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Part 1AS: Timing and synchronization for time-sensitive applications in bridged local area networks

TECHNICAL CORRIGENDUM 1: Technical and editorial corrections

Technologies de l'information — Télécommunications et échange d'information entre systèmes — Réseaux locaux et métropolitains — Exigences spécifiques —

Partie 1AS: Temporisation et synchronisation pour les applications sensibles au temps des réseaux locaux pontés

RECTIFICATIF TECHNIQUE 1:

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IEEE Std 802.1AS™-2020/Cor 1-2021
(Corrigendum to IEEE Std 802.1AS-2020)

IEEE Standard for
Local and Metropolitan Area Networks—

Timing and Synchronization for Time-Sensitive Applications

Corrigendum 1: Technical and Editorial Corrections

Developed by the

LAN/MAN Standards Committee
of the
IEEE Computer Society

Approved 8 December 2021

IEEE SA Standards Board

Abstract: Technical and editorial corrections to IEEE Std 802.1AS™-2020 are provided in this corrigendum.

Keywords: best master, frequency offset, Grandmaster Clock, Grandmaster PTP Instance, PTP End Instance, PTP Relay Instance, IEEE 802.1AS™, phase offset, synchronization, syntonization, time-aware system

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Introduction

This introduction is not part of IEEE Std 802.1AS-2020/Cor 1-2021, IEEE Standard for Local and Metropolitan Area Networks—Timing and Synchronization for Time-Sensitive Applications—Corrigendum 1: Technical and Editorial Corrections.

The first edition of IEEE Std 802.1AS was published in 2011. A first corrigendum, IEEE Std 802.1AS-2011/Cor1-2013, provided technical and editorial corrections. A second corrigendum, IEEE Std 802.1AS-2011/Cor2-2015 provided additional technical and editorial corrections.

The second edition, IEEE Std 802.1AS-2020, added support for multiple gPTP domains, Common Mean Link Delay Service, external port configuration, and Fine Timing Measurement for 802.11 transport. Backward compatibility with IEEE Std 802.1AS-2011 was maintained.

This corrigendum, IEEE Std 802.1AS-2020/Cor1-2021, provides technical and editorial corrections.

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IEEE Standard for
Local and metropolitan area networks—

Timing and Synchronization for Time-Sensitive Applications

Corrigendum 1: Technical and Editorial Corrections

[This corrigendum is based on IEEE Std 802.1AS™-2020.]

NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.

The editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strikethrough~~ (to remove old material) and <u>underscore</u> (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Deletions and insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editing instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.[6]

[6]Notes in text, tables, and figures are given for information only, and do not contain requirements needed to implement the standard.

5. Conformance

5.4 PTP Instance requirements and options

Change 5.4.1 as follows:

5.4.1 Summary of requirements

An implementation of a PTP Instance shall:

a) Implement the generalized precision time protocol (gPTP) requirements specified in Clause 8.
b) Support the requirements for time-synchronization state machines (10.1.2, 10.2.1, 10.2.2, 10.2.3, 10.2.4, 10.2.5, and 10.2.6).
c) Support at least one PTP Port.
d) On each supported PTP Port, implement the PortSyncSyncReceive state machine (10.2.8).
e) Implement the ClockSlaveSync state machine (10.2.13).
f) Support the following best master clock algorithm (BMCA) requirements:
    1) Implement the BMCA (10.3.1.1, 10.3.1.2, 10.3.2, 10.3.3, 10.3.4, 10.3.5, 10.3.6, 10.3.8, and 10.3.10).
    2) For domain 0, implement specifications for externalPortConfigurationEnabled value of FALSE (10.3.1).
    3) Implement the PortAnnounceReceive state machine (10.3.11).
    4) Implement the PortAnnounceInformation state machine (10.3.12).
    5) Implement the PortStateSelection state machine (10.3.13).
    6) Have the BMCA as the default mode of operation, with externalPortConfiguration FALSE, on domain 0.
    7) Implement at least one of the possibilities for externalPortConfigurationEnabled (i.e., FALSE, meaning the BMCA is used, and TRUE, meaning external port configuration is used) on domains other than domain 0.
g) Implement the SiteSyncSync state machine (10.2.7).
h) Implement the state machines related to signaling gPTP capability (10.4).
i) For receipt of all messages and for transmission of all messages except Announce (see 10.6.3) and Signaling (see 10.6.4), support the message requirements as specified in 10.5, 10.6, and 10.7.
j) Support the performance requirements in B.1 and B.2.4.

Change 5.5 as follows:

5.5 MAC-specific timing and synchronization methods for full-duplex IEEE 802.3 links

An implementation of a time-aware system with IEEE 802.3 media access control (MAC) services to physical ports shall:

a) Support full-duplex operation, as specified in 4.2 and Annex 4A of IEEE Std 802.3-2018.
b) Support the requirements as specified in Clause 11 [with the exception of requirements more specifically addressed in this subclause (5.5)].
c) Implement the SyncIntervalSetting state machine (10.3.18).

d) Provide the Common Mean Link Delay Service (CMLDS) if the time-aware system implements more than one domain, as specified in 11.2.17 and 11.2.18.

An implementation of a PTP Instance with IEEE 802.3 MAC services to physical ports may:

e) Support asymmetry measurement mode as specified in 10.3.12, 10.3.13, 10.3.16, 11.2.14, 11.2.15, 11.2.19, and 14.8.45.

f) Support one-step capability on receive as specified in 11.2.14.

g) Support one-step capability on transmit as specified in 11.2.15.

h) Support the OneStepTxOperSetting state machine specified in 11.2.16.

i) Support propagation delay averaging, as specified in 11.2.19.3.4.

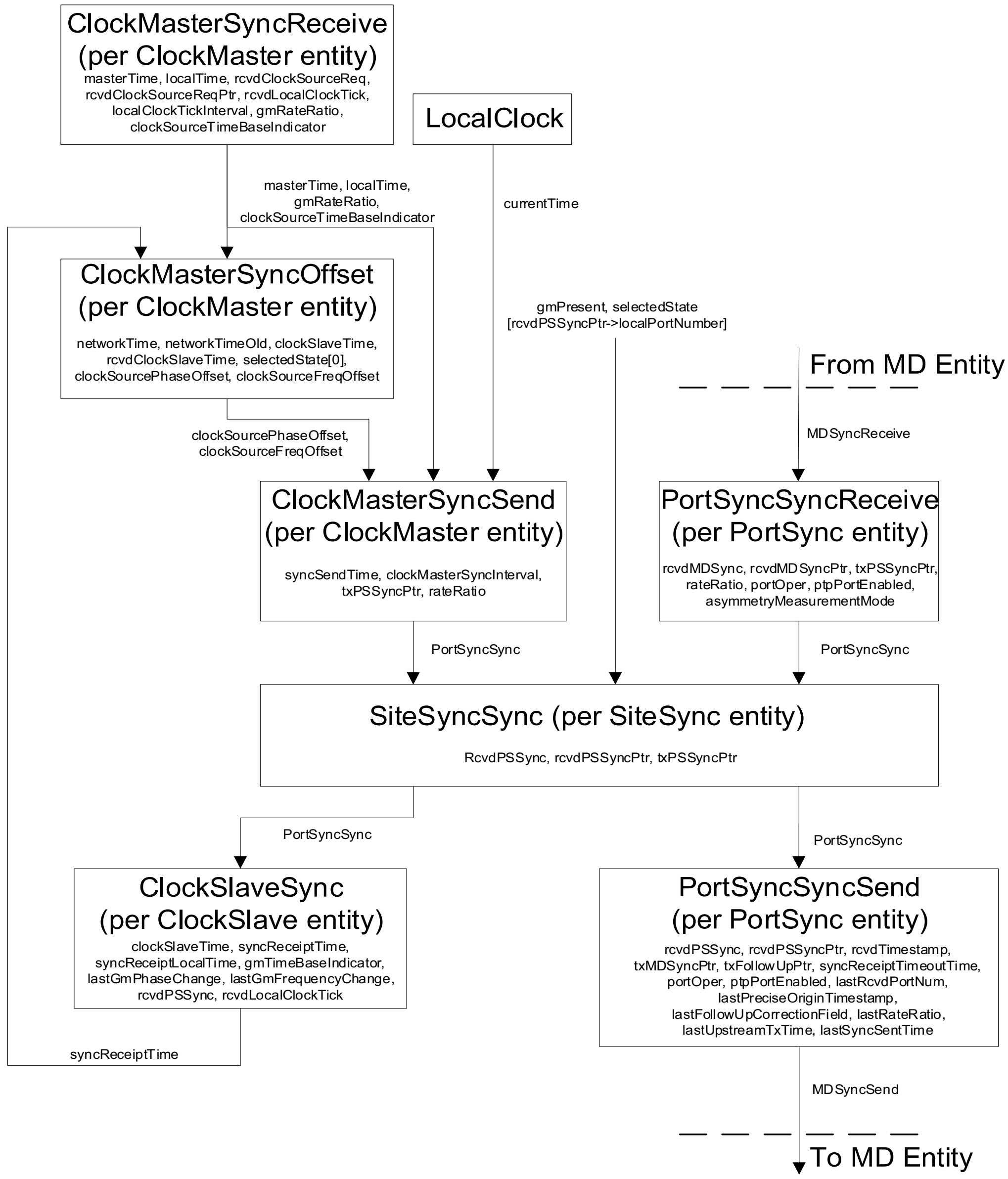
j) Provide the Common Mean Link Delay Service (CMLDS) if the time-aware system implements only one domain, as specified in 11.2.17 and 11.2.18.

10. Media-independent layer specification

10.2 Time-synchronization state machines

10.2.1 Overview

Replace Figure 10-2 with the following figure and insert NOTE immediately after Figure 10-2 as shown:



Notes:
a) selectedState for each port and gmPresent are set by Port State Selection state machine (see 10.3.12)
b) currentTime is a global variable that is always equal to the current time relative to the local oscillator
c) application interfaces to higher layers are not shown
d) the ClockMasterSyncReceive, ClockMasterSyncSend, and ClockMasterSyncOffset state machines are optional for PTP Instances that are not grandmaster-capable.

Figure 10-2—Time-synchronization state machines—overview and interrelationships

NOTE—Figure 10-2 differs from the 2020 edition of this standard in that the global variable syncSequenceId is removed from the ClockMasterSyncSend block.

10.2.5 Per-port global variables

Change 10.2.5.17 as follows:

10.2.5.17 syncSlowdown: A Boolean that is set to TRUE if the SyncIntervalSetting state machine (see Figure 10-20 in 10.3.18.3) receives a TLV that requests a larger sync interval (see 10.7.2.3) and FALSE otherwise. When syncSlowdown is set to TRUE, the PortSyncSyncSend state machine (see Figure 10-8) continues to send time synchronization event messages (see 11.4.3, 12.1, 12.2, and 13.3.1) at the old (i.e., faster) rate until the number of time synchronization event messages equal to syncReceiptTimeout (see 10.7.3.1) have been sent, but with the respective time synchronization event message transmission interval field (see 11.4.2.9, 12.7, Figure 12-8, and 13.3.1.2.10) of the time synchronization event message set equal to the new sync interval (i.e., corresponding to the slower rate). After syncReceiptTimeout Sync messages have been sent, subsequent time synchronization event messages are sent at the new (i.e., slower) rate and with the respective time synchronization event message transmission interval field of the time synchronization event message set to the new sync interval. When syncSlowdown is set to FALSE, the PortSyncSyncSend state machine immediately sends time synchronization event messages at the new (i.e., ~~slower~~faster or the same) rate.

NOTE—If a receiver of time synchronization event messages (see 11.4.3, 12.1, 12.2, and 13.3.1) requests a slower rate, the receiver will continue to use the upstream sync interval value, which it obtains from the respective time synchronization event message transmission interval field (see 11.4.2.9, 12.7, Figure 12-8, and 13.3.1.2.10) of the received time synchronization event message, until it receives a time synchronzation event message where that value has changed. If, immediately after requesting a slower time synchronization event message rate, up to syncReceiptTimeout consecutive time synchronization event messages sent to the receiver are lost, sync receipt timeout could occur if the sender had changed to the slower rate immediately. Delaying the slowing down of the sending rate of time synchronization event messages for syncReceiptTimeout messages prevents this timeout from happening.

Change 10.2.5.19 as follows:

10.2.5.19 gPtpCapableMessageSlowdown: A Boolean that is set to TRUE if the GptpCapableIntervalSetting state machine (see Figure 10-19 in 10.3.17.3) receives a TLV that requests a larger gPTP-capable message interval (see 10.7.2.5) and FALSE otherwise. When gPtpCapableMessageSlowdown is set to TRUE, the GptpCapableTransmit state machine (see Figure 10-21 in 10.4.1.3) continues to send Signaling messages containing the gPTP-capable TLV at the old (i.e., faster) rate until a number of Signaling messages containing the gPTP-capable TLV, equal to gPtpCapableReceiptTimeout (see 10.7.3.3), have been sent, but with the logGptpCapableMessageInterval field of the gPTP-capable TLV (see 10.6.4.5.6) set equal to the new gPTP-capable message interval (i.e., corresponding to the slower rate). After gPtpCapableReceiptTimeout Signaling messages containing the gPTP-capable TLV have been sent, subsequent such Signaling messages are sent at the new (i.e., slower) rate and with the logGptpCapableMessageInterval field of the gPTP-capable TLV set to the new gPTP-capable message interval. When gPtpCapableSlowdown is set to FALSE, the GptpCapableTransmit state machine immediately sends Signaling messages containing the gPTP-capable TLV at the new (i.e., ~~slower~~faster or the same) rate.

NOTE—If a receiver of Signaling messages containing the gPTP-capable TLV requests a slower rate, the receiver will continue to use the old gPTP-capable message interval value in determining, via the GptpCapableReceive state machine (see 10.4.2), if its neighbor is no longer capable of invoking gPTP, until it has received gPtpCapableReceiptTimeout such Signaling messages. If, immediately after requesting a slower rate, up to gPtpCapableReceiptTimeout consecutive Signaling messages, containing the gPTP-capable TLV, sent to the receiver are lost, a declaration that the sender is no longer capable of invoking gPTP could occur if the sender had changed to the slower rate immediately. Delaying the slowing down of the sending rate of Signaling messages containing the gPTP-capable TLV for gPtpCapableReceiptTimeout messages prevents this timeout from happening.

10.3 Best master clock selection, external port configuration, and announce interval setting state machines

10.3.10 Per-port global variables

Change 10.3.10.2 as follows:

10.3.10.2 announceSlowdown: A Boolean that is set to TRUE if the AnnounceIntervalSetting state machine (see Figure 10-19 in item 10.3.17.3) receives a TLV that requests a larger Announce message transmission interval (see 10.7.2.2) and FALSE otherwise. When announceSlowdown is set to TRUE, the PortAnnounceTransmit state machine (see Figure 10-18) continues to send Announce messages at the old (i.e., faster) rate until a number of Announce messages equal to announceReceiptTimeout (see 10.7.3.2) have been sent, but with the logMessageInterval field of the PTP common header set equal to the new announce interval (i.e., corresponding to the slower rate). After announceReceiptTimeout Announce messages have been sent, subsequent Announce messages are sent at the new (i.e., slower) rate and with the logMessageInterval field of the PTP common header set to the new announce interval. This variable is used by both the BMCA and the explicit port state configuration option. When announceSlowdown is set to FALSE, the PortAnnounceTransmit state machine immediately sends Announce messages at the new (i.e., ~~slower~~faster or the same) rate.

NOTE—If a receiver of Announce messages requests a slower rate, the receiver will continue to use the upstream announceInterval value, which it obtains from the logMessageInterval field of received Announce messages, until it receives an Announce message where that value has changed. If, immediately after requesting a slower Announce message rate, up to announceReceiptTimeout minus one consecutive Announce messages sent to the receiver are lost, announce receipt timeout could occur if the sender had changed to the slower rate immediately. Delaying the slowing down of the sending rate of Announce messages for announceReceiptTimeout messages prevents announce receipt timeout from occurring until at least announceReceiptTimeout Announce messages have been lost. Note that networks with high packet loss can still experience announce receipt timeout under high-packet-loss conditions; however, the announce receipt timeout condition occurs only after at least announceReceiptTimeout Announce messages have been lost.

10.3.17 AnnounceIntervalSetting state machine

10.3.17.3 State diagram

Replace Figure 10-19 with the following figure and insert the NOTE immediately after Figure 10-19 as shown:

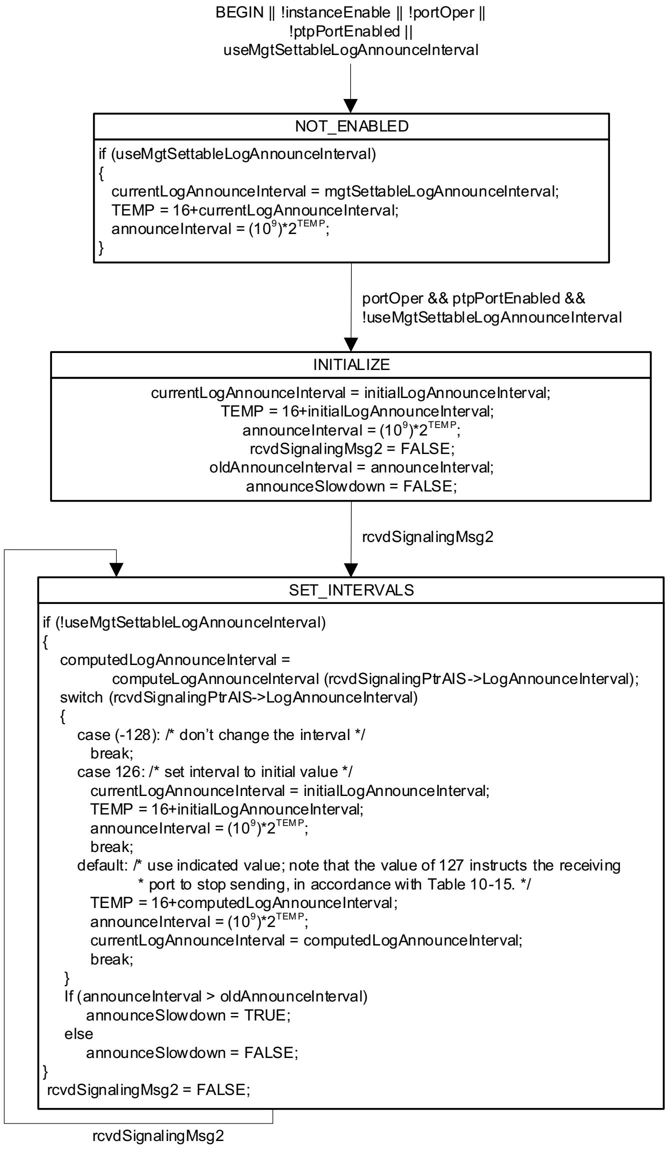


Figure 10-19—AnnounceIntervalSetting state machine

NOTE—Figure 10-19 differs from the 2020 edition of this standard in that the condition for setting announceSlowdown to TRUE is changed from “announceInterval < oldAnnounceInterval” to “announceInterval > oldAnnounceInterval.”

10.3.18 SyncIntervalSetting state machine

10.3.18.3 State diagram

Replace Figure 10-20 with the following figure and insert the NOTE immediately after Figure 10-20 as shown:

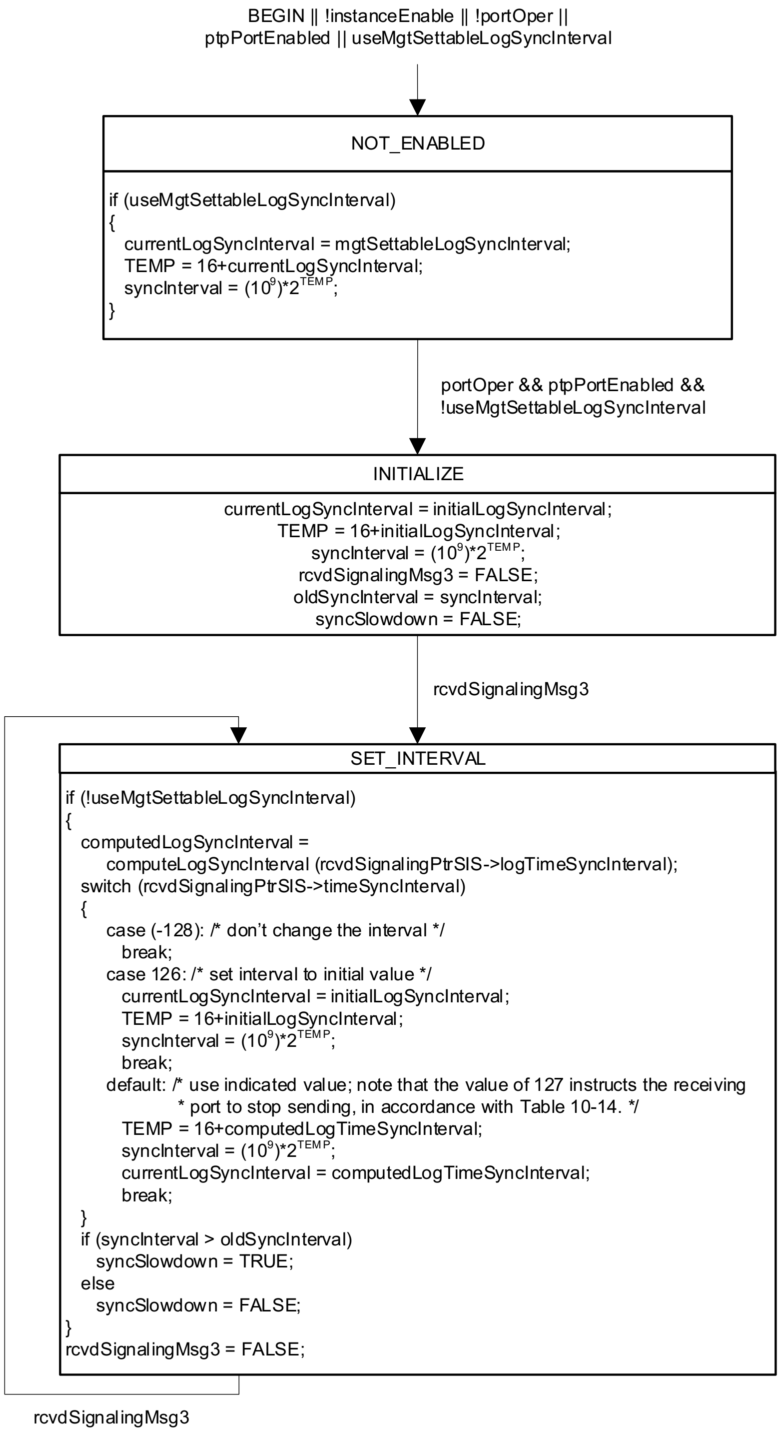


Figure 10-20—SyncIntervalSetting state machine

NOTE—Figure 10-20 differs from the 2020 edition of this standard in that the condition for setting syncSlowdown to TRUE is changed from “syncInterval < oldSyncInterval” to “syncInterval > oldSyncInterval.”

10.4 State machines related to signaling gPTP capability

10.4.3 GptpCapableIntervalSetting state machine

10.4.3.3 State diagram

Replace Figure 10-23 with the following figure and insert the NOTE immediately after Figure 10-23 as shown:

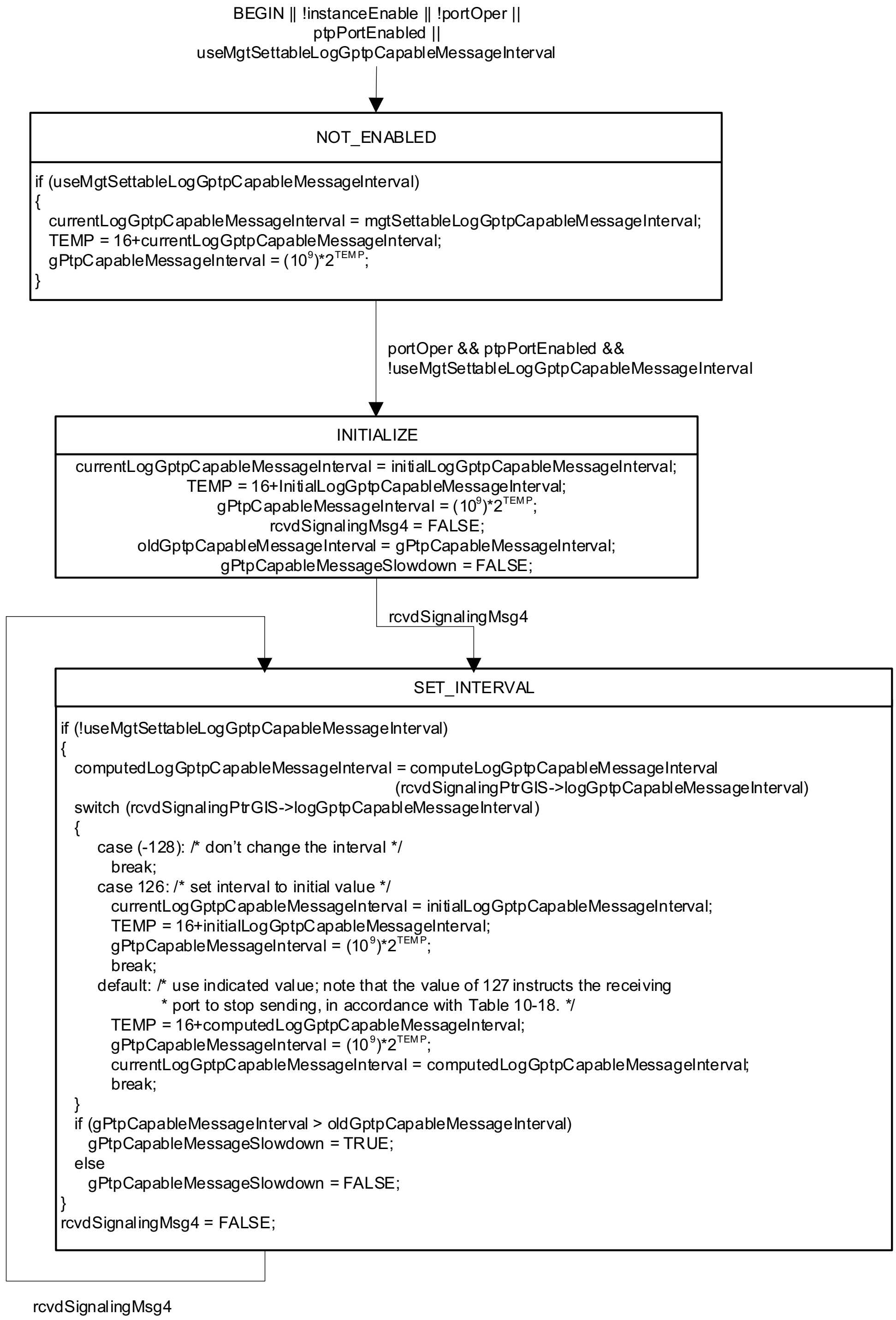


Figure 10-23—GptpCapableIntervalSetting state machine

NOTE—Figure 10-23 differs from the 2020 edition of this standard in that the condition for setting gPtpCapableMessageSlowdown to TRUE is changed from "gPtpCapableMessageInterval < oldGptpCapableMessageInterval" to "gPtpCapableMessageInterval > oldGptpCapableMessageInterval."

11. Media-dependent layer specification for full-duplex point-to-point links

11.2 State machines for MD entity specific to full-duplex point-to-point links

11.2.1 General

Replace Figure 11-4 with the following figure and insert the NOTE immediately after Figure 11-4 as shown:

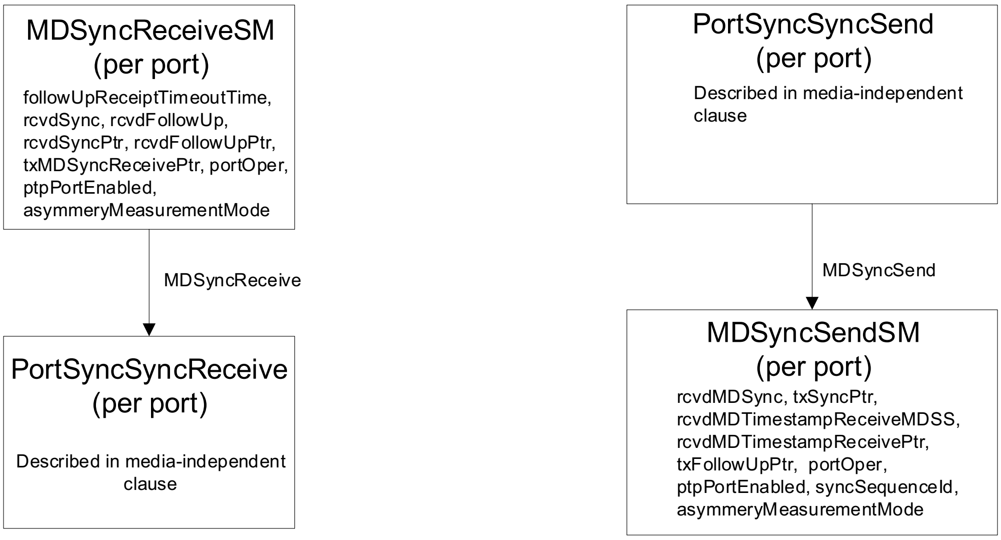


Figure 11-4—Detail of MD entity time-synchronization state machines for full-duplex point-to-point links

NOTE—Figure 11-4 differs from the 2020 edition of this standard in that the global variable syncSequenceId is added to the MDSyncSendSM block.

11.2.19 MDPdelayReq state machine

11.2.19.4 State diagram

Replace Figure 11-9 with the following figure and insert the NOTE immediately after Figure 11-9 as shown:

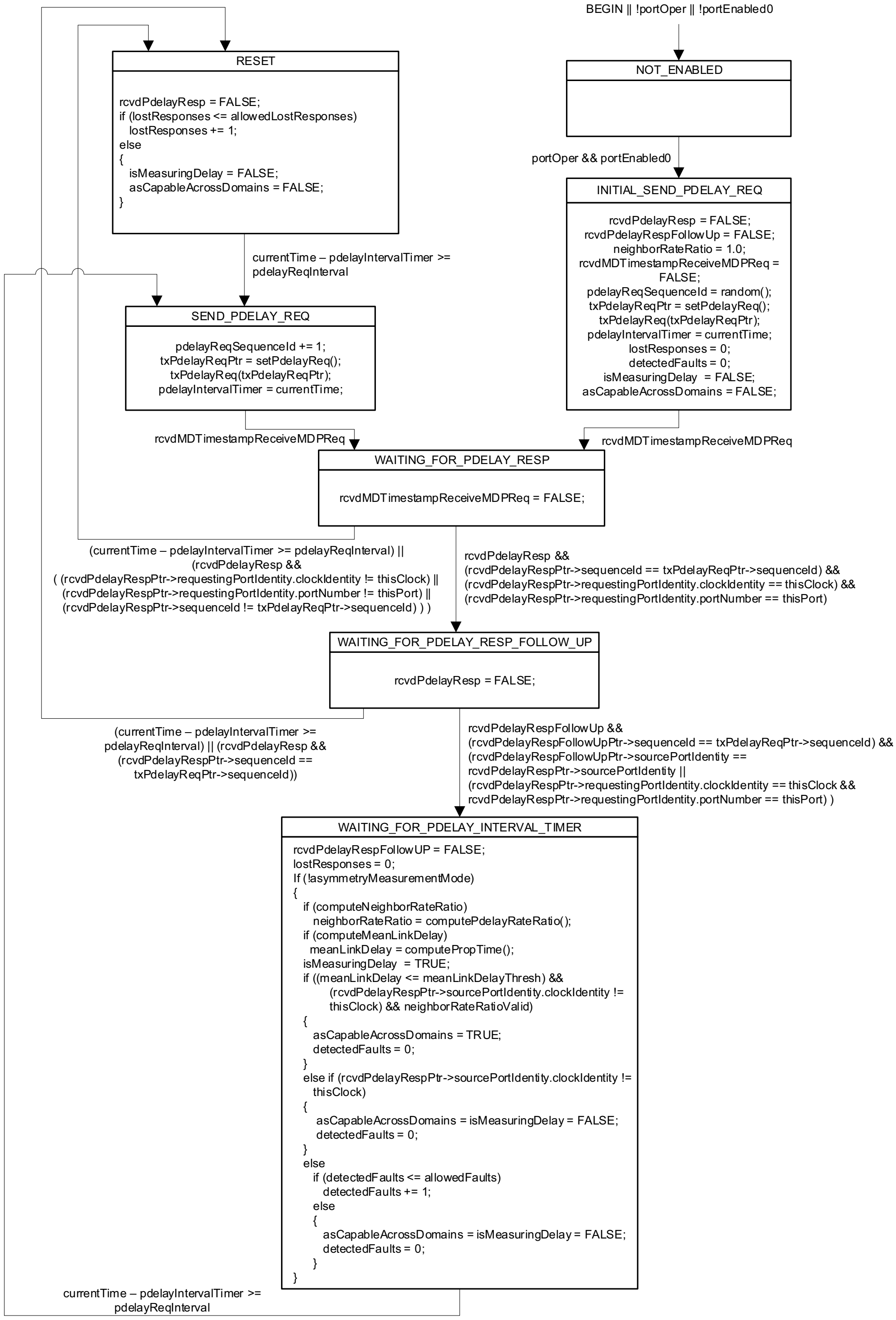


Figure 11-9—MDPdelayReq state machine

NOTE—Figure 11-9 differs from the 2020 edition of this standard in that a close curly brace is added on a new line just after the final line of the existing text in the WAITING_FOR_PDELAY_INTERVAL_TIMER state of the MDPdelayReq state machine.

12. Media-dependent layer specification for IEEE 802.11 links

12.5 State machines

12.5.1 Media-dependent master state machines

Change 12.5.1.2 as follows:

12.5.1.2 State diagrams

NOTE—In the computation of the burstDuration in master state machine B, the burst duration parameter from IEEE Std 802.11~~-2016~~ is converted to UScaledNs (i.e., units of 2^{-16} ns; see ~~6.3.3.2~~6.4.3.2~~ of IEEE Std 802.11-2016~~). The burst duration in UScaledNs (see 6.4.3.2) is related to the quantity *A* = initReqParamsDot11MasterB.burstDuration–2 by:

$$\text{burst duration in UScaledNs } = 1000 \cdot (2^{16}) \cdot 250 \cdot 2^{A}$$

i.e., *A* is the logarithm to base 2 of the burst duration, in microseconds, divided by 250. Also, it is assumed that the burst duration starts when the initial FTM request is received. In actuality, the timer begins by the partial TSF timer value indicated in the initial FTM frame, which is slightly after the initial FTM request is received.

16. Media-dependent layer specification for CSN

16.5 Synchronization messages

16.5.3 Synchronization message propagation on a CSN with network reference clock

16.5.3.2 CSN ingress node

16.5.3.2.2 CSN TLV

16.5.3.2.2.1 General

Replace Table 16-1 with the following table:

.

Table 16-1—CSN TLV

Bits (7 6 5 4 3 2 1 0)	Octets	Offset from start of TLV
tlvType	2	0
lengthField	2	2
organizationId	3	4
organizationSubType	3	7
upstreamTxTime	12	10
neighborRateRatio	4	22
meanLinkDelay	12	26
delayAsymmetry	12	38
domainNumber	1	50

Annex A

(normative)

Protocol Implementation Conformance Statement (PICS) proforma[7]

Change A.7 as follows:

A.7 Minimal time-aware system

Item	Feature	Status	References	Support
MINTA-16	For receive of all messages and for transmit of all messages except Announce and Signaling, does the PTP Instance support the message requirements?	M	item i) of ~~5.4~~5.4.1, 10.5, 10.6, 10.7	Yes [ ]

Insert rows at the bottom of the table in A.13 as follows:

A.13 Media-dependent, full-duplex point-to-point link

Item	Feature	Status	References	Support
MDFDPP-36	If the time-aware system implements more than one domain, does the time-aware system provide CMLDS?	MDFDPP:M	11.2.17.1	Yes [ ]
MDFDPP-37	If the time-aware system implements only one domain, does the time-aware system provide CMLDS?	MDFDPP:O	11.2.17.2	Yes [ ] No [ ]

[7] *Copyright release for PICS proformas:* Users of this standard may freely reproduce the PICS proforma in this annex so that it can be used for its intended purpose and may further publish the completed PICS.