Changes to IEEE 1588 in the 2019 edition compared to the 2008 edition

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All references to specific clauses refer to the 2019 edition (i.e. this edition) unless the 2008 edition is explicitly stated.

Clarification of terms

While the 2008 edition acknowledged PTP Networks supporting several PTP domains, the specification was primarily directed to single domain systems. As a consequence, the terminology used in the 2008 edition was in many respects inconsistent and ill-defined when applied to multi-domain PTP Networks. In this edition, the definitions Clause 3 and a revision of 6.1 correct this situation.

These changes do not affect the compatibly of implementations conformant to the 2008 and the 2019 edition.

Compatibility with IEEE 1588-2002

Compatibility with IEEE 1588-2002 is no longer supported in IEEE 1588-2019.

Clock Synchronization Model (Clause 6)

In both the 2008 and the 2019 edition, Clause 6 presents the architectural model underlying the specifications, describes certain aspects of the behavior of the protocol, and outlines the structure of the specifications.

The first major change in Clause 6 is the replacement of the 2008 architectural model by a layered model. The new model:

- Permits the introduction of capabilities enabled by a new PTP Port model- the Special Port. Special Ports enable the inclusion of network links based on technologies that provide inherent timing support as opposed to the use of PTP timing messages, e.g. IEEE 802.11 and EPON (see 19.4.6).
- Permits principled interactions between different PTP domains .

The second major change is the removal of discussions of different models of clock synchronization, material that was never referenced in the 2008 edition.

These changes do not affect the compatibly of implementations conformant to the 2008 and this edition.

Updates to options present in the 2008 edition

Alternate timescales (see 16.3). The changes include the clarification of the propagation of the ALTERNATE_TIME_OFFSET_INDICATOR TLV by Boundary Clocks, and clarification on using this option. PTP Instances conformant to this edition are compatible with those of the 2008 edition.

Acceptable master table (see 17.5). The representation of acceptable masters has been changed from protocol address to portIdentity to correct a possible flaw in the 2008 specifications, relevant when Transparent Clocks are part of the PTP Network topology. PTP Instances conformant to the 2008 edition, within a network including Transparent Clocks that update the source address per specification

in IEEE 802.1, might incorrectly not accept messages from a configured acceptable master. PTP Instances conformant to this edition will correctly accept the message irrespective of whether Transparent Clocks are present.

New rules on values for clockIdentity

Several of the specifications for clockIdentity values permitted under the 2008 edition are no longer permissible due to the small but finite possibility of duplication. clockIdentity values assigned based on this edition are compatible with those of the 2008 edition. However, the presence of implementations using the specifications of the 2008 edition does introduce the possibility of duplicate clockIdentities in a PTP Network (see NOTE 2− of clause 7.5.2.2.2.1).

Revision of clause 8

The data set specifications of Clause 8 are revised and are now to be interpreted as:

- An information model to be used as the basis for constructing management tools. For example, management tools based on a MIB [B53] or YANG [B54] model can be constructed from the specifications of Clause 8, and/or
- A definition of data used in the operation of the PTP protocol.

As part of this revision, the existing management specifications, clause 15 of the 2008 edition, are revised such that they are based on the revised data sets, and any existing management specifications present in options of the 2008 edition are now specified in Clause 15 of this edition. The use of Clause 15 specifications of this edition is compatible with those of the 2008 edition.

Revision of the specifications of a Transparent Clock

Two major changes have been made in the specifications of Transparent Clocks. The optional data sets for Transparent Clocks in the 2008 edition have been replaced by attributes in the defaultDS and portDS data sets and the specifications are now explicitly per PTP Instance and therefore domain specific.

In the 2008 edition, the Transparent Clock specifications could be interpreted as domain specific, or domain independent (at least concerning the data sets). See the note in 8.3.1 of the 2008 edition concerning the optional data sets. PTP Networks containing implementations conformant to the 2008 edition might not operate correctly in networks including PTP Instances of this edition if:

- The PTP Instances of this edition require a Transparent Clock to modify a PTP message field other than the correctionField (and any resulting updates of transport layer fields), and/or
- Options of this edition or of PTP Profiles have specifications that are explicitly per domain.

Special Ports

The 2019 edition includes a definition of Special Ports which were not specified in the 2008 edition. A special port connects a PTP network to a network with a built in timing mechanism, such as WIFI or EPON. See 11.5.

Version number in the common header

A minorVersionPTP field has been created in the common PTP message header, from a previously reserved field. Implementations compatible to the 2019 edition shall indicate a versionPTP field value of 2 and minorVersionPTP field value of 1, indicating that this is PTP version 2.1.

Holdover upgrade

16.4 provides a mechanism for a PTP Instance that:

- is not currently a Grandmaster PTP Instance, and
- has very good holdover capabilities, and
- has no direct access to the desired source of time (or of appropriate frequency) for the domain,

to potentially become the Grandmaster PTP Instance in the event the previous Grandmaster PTP Instance is disconnected or its characteristics degrade. Such a clock is termed a holdover-upgradable PTP Instance for purposes of this option. This option is compatible with implementations compliant with the 2008 edition.

Revised specifications for domains

The specifications defining a domain in this edition include two fields, the domainNumber and the sdoId. The structure of the sdoId is such that compatibility with the 2008 edition is maintained. (A portion of the sdoId is the repurposed transportSpecific field from 2008.) The compatibility of the sdoId with the corresponding attributes of the 2008 edition ensures that the Profile Isolation option of 16.5 correctly operates in the presence of implementations conformant to the 2008 edition.

Optional Common Mean Link Delay Service

This option, defined in 16.6, allows multiple PTP implementations in different domains, but sharing a physical port to use receive link delay information without repeating peer delay messages. This option is not useful with implementations conformant to the 2008 edition but will not disrupt the operation of the protocol in a PTP Network of such implementations.

New options and default profile for enhanced synchronization performance

The new options are defined in 16.7 for configurable correction of timestamps, 16.8 for calculation of the <delayAsymmetry> for certain media, and Annex O for Layer-1 based synchronization performance enhancements. The new High Accuracy Delay Request-Response Default PTP Profile is defined in J.5. Related additional informative annexes were added: annex P which explains how to implement the new profile to achieve sub-ns synchronization, and annex Q which provides calibration procedures. These enhancements are based on White Rabbit (https://www.ohwr.org/project/wr-std/wikis/wrin1588).

PTP Instances using these options and/or profile will operate correctly in a PTP Network of implementations conformant to the 2008 edition. Since 2008 devices do not implement these options, the improvement of synchronization accuracy will be sub-optimal compared to a PTP Network where all PTP Instance implement these options.

Mixed unicast/multicast operation

Mixed multicast/unicast operation is allowed in the 2008 edition, but not explicitly discussed. In the 2019 edition this communication mode is described in 16.9 including the definition of TLVs to facilitate it.

Option for using cumulative rate ratios

This option is defined in 16.10. It is a mechanism collecting the effect of different clock rates in a network path. The mechanism is not compatible with implementations conformant to the 2008 edition.

Options for monitoring

Options for monitoring PTP implementations are defined in 16.11 for Slave Event Monitoring and Annex M for Performance Monitoring Options.

Enhanced Accuracy Metrics TLV

A TLV, defined in 16.12, carries the worst-case timing errors coming from the Grandmaster and accumulated in the network path. The errors are broken down by static, dynamic and transient. Boundary Clocks and Transparent Clocks which support this option update the fields so that information about the errors so that PTP Instances which receive the TLV have information about time accuracy from PTP at their location in the network.

Message length extension option

A TLV for adding length to a PTP messages is defined in 16.13. This is useful, for example to make Peer delay messages the same length when they travers a media converter which has a message length dependent delay.

Options for greater security

A new TLV is defined, in 16.14. for cryptographic message and source authentication. Additionally there is a new informative annex, Annex S, on security. Annex K in the 2008 edition has been removed.

New PTP Port state configuration options

The new option 17.6 permits external configuration of PTP Port state in PTP Instances conformant to this edition, effectively disabling the BMCA. The new option 17.7 permits absence of some state and <ForeignMasterList> in the implementations conformant to this edition. MasterOnly feature permits configuration of a PTP Port such that it never enters PTP Slave state. These changes are compatible with the specifications of the 2008 edition. The presence of implementations conformant to the 2008 edition in a PTP Network of PTP Instances conformant to this edition can limit the utility of these new options in controlling PTP Network topology since the port states of 2008 devices are determined by the BMCA and not by configuration.