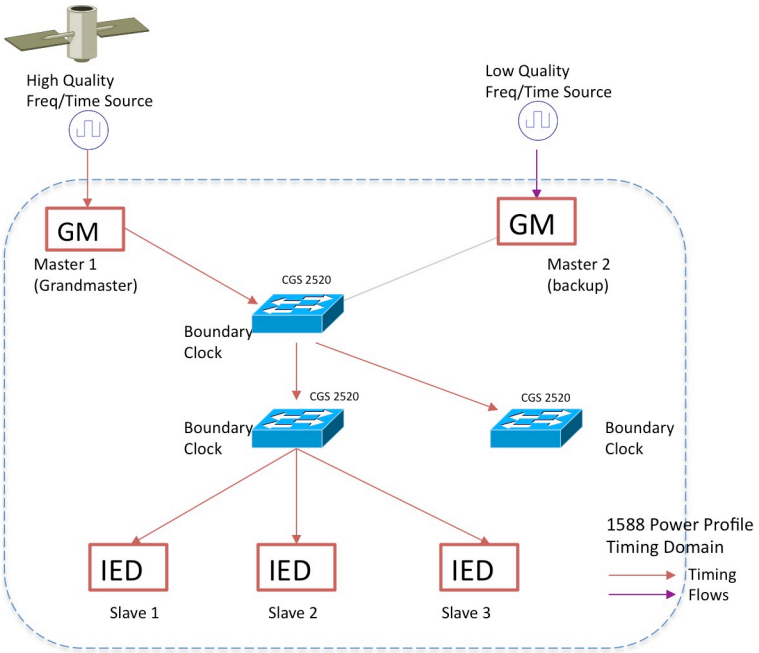

Figure 2 Substation PTP Timing Domain

Boundary Clock (BC) devices (typically network switches) synchronize their own clock to an upstream GM using PTP, and then provide the master clock functionality to other clocks downstream using PTP. End devices (typically Fault Recorders, IEDs, PMUs, etc) are classified as Ordinary Clocks (OC) that synchronize with an upstream master clock, be it a GM or BC. The "Power Profile" of 1588 is designed for power substations and networks and uses a layer 2 network packet type to carry the PTP protocol messages.

Cisco Connected Grid Switch (CGS) implements the 1588 Power Profile to act as a Boundary Clock device, interoperating with GM devices to synchronize its own clock

and with OC devices (e.g. PMUs, IEDs) to provide them clock synchronization. This solution brief addresses both of these interoperability use cases.

This document focuses on devices using the 1588 Power Profile clock distribution. Figure 2 depicts the hierarchy of clock sources and clients connected by the Cisco CGS 2520 devices in a substation.

For PTP GM device vendors, verifying the propagation of your clock through the Cisco switched network using the 1588 Power Profile provides the end-devices with confidence in your joint solution with Cisco.

For end-devices that implement the Power Profile, testing with the Cisco switches provides confidence that your 1588 implementation is interoperable with Cisco's Boundary Clock implementation.

Solution Testing

Solution integration testing will typically consists of the following steps:

1. Define test plan
    a. Functional test cases
    b. Performance test cases
2. Physical connection of the devices and network
3. Network configuration
    a. Switch setup and configuration
    b. Device(s) setup and configuration
4. Execute test plan

More information on suggested test plans, detailed equipment configurations, etc. is available to Cisco Developer Network for Connected Energy (CDN/CE) registered partners. Here is where to get started.

http://developer.cisco.com/web/partner/getstart