

SMPTE STANDARD

SMPTE Profile for Use of
IEEE-1588 Precision Time
Protocol in Professional
Broadcast Applications



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Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE's Engineering Documents, including Standards, Recommended Practices, and Engineering Guidelines, are prepared by SMPTE's Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual.

SMPTE ST 2059-2 was prepared by Technology Committee 32NF.

Intellectual Property

SMPTE draws attention to the fact that it is claimed that compliance with this Standard may involve the use of one or more patents or other intellectual property rights (collectively, "IPR"). The Society takes no position concerning the evidence, validity, or scope of this IPR.

Each holder of claimed IPR has assured the Society that it is willing to License all IPR it owns, and any third party IPR it has the right to sublicense, that is essential to the implementation of this Standard to those (Members and non-Members alike) desiring to implement this Standard under reasonable terms and conditions, demonstrably free of discrimination. Each holder of claimed IPR has filed a statement to such effect with SMPTE. Information may be obtained from the Director, Standards & Engineering at SMPTE Headquarters.

Attention is also drawn to the possibility that elements of this Standard may be subject to IPR other than those identified above. The Society shall not be responsible for identifying any or all such IPR.

Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

IEEE 1588 is a standard for a Precision Time Protocol (PTP) that enables precise synchronization of clocks in measurement and control systems implemented with technologies such as network communication, local computing, and distributed objects. The clocks communicate with each other over a communication network. The protocol generates a master-slave relationship among the clocks in the system. All clocks ultimately derive their time from a clock known as the grandmaster clock. In its basic form, this protocol is intended to be administration free.

IEEE Std 1588-2008 introduces the concept of a PTP profile. The purpose is to specify particular combinations of options and attribute values to support a given application. The purpose of the profile is described in Subclause 19.3.1.1 'General' of IEEE Std 1588-2008:

"The purpose of a PTP profile is to allow organizations to specify specific selections of attribute values and optional features of PTP that, when using the same transport protocol, inter-work and achieve a performance that meets the requirements of a particular application."

A PTP profile is a set of required options, prohibited options, and the ranges and defaults of configurable attributes. Profiles specifications shall be consistent with the specifications in Subclauses 19.2.1 and 19.2.2."

Subclause 19.3.1.2 'PTP profile recommendations' of IEEE Std 1588-2008 specifies what a PTP Profile should contain. This includes:

- Which of the best master clock algorithm options is to be implemented.
- Which of the configuration management options is to be implemented.
- Which of the path delay mechanisms, delay request-response or peer delay is to be implemented.
- The range and default values of all PTP configurable attributes and data set members.
- The transport mechanisms required, permitted, or prohibited.
- The node types required, permitted, or prohibited.
- The options required, permitted, or prohibited.

This Standard defines the SMPTE PTP Profile for time and frequency synchronization in a professional broadcast environment. It is intended to be used with SMPTE ST 2059-1 which defines a point in time, the SMPTE Epoch, which is used for alignment of real-time signals; formulae which specify the ongoing alignment of signals to time since the SMPTE Epoch; and formulae which specify the calculation of SMPTE ST 12-1 time address values and SMPTE ST 309 date values. A basic understanding of these concepts that are described in SMPTE ST 2059-1 will be helpful to readers of ST 2059-2.

Synchronization is considered to have been achieved when network-based time accuracy between any two slave devices with respect to the master reference is within 1 microsecond. This standard is capable of providing a higher degree of accuracy depending on the network architecture.

This profile is designed with the following purposes in mind:

- To permit a slave to be synchronized within 5 seconds of its connection to the operational PTP network. While there are many factors that will in practice influence the synchronization time, the default values of configurable attributes have been chosen to help achieve this target.
- Having achieved initial synchronization, to maintain network-based time accuracy between any two slave devices with respect to the master reference within 1 microsecond.
- To convey Synchronization Metadata (SM) required for synchronization and time labeling of audio/video signals.

1 Scope

This standard specifies a Precision Time Protocol profile specifically for the synchronization of audio/video equipment in a professional broadcast environment.

The profile is based on IEEE Std 1588-2008 and includes a self-contained description of parameters, their default values, and permitted ranges.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword "reserved" indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword "forbidden" indicates "reserved" and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; followed by formal languages; then figures; and then any other language forms.

3 Normative References

The following standards contain provisions that, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

IEEE Std 1588-2008, IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems¹

IETF RFC 2236, Internet Group Management Protocol , Version 2 (IGMPv2)

¹ IEEE-1588 is a registered trademark of the Institute of Electrical and Electronics Engineers, Inc.

IETF RFC 2710, Multicast Listener Discovery (MLD) for IPv6

IETF RFC 3376, Internet Group Management Protocol, Version 3 (IGMPv3)

IETF RFC 3810, Multicast Listener Discovery Version 2 (MLDv2) for IPv6

4 Definition of Terms and Acronyms

4.1 Big-endian

Also known as 'network order', a byte order where the bytes of a word are transmitted such that the most significant Byte is transmitted first.

4.2 Byte

An ordered sequence of 8-bits, also termed an octet.

4.3 Daily Jam

An optional daily procedure carried out within a facility that uses SMPTE ST 12-1 time code in which the time address value is adjusted to correspond to Local Time at the chosen time of the Daily Jam. It is usually carried out in the early hours of the morning at a non-sensitive time as determined by the operator of the facility.

Note: The term "Daily Jam" is historical and used in that context. This standard does not constrain the jam to take place on a daily basis. In some systems it could occur only as required to accommodate discontinuities such as Leap Seconds or daylight saving time adjustment.

4.4 Grandmaster clock

Within a PTP domain, a clock that is the ultimate source of time for clock synchronization using the Precision Time Protocol as defined in IEEE Std 1588-2008.

4.5 Link

A network segment between two Precision Time Protocol (PTP) ports supporting the peer delay mechanism of the IEEE Std 1588-2008.

4.6 Local Time

The time (and date) as chosen by the facility's system administrator and implemented by the system. This is typically the calendar date and time-of-day in common use in the locality. It usually includes an offset from UTC indicating the time zone, accumulated Leap Seconds by the rules of UTC, and, where observed, daylight saving time (summer time) by the rules of the responsible authority.

4.7 Master clock

In the context of a single Precision Time Protocol (PTP) communication path, a clock that is the source of time to which all other clocks on that path synchronize.

4.8 Octet

A sequence of 8 bits, also known as a byte.

4.9 PTP

Precision Time Protocol as defined in IEEE Std 1588-2008.

4.10 PTP Domain

A logical grouping of clocks that synchronize to each other using the Precision Time Protocol, but that are not necessarily synchronized to clocks in another domain. See also IEEE Std 1588-2008, Subclause 7.1.

4.11 PTP epoch

The origin of the timescale of a domain as defined in IEEE Std 1588-2008 (see Subclause 7.2.2).

4.12 PTP time

The time elapsed since the PTP epoch as conveyed by the Precision Time Protocol as defined in IEEE Std 1588-2008 (see Subclause 7.2).

Note: The PTP epoch as defined above is 63072010 seconds before 1972-01-01T00:00:00Z (UTC).

Note: This PTP epoch is the same as the SMPTE epoch as defined in SMPTE ST 2059-1.

4.13 Slave clock

In the context of a single Precision Time Protocol (PTP) communication path, a clock that may synchronize to another clock.

4.14 SM: Synchronization Metadata

Metadata required for the synchronization of audio/video signals.

4.15 Synchronization signal

A reference signal used for the synchronization of audio/video equipment in a professional broadcast environment, for which a phase relationship with respect to the SMPTE Epoch has been defined (see SMPTE ST 2059-1).

4.16 Time Jump

A discontinuity in local time that is known in advance, caused typically by an adjustment to the number of accumulated leap seconds or a change in daylight saving time.

5 PTP Profile

5.1 Profile Identification

The PTP Profile shall be identified as follows:

PTP Profile:

SMPTE profile for synchronization in a professional broadcast environment

Version 1.0

Profile identifier: 68-97-E8-00-01-00

This profile is specified by Society of Motion Picture and Television Engineers (SMPTE)

A copy may be obtained from www.smpte.org

5.2 Best Master Clock Algorithm (BMCA)

The default best master clock algorithm (BMCA) defined in IEEE Std 1588-2008 (Subclauses 9.3.2, 9.3.3, 9.3.4) shall be used.