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IEEE Standard Profile for Use of IEEE 1588™ Precision Time Protocol in Power System Applications

IEEE Power & Energy Society

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Power System Relaying Committee
and
Substations Committee

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Abstract: A common profile for the use of Precision Time Protocol (PTP) of IEEE Std 1588-2008 in power system protection, control, automation, and data communication applications utilizing an Ethernet communications architecture is specified.
Keywords: grandmaster clock, IEEE 1588, power substation, precise time synchronization, Precision Time Protocol (PTP), sample synchronization, slave-only clock, synchrophasors, transparent clock

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Introduction

This introduction is not part of IEEE Std C37.238-2011, IEEE Standard Profile for Use of IEEE 1588™ Precision Time Protocol in Power System Applications.

This standard specifies a common profile for use of IEEE 1588 Precision Time Protocol (PTP) in power system protection, control, automation, and data communication applications utilizing an Ethernet communications architecture.

Typical Ethernet-based time distribution architecture consists of a reference clock, bridges, and end devices. Bridges with boundary clock functionality may also be used at interconnection points between different PTP domains or PTP profiles.

In addition to distributing global time that is traceable to a recognized standard time source, the profile has a provision for distributing local time for the cases when connectivity to recognized standard time sources is lost.

The profile can be used for precise time synchronization of the devices in a substation, and between substations in a larger geographical area, if performance requirements of this standard are met.

The use of different physical layer communication technologies to carry Ethernet frames, including SONET/SDH and wireless technologies, is not precluded if they can meet performance requirements of this standard.

Time distribution specified in this standard is based on the following basic assumptions:

- All devices that participate in time distribution support this standard.
- All devices are in the same time distribution domain.
- All devices have point-to-point connections to their neighbors.
- Transmit and receive cable delay for each point-to-point connection is assumed to be symmetrical. Known asymmetry in cable delay can be configured and corrected.

The use of security techniques is an important consideration and, based on the application, may be desirable or mandated. Security extensions and network engineering methods for hardening the PTP-based time distribution system against malicious attacks are not covered, and are outside of scope of this standard. If security techniques are used, they should not impair the ability of devices to achieve performance, specified in this standard. Future improvements in IEEE 1588 security mechanism will be considered in a revision of this standard.

Redundancy is an important consideration; some applications recommend or mandate support for different time distribution technologies, e.g., Global Positioning System (GPS) and Inter-Range Instrumentation Group B (IRIG-B). Support for multiple time distribution technologies at the same time is out of scope of this standard.

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IEEE Standard Profile for Use of IEEE 1588™ Precision Time Protocol in Power System Applications

1. Overview

1.1 Scope

This standard specifies a common profile for the use of IEEE 1588 Precision Time Protocol (PTP) in power system protection, control, automation, and data communication applications utilizing an Ethernet communications architecture.

The profile specifies a well-defined subset of IEEE 1588 mechanisms and settings aimed at enabling device interoperability, robust response to network failures, and deterministic control of delivered time quality. It specifies the preferred physical layer (Ethernet) higher level protocol used for PTP message exchange and the PTP protocol configuration parameters. Special attention is given to ensuring consistent and reliable time distribution within substations, between substations, and across wide geographic areas.

1.2 Purpose

The purpose of this standard is to facilitate adoption of IEEE Std 1588-2008 for power system applications requiring high precision time synchronization.[1] It specifies a common subset of PTP parameters and options to provide global time availability, device interoperability, and failure management. This set of PTP

[1] Information on references can be found in Clause 2.