P802.1ASds/D0.3
April 1, 2024
(Amendment to IEEE Std 802.1AS™-202x)

Draft Standard for Local and metropolitan area networks—

Timing and Synchronization for Time-Sensitive Applications

Amendment: Support for the IEEE Std 802.3 Clause 4 Media Access Control (MAC) operating in half-duplex

Sponsor

LAN/MAN Standards Committee of the **IEEE Computer Society**

Time-Sensitive Networking (TSN) Task Group of IEEE 802.1

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The text proper of this draft begins with the title page (1). The cover pages (a), (b), (c) etc. are for 802.1 WG information, and will be removed prior to Sponsor Ballot.

Editors' Foreword

This draft standard is an amendment. The scope of changes to the base standard is thus strictly limited, as detailed in the PAR.

Information on participation in this project, and in the IEEE 802.1 Working Group can be found here.

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Project Authorization Request, Scope, Purpose, and Criteria for Standards Development (CSD)

The complete amendment PAR, as approved by IEEE NesCom 23 February 2022, can be found at:

https://development.standards.ieee.org/myproject-web/public/view.html#pardetail/9522

The ‘Scope of the Proposed changes’ and the ‘Need for the Project’ specify the changes to be made by this amendment (see below).

Scope of the Proposed changes:

This amendment specifies protocols, procedures, and managed objects that support IEEE Std 802.3 Clause 4 Media Access Control (MAC) operating in half-duplex while retaining existing functionality and backward compatibility, and remaining a profile of IEEE Std 1588™-2019.
This amendment addresses errors and omissions in the description of existing functionality.

Need for the Project:

Support is needed in applications such as automotive in-vehicle networks and industrial automation networks for the IEEE Std 802.3 Clause 4 MAC operating in half-duplex, including those using links with the 10BASE-T1S PHY in either point-to-point or multidrop half-duplex mode recently introduced by IEEE Std 802.3cg-2019.

Criteria for Standards Development:

The complete Criteria for Standards Development (CSD) can be found at:

https://mentor.ieee.org/802-ec/dcn/21/ec-21-0308-00-ACSD-p802-1asds.pdf

Draft IEEE Standard for Local and metropolitan area networks—

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Amendment: Support for the IEEE Std 802.3 Clause 4 Media Access Control (MAC) operating in half-duplex

[This amendment is based on IEEE Std 802.1AS™-20xx (IEEE Std 802.1AS™-2020 Revision).

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 underscore (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.[1]

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

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Prepared by the
Time-Sensitive Networking (TSN)Task Group of IEEE 802.1

Sponsor
LAN/MAN Standards Committee
of the
IEEE Computer Society

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Abstract: This amendment to IEEE Std 802.1AS™-2020 specifies protocols, procedures, and managed objects that support IEEE Std 802.3 Clause 4 Media Access Control (MAC) operating in half-duplex while retaining existing functionality and backward compatibility, and remaining a profile of IEEE Std 1588™-2019.

This amendment addresses errors and omissions in the description of existing functionality.

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

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

PDF: ISBN 978-X-XXX-XXX-X STDXXXXX
Print: ISBN 978-X-XXX-XXX-X STDPDXXXXX

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Jessy Rouyer, *Vice Chair*
János Farkas, *TSN Task Group Chair*
Silvana Rodrigues, *Editor IEEE Std 802.1AS*
Silvana Rodrigues, *Editor P802.1ASds*

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

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Introduction

This introduction is not part of IEEE Std 802.1ASds™-20xx, IEEE Standard for Local and metropolitan area networks—Timing and Synchronization for Time-Sensitive Applications—Amendment: Support for the IEEE Std 802.3 Clause 4 Media Access Control (MAC) operating in half-duplex

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

The third edition, IEEE Std 802.1AS-202x is a roll-up of IEEE Std 802.1AS-2020 with the corrigendum IEEE Std 802.1AS-2020/Cor1, and its amendments: IEEE Std 802.1ASdr, IEEE Std 802.1ASdn, and IEEE Std 802.1ASdm.

This amendment to IEEE Std 802.1AS-202x specifies protocols, procedures, and managed objects that support IEEE Std 802.3 Clause 4 Media Access Control (MAC) operating in half-duplex while retaining existing functionality and backward compatibility, and remaining a profile of IEEE Std 1588™-2019.

This amendment addresses errors and omissions in the description of existing functionality

<<Editor's note: P802.1ASds is an amendment to 802.1AS-REV>>

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IEEE Standard for Local and Metropolitan Area Networks — Timing and Synchronization for Time-Sensitive Applications

Amendment: Support for the IEEE Std 802.3 Clause 4 Media Access Control (MAC) operating in half-duplex

1. Overview

1.1 Scope

This standard specifies protocols, procedures, and managed objects used to ensure that the synchronization requirements are met for time-sensitive applications, such as audio, video, and time-sensitive control, across networks, for example, IEEE 802 and similar media. This includes the maintenance of synchronized time during normal operation and following addition, removal, or failure of network components and network reconfiguration. It specifies the use of IEEE Std 1588™ specifications where applicable in the context of IEEE Std 802.1Q™-2018. Synchronization to an externally provided timing signal [e.g., a recognized timing standard such as Coordinated Universal Time (UTC) or International Atomic Time (TAI)] is not part of this standard but is not precluded.

1.2 Purpose

This standard enables systems to meet the respective jitter, wander, and time-synchronization requirements for time-sensitive applications, including those that involve multiple streams delivered to multiple end stations. To facilitate the widespread use of packet networks for these applications, synchronization information is one of the components needed at each network element where time-sensitive application data are mapped or demapped or a time-sensitive function is performed. This standard leverages the work of the IEEE 1588 Working Group by developing the additional specifications needed to address these requirements

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).[1,2]

The word *should* indicates 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 (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals is *able to*).

[1] The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

[2] The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

3. Definitions

Insert the following definitions in Clause 3, and renumber the definitions as appropriate:

3.17 Half-duplex Ethernet: An Ethernet whose physical ports use the IEEE Std 802.3™ Clause 4 MAC in half-duplex mode, independent of the physical medium access method and independent of the physical topology of the shared medium connected.

4. Acronyms and abbreviations

Insert the following acronym in clause 4 as follows:

HDE	Half-duplex Ethernet

5. Conformance

Insert 5.9 as follows:

5.9 MAC-specific timing and synchronization methods for HDE links

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

a) Support half-duplex operation, as specified in Clause 4 of IEEE Std 802.3-2022.
b) Support the requirements as specified in 19.

7. Time-synchronization model for a packet network

7.2 Architecture of a time-aware network

7.2.1 General

Add item g) after item f) in the lettered list in 7.2.1 as follows:

g) IEEE 802.3 Clause 4 Media Access Control (MAC) operating in half-duplex (Clause 19)

8. IEEE 802.1AS concepts and terminology

8.5 Ports

8.5.1 General

Change 8.5.1 as follows:

The PTP Instances in a gPTP domain interface with the network media via physical ports. gPTP defines a logical port, i.e., a PTP Port, in such a way that communication between PTP Instances is point-to-point or, in the case of an HDE link (see Clause 19), point-to-multipoint. A logical port consists of one PortSync entity and one media-dependent (MD) entity. Multiple PTP Ports can be associated with a single physical port. ~~even over physical ports that are attached to shared media. One~~ For shared media, there are multiple possibilities:

a) one logical port~~, consisting of one PortSync entity and one media-dependent (MD) entity, is~~ can be instantiated for each PTP Instance with which the PTP Instance communicates, i.e., the PTP communication paths are logically point-to-point even though the physical port is attached to a shared medium, e.g., CSN (see 16); or

b) the PTP communication path can be logically point-to-multipoint, e.g., for an HDE link (see 19). ~~For shared media, multiple logical ports can be associated with a single physical port.~~

Unless otherwise qualified, each instance of the term *port* refers to a *logical port*.

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

11.1 Overview

11.1.1 General

Add a NOTE at the end of 11.1.1 as follows:

NOTE—PTP links using the IEEE 802.3 Clause 4 MAC operating in half-duplex mode are specified in Clause 19."

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

11.2.2 Determination of asCapable and asCapableAcrossDomains

Change 11.2.2 as follows:

There is one instance of the global variable asCapable (see 10.2.5.1) per PTP Port, per domain. There is one instance of the global variable asCapableAcrossDomains (see 11.2.13.12), per port, that is common across, and accessible by, all the domains.

The per-PTP Port global variable asCapable (see 10.2.5.1) indicates whether the IEEE 802.1AS protocol is operating, in this domain, on the PTP Link attached to this PTP Port, and can provide the required time-synchronization performance ~~described in B.3~~. asCapable is used by the PortSync entity, which is media-independent; however, the determination of asCapable is media-dependent.

The per-port global variable asCapableAcrossDomains is set by the MDPdelayReq state machine (see 11.2.19 and Figure 11-9). For a port attached to a full-duplex point-to-point PTP Link or to an HDE link, asCapableAcrossDomains shall be set to TRUE if and only if either:

a) I~~i~~t is determined, via the peer-to-peer delay mechanism, that the following conditions hold for the port:
   1) ~~a)~~The port is exchanging peer delay messages with its neighbor,
   2) ~~b)~~The measured delay does not exceed meanLinkDelayThresh,
   3) ~~c)~~The port does not receive multiple Pdelay_Resp or Pdelay_Resp_Follow_Up messages in response to a single Pdelay_Req message, and
   4) ~~d)~~The port does not receive a response from itself or another PTP Port of the same PTP Instance.

or:

b) pdelayReqSendDisabled is set to TRUE

NOTE 1—If a PTP Instance implements only domain 0 and the MDPdelayReq and MDPdelayResp state machines are invoked on domain 0 (see 11.2.19), asCapableAcrossDomains is still set by the MDPdelayReq state machine.

The default value of meanLinkDelayThresh shall be set as specified in Table 11-1.

Table 11-1—Value of meanLinkDelayThresh for various links

Link	Value of meanLinkDelayThresh (ns) (see NOTE)
100BASE-TX, 1000BASE-T	800_{10}
100BASE-FX, 1000BASE-X, HDE	FFFF FFFF FFFF FFFF FFFF FFFF$_{16}$
NOTE—The actual propagation delay for 100BASE-TX and 1000BASE-T links is expected to be smaller than the above respective threshold. If the measured mean propagation delay (i.e., meanLinkDelay; see 10.2.5.8) exceeds this threshold, it is assumed that this is due to the presence of equipment that does not implement gPTP. For 100BASE-FX, ~~and~~ 1000BASE-X, and ~~-~~HDE links, the actual propagation delay can be on the order of, or larger than, the delay produced by equipment that does not implement gPTP; therefore, such equipment cannot be detected by comparing measured propagation delay with a threshold. In this case, meanLinkDelayThresh is set to the largest possible value (i.e., all 1s).	

<<Editor's note: Table 11-1 may need to be generalized.>>

The per-PTP Port, per-domain global variable asCapable shall be set to TRUE if and only if the following conditions hold:

c) ~~c)~~The value of asCapableAcrossDomains is TRUE, and

d) ~~d)~~One of the following conditions holds:

1) The value of neighborGptpCapable for this PTP Port is TRUE, or

2) The value of domainNumber is zero, and the value of sdoId for peer delay messages received on this PTP Port is 0x100.

NOTE 2—Condition ~~d)~~d) 2) ensures backward compatibility with the 2011 edition of this standard. A PTP Instance compliant with the current edition of this standard that is attached, via a full-duplex point-to-point PTP Link, to a PTP Instance compliant with the 2011 edition of this standard will not receive Signaling messages that contain the gPTP capable TLV and will not set neighborGptpCapable to TRUE. However, condition ~~d)~~d) 2) ensures that asCapable for this PTP Port and domain (i.e., domain 0) will still be set to TRUE if condition c) holds because the peer delay messages received from the time-aware system compliant with the 2011 edition of this standard will have sdoId set to 0x100.

11.2.13 MD entity global variables

Change 11.2.13.12 as follows:

11.2.13.12 asCapableAcrossDomains: A Boolean that is TRUE if and only if either: 1) conditions a) through d) of 11.2.2 are satisfied, or 2) pdelayReqSendDisabled is set to TRUE. ~~This Boolean~~ asCapableAcrossDomains is set by the MDPdelayReq state machine and is used in determining asCapable for a port (see 11.2.2). There is one instance of this variable for all the domains (per port)) for full-duplex point-to-point links. ~~T~~and the variable is accessible by all the domains. There is one instance of this variable per PTP Instance (i.e., per domain) for HDE links (see 19.2.2). When only one domain is active, asCapableAcrossDomains is equivalent to the variable asCapable (see 10.2.5.1).

11.2.19 MDPdelayReq state machine

11.2.19.2 State machine variables

Change 11.2.19.2.2 as follows:

11.2.19.2.2 rcvdPdelayResp: A Boolean variable that notifies the current state machine when a Pdelay_Resp message is received and its requestingPortIdentity.clockIdentity is equal to the clockIdentity of the current PTP Instance. This variable is reset by the current state machine.

Change 11.2.19.2.4 as follows:

11.2.19.2.4 rcvdPdelayRespFollowUp: A Boolean variable that notifies the current state machine when a Pdelay_Resp_Follow_Up message is received and its requestingPortIdentity.clockIdentity is equal to the clockIdentity of the current PTP instance. This variable is reset by the current state machine.

Insert a new variable after 11.2.19.2.13 as follows:

11.2.19.2.14 pdelayReqSendDisabled: A boolean that is administratively set to TRUE if Pdelay_Req messages are not transmitted by this port. The default value for this variable shall be FALSE.

11.2.19.4 State diagram

Replace Figure 11-9 with the following:.

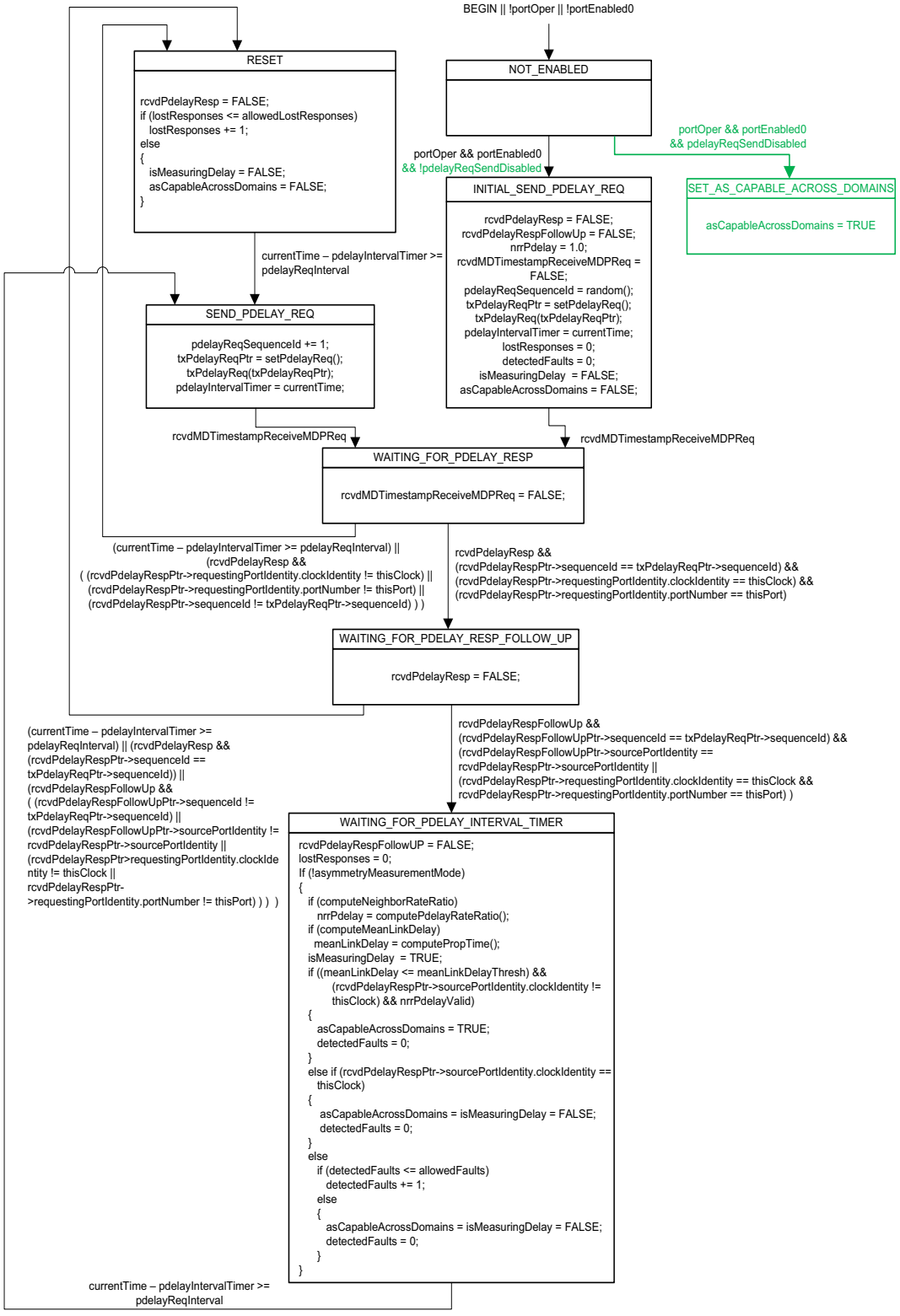


Figure 11-9—MDPdelayReq state machine

Add a NOTE after Figure 11-9 as follows:

NOTE—A change in the value of the variable pdelayReqSendDisabled takes effect only when portEnabled0 (see 11.2.19.2.12) is FALSE.

11.2.20 MDPdelayResp state machine

11.2.20.2 State machine variables

Insert a new variable after 11.2.20.2.5 as follows:

11.2.20.2.6 pdelayRespSendDisabled: A boolean that is administratively set to TRUE if Pdelay_Resp messages are not transmitted by this port. The default value for this variable shall be FALSE.

11.2.20.4 State diagram

.***Replace Figure 11-10 with the following:***

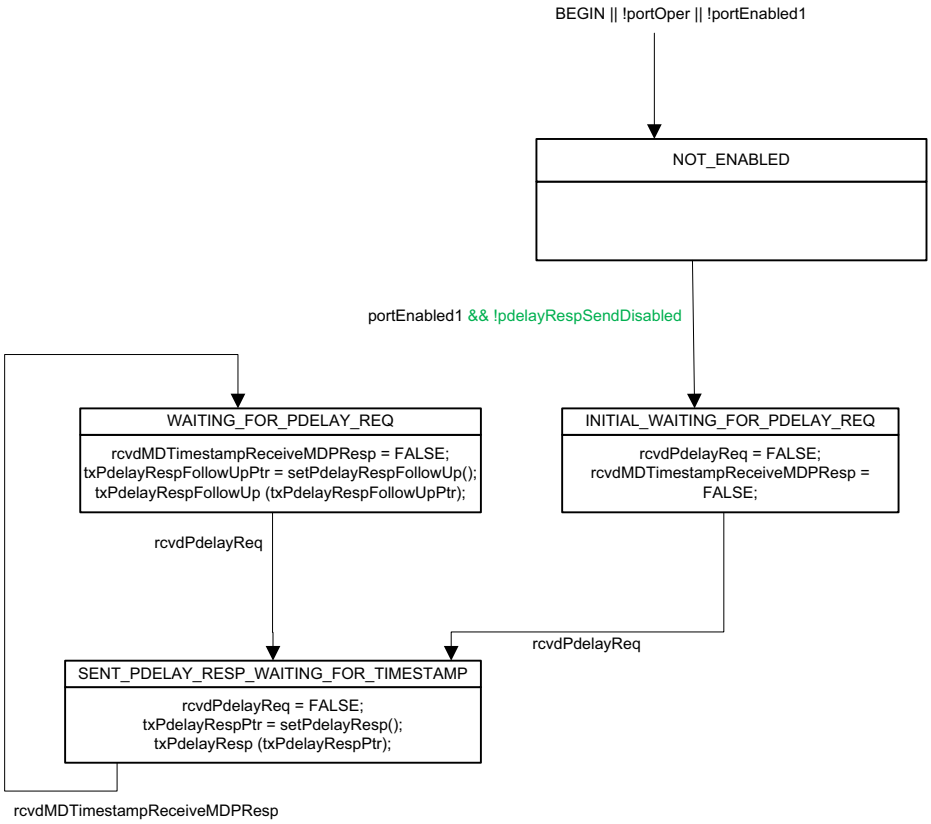


Figure 11-10—MDPdelayResp state machine

Add a NOTE after Figure 11-10 as follows:

NOTE—A change in the value of the variable pdelayRespSendDisabled takes effect only when portEnabled1 (see 11.2.20.2.5) is FALSE.

14. Timing and synchronization management

14.8 Port Parameter Data Set (portDS)

Insert 14.8.59 and 14.8.60 as follows:

14.8.59 pdelayReqSendDisabled

The value is equal to the value of the per-PTP Port global variable pdelayReqSendDisabled (see 11.2.19.2.14). If its value is TRUE, the Pdelay_Req messages are not transmitted by the PTP Port. The default value for this variable shall be FALSE.

14.8.60 pdelayRespSendDisabled

The value is equal to the value of the per-PTP Port global variable pdelayRespSendDisabled (see 11.2.20.2.6). If its value is TRUE, the Pdelay_Resp messages are not transmitted by the PTP Port. The default value for this variable shall be FALSE.

14.8.59 portDS table

Insert the following items after the final item of Table 14-10:

Table 14-10—portDS table

Name	Data type	Operations supported[a]	References
pdelayReqSendDisabled	Boolean	RW	14.8.59
pdelayRespSendDisabled	Boolean	RW	14.8.60

[a] R = Read only access; RW = Read/write access.

Insert the following new Clause 19:

19. Media-dependent layer specification for IEEE 802.3 Clause 4 Media Access Control (MAC) operating in half-duplex

19.1 Overiew

19.1.1 General

Accurate synchronized time is distributed throughout a gPTP domain through time measurements between adjacent PTP Relay Instances or PTP End Instances in a packet network. Time is communicated from the root of the clock spanning tree (i.e., the Grandmaster PTP Instance) toward the leaves of the tree (i.e., from leaf-facing timeTransmitter ports to root-facing timeReceiver ports) through measurements made across the links connecting the PTP Instances. While the semantics of time transfer are consistent across the time-aware packet network, the method for communicating synchronized time from a timeTransmitter port to its immediate downstream link partner(s) varies depending on the type of link interconnecting the two or more PTP Instances. This clause specifies the protocol that provides accurate synchronized time across links that use IEEE 802.3 (Ethernet) Clause 4 MACs operating in half-duplex mode as part of a packet network.

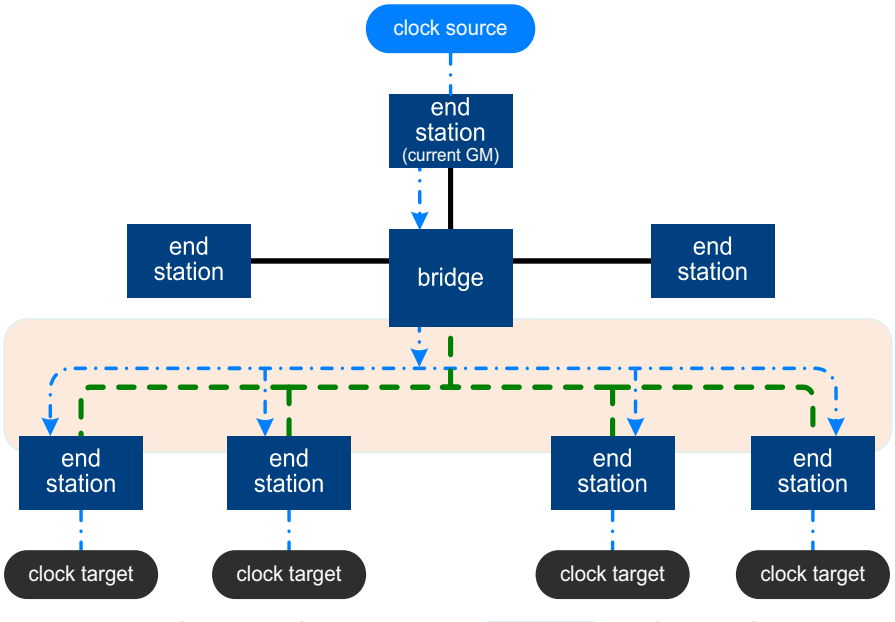
19.1.1.1 Half-duplex Ethernet (HDE) characteristics

The Ethernet IEEE 802.3 Clause 4 MAC can operate in either full-duplex or half-duplex mode. When this MAC is operating in full-duplex, its media-dependent specification for gPTP is covered in Clause 11 of this document. The present clause is used when the 802.3 Clause 4 MAC is operating in half-duplex as this mode necessitates additional managed object settings and frame processing due to the effects of the shared media this mode supports.

NOTE—Shared media allow multiple devices to be connected to the same physical wire without the need of bridges or PTP Relay Instances between them, as shown in Figure 19-1.

A half-duplex Ethernet (HDE) network is a Carrier Sense Multiple Access with Collision Detect (CSMA/CD) network when used with most IEEE 802.3 physical layer devices (PHYs) specified to connect to the 802.3's Clause 4 MAC. The CSMA/CD mechanism allows only one device at a time to successfully transmit a frame on the shared media using a non-deterministic random back-off mechanism whenever a collision is detected (see Clause 4.2 of IEEE Std 802.3-2022). This mechanism supports a deterministic, collision-free, network when used with an 802.3 PHY that supports Physical Layer Collision Avoidance (PLCA - see Clause 148 of IEEE Std 802.3-2022 and 19.3).

The same Clause 4 MAC operating in half-duplex mode can be used with either PHY type (i.e., PLCA or not). While gPTP could know what kind of PHY is attached to a given MAC via managed objects, the frames the MAC receives and passes up to the gPTP layer are not different based on the PHY being used, as every MAC only receives frames successfully transmitted on the wire. Therefore, both PHY types can use the same gPTP protocol as long as the timestamps follow 8.4.3. This is due to gPTP being a higher layer protocol that only deals with successfully received frames.



Note 1: The "bridge" in this figure is an example of a time-aware system that contains a PTP Relay Instance, and the end stations with clock targets are examples of time-aware systems that contain PTP End Instances.
Note 2: GM denotes Grandmaster PTP Instance

Figure 19-1—Time-aware network example where the lower links use HDE

When using HDE links, the use of neighbor refers to device or devices (end station or bridge) that is/are the intended recipient(s) of a transmitted PTP message.The intended recipient may not be the next physically closest device that is attached to the shared media.

19.1.1.2 Half-duplex Ethernet (HDE) using PLCA (10BASE-T1S) PHYs

IEEE 802.3 PHYs that support Physical Layer Collision Avoidance (PLCA) form deterministic links by avoiding the MAC's random back-off caused by collisions (see Clause 148 of IEEE Std 802.3-2022). Simply stated, collisions are avoided by assigning local_nodeIDs that represent a device's transmit opportunity number. One of the devices on the link sends out a BEACON, which starts the transmit opportunity cycle. Following each BEACON, the lowest local_nodeID gets to transmit first (assuming it has a frame ready to transmit) followed by the next higher local_nodeID, etc., until all the link's local_nodeIDs have been given a transmit opportunity. Then the process is repeated with another BEACON.

NOTE 1—In IEEE Std 802.3-2022, the only PHY that supports PLCA is 10BASE-T1S, which is specified in Clause 147 of IEEE Std 802.3-2022.

NOTE 2—Configuration of PLCA local_nodeID numbers, etc., are out of scope of this standard.

19.1.1.3 Overview of the major differences and restrictions of using HDE

The present clause uses 11 in its entirety with the following major differences and restrictions (complete details follow starting in 19.1.2).

a) The peer delay initiator is restricted to timeReceivers only (see 19.1.2).
b) One-step time transport is not supported (see 19.1.3 and 19.2.16)
c) CMLDS is not supported (see 19.2.17)
d) External port configuration mode is the only mode supported (see 19.8)
e) The use of Signaling messages is not specified (see 19.8)

19.1.2 Propagation delay measurement over links

The measurement of propagation delay on an HDE PTP Link using the peer-to-peer delay mechanism is illustrated in Figure 11-1 and is described in 11.1.2, with the exception that the peer delay initiator is restricted to each timeReceiver port (e.g., an end station) and the timeTransmitter port does not initiate the peer-to-peer delay mechanism. Therefore, pdelayReqSendDisabled and pdelayRespSendDisabled are set as follows:

a) pdelayReqSendDisabled shall be set to TRUE for a timeTransmitter port or a PassivePort.
b) pdelayRespSendDisabled shall be set to TRUE for a timeReceiver port or a PassivePort.

19.1.3 Transport of time-synchronization information

The transport of time-synchronization information by a PTP Instance, using Sync and Follow_Up messages, is illustrated in Figure 11-2.

HDE links shall use two-step time transport as described in clause 11.1.3.

19.1.4 Model of operation

A PTP Instance contains one MD entity per PTP Instance, per PTP Port. This entity contains functions generic to all media, which are described in Clause 10, and functions specific to the respective medium for the PTP Link. Functions specific to HDE links are described in the current clause.

The model for a PTP Instance of a time-aware system with full-duplex point-to-point links is shown in Figure 11-3. This (HDE) Clause reuses Figure 11-3 (as its structure is unchanged for this clause), where all references to clause 11 in Figure 11-3 are to be replaced by references to clause 19 (this clause). The presence of one HDE MD entity per PTP Port is assumed. The media-independent entities shown in Figure 11-3 are described in 10.1.2.

A general, media-independent description of the generation of timestamps is given in 8.4.3. A more specific description for PTP event messages is given in 11.3.2.1. A PTP event message is timestamped relative to the LocalClock entity when the message timestamp point (see 3.17) crosses the timestamp measurement plane (see 3.33). The timestamp is corrected for any ingressLatency or egressLatency (see 8.4.3) to produce a timestamp relative to the reference plane (see 3.26). The corrected timestamp value is provided to the MD entity.

The MD entity behavior and detailed state machines specific to full-duplex point-to-point links, which are described in 11.2, are reused for HDE links subject to the conditions defined in 19.2. The behavior of the MD entity that is generic to all media is described in Clause 10.

19.2 State machines for HDE links

<<**Editor's note: Need to check the changes made in P802.1ASdm to clause 11.2 and its subclauses whether or not they have any implications for HDE.**>>

19.2.1 General

The state machines for HDE links are described in 11.2.1.

19.2.2 Determination of asCapable and asCapableAcrossDomains

Determination of asCapableAcrossDomains shall be as specified in 11.2.13.12.

NOTE: For full-duplex point-to-point links, asCapableAcrossDomains is a global variable for all domains per linkport. For HDE links, asCapableAcrossDomains is a global variable per PTP Instance (i.e., per domain), the name asCapableAcrossDomains has been kept for backwards compatibility with existing implementations.

19.2.3 Use of MAC Control PAUSE operation

This is not applicable when the IEEE 802.3 Clause 4 MAC is in half-duplex mode (see Clause 1.4.458 in Annex 31B of IEEE Std 802.3-2022).

19.2.4 Use of priority-based flow control

This is not applicable when the IEEE 802.3 Clause 4 MAC is in half-duplex mode (see Clause 1.4.489 of IEEE Std 802.3-2022).

19.2.5 Use of link aggregation

This is not applicable when the IEEE 802.3 Clause 4 MAC is in half-duplex mode (see Introduction in IEEE Std 802.1AX-2020).

19.2.6 Service interface primitives and data structures communicated between state machines

The following subclauses describe the service primitives and data structures communicated between the time-synchronization state machines of the MD entity. First the service primitives are described, followed by the data structures.

19.2.7 DL-UNITDATA.request

This service primitive is described in 2.2.1.1.1 of ISO/IEC 8802-2:1998 [B16].

19.2.8 DL-UNITDATA.indication

This service primitive is described in 2.2.1.1.1 of ISO/IEC 8802-2:1998 [B16].

19.2.9 MDTimestampReceive

This structure shall be as specified in in 11.2.9.

19.2.10 MDSyncReceive

This structure shall be as specified in 10.2.2.2.

19.2.11 MDSyncSend

This structure shall be as specified in 10.2.2.1.

19.2.12 Overview of MD entity global variables

The overview of MD entity global variables is given in 11.2.12.

19.2.13 MD entity global variables

19.2.13.1 currentLogPdelayReqInterval: This variable shall be as specified in 11.2.13.1.

19.2.13.2 initialLogPdelayReqInterval: This variable shall be as specified in 11.2.13.2.

19.2.13.3 pdelayReqInterval: This variable shall be as specified in 11.2.13.3.

19.2.13.4 allowedLostResponses: This variable shall be as specified in 11.2.13.4.

19.2.13.5 allowedFaults: This variable shall be as specified in 11.2.13.5.

19.2.13.6 isMeasuringDelay: This variable shall be as specified in 11.2.13.6.

19.2.13.7 meanLinkDelayThresh: This variable shall be as specified in 11.2.13.7.

19.2.13.8 syncSequenceId: This variable shall be as specified in 11.2.13.8.

19.2.13.9 oneStepReceive: This variable shall be as specified in 11.2.13.9. It shall be set to FALSE for HDE.

19.2.13.10 oneStepTransmit: This variable shall be as specified in 11.2.13.10. It shall be set to FALSE for HDE.

19.2.13.11 oneStepTxOper: This variable shall be as specified in 11.2.13.11. It shall be set to FALSE for HDE.

19.2.13.12 asCapableAcrossDomains: This variable shall be as specified in 11.2.13.12.

19.2.13.13 nrrPdelay: This variable shall be as specified in 11.2.13.13.

19.2.13.14 nrrSync: This variable shall be as specified in 11.2.13.14.

19.2.13.15 nrrCompMethod: This variable shall be as specified in 11.2.13.15.

19.2.14 MDSyncReceiveSM state machine

The MDSyncReceiveSM state machine shall be as specified in 11.2.14.

19.2.15 MDSyncSendSM state machine

The MDSyncSendSM state machine shall be as specified in 11.2.15.

19.2.16 OneStepTxOperSetting state machine

This state machine is not used for HDE.

19.2.17 Common Mean Link Delay Service (CMLDS)

The Common Mean Link Delay Service (CMLDS) shall not be used for HDE.

HDE uses the transport-specific peer-to-peer delay mechanism for all domains. Therefore, if the time-aware system implements other domains whose domain numbers are not 0, the transport-specific peer-to-peer delay mechanism is used.

If multiple TimeTransmitter ports are present on an HDE link, they are in different gPTP domains. CMLDS cannot be used because, in general, the TimeTransmitter ports can be on physical ports of different time-aware systems (i.e., different bridges). In this case, both meanLinkDelay and neighborRateRatio between a PTP End Instance in one of the domains and the TimeTransmitter it is communicating with can be different from meanLinkDelay and neighborRateRatio between a PTP End Instance in another domain on the same end station and the TimeTransmitter that PTP End Instance is communicating with.

19.2.18 Common Mean Link Delay Service (CMLDS) global variables

The Common Mean Link Delay Service (CMLDS) global variables are not used for HDE links.

19.2.19 MDPdelayReq state machine

The MDPdelayReq state machine shall be as specified in 11.2.19.

The variable pdelayReqSendDisabled is set per 19.1.2.

19.2.20 MDPdelayResp state machine

The MDPdelayResp state machine shall be as specified in 11.2.20.

The variable pdelayRespSendDisabled is set per 19.1.2.

19.2.21 LinkDelayIntervalSetting state machine

This is state machine is not used for HDE.

19.3 Message attributes

Message attributes shall be as specified in 11.3.

19.4 Message formats

Message formats shall be as specified in 11.4, except for 11.4.2.4.

The domainNumber for Pdelay_Req, Pdelay_Resp, and Pdelay_Resp_Follow_Up messages shall be the domain number of the HDE gPTP domain used by the transport-specific peer delay mechanism. The domainNumber for all other PTP messages is as specified in 10.6.2.2.6.

19.5 Protocol timing characterization

19.5.1 General

This subclause specifies timing attributes for the media-dependent sublayer specified in this clause.

19.5.2 Message transmission intervals

19.5.2.1 General interval specification

The mean time interval between successive Pdelay_Req messages is represented as the logarithm to the base 2 of this time interval measured in seconds. The value of this logarithmic attribute shall be as specified in 19.5.2.2.

The mean time interval between successive Sync messages shall be as specified in 10.7.2.1, 10.7.2.3, and 19.5.2.3.

19.5.2.2 Pdelay_Req message transmission interval

Pdelay_Req message transmission interval is specified in 11.5.2.2. The variable useMgtSettableLogPdelayReqInterval shall be set to TRUE.

19.5.2.3 Sync message transmission interval default value

The Sync message transmission interval default value shall be as specified in 11.5.2.3.

19.5.3 allowedLostResponses

The variable allowedLostResponses shall be as specified in 11.5.3.

19.5.4 allowedFaults

The variable allowedFaults shall be as specified in 11.5.4.

19.6 Control of computation of neighborRateRatio

The control of computation of neighborRateRatio shall be as specified in 11.6.

19.7 Control of computation of meanLinkDelay

The control of computation of meanLinkDelay shall be as specified in 11.7.

19.8 HDE settings and configuration

This clause provides settings and configurations that are specific for HDE.

The per PTP Instance global variable externalPortConfigurationEnabled shall be set to TRUE for HDE.

Both GptpCapableTransmit and GptpCapableReceive state machines shall be disabled for HDE, and therefore gptpCapableStateMachinesEnabled shall be set to FALSE (see 10.4.1). According to 10.4.1, if the managed object gptpCapableStateMachinesEnabled is FALSE, the global variable neighborGptpCapable for the port (see 10.2.5.16) is set to TRUE.

<<Editor's note: The ability to disable GptpCapableTransmit and GptpCapableReceive state machines are specified in clause 10.4.1 in P802.1ASdm, however P802.1ASds is an amendment of IEEE 1588AS-REV, then P802.1ASdm is not mentioned in the paragraph above, as it will be rolled up in IEEE 1588AS-REV>>

The use of Signaling messages on HDE links is not specified by this standard.

SyncIntervalSetting and the AnnounceIntervalSetting state machines are not used for HDE. The variables useMgtSettableLogSyncInterval and useMgtSettableLogAnnounceInterval shall be set to TRUE.

Annex A

(normative)

Protocol Implementation Conformance Statement (PICS) proforma[3]

Add a row at the end of Table A.5 as follows:

A.5 Major Capabilities

Item	Feature	Status	References	Support
MDHDE	Does the PTP Instance support media-dependent HDE link functionality on one or more PTP Ports?	O.1	5.9, 11, 19, A.6, A.22	Yes [ ] No [ ]

Change A.6 as follows:

A.6 Media access control methods

Item	Feature	Status	References	Support
MAC-IEEE-802.3 MAC-IEEE-802.11	Which MAC methods are implemented in conformance with the relevant MAC standards?	O:2 O:2	11.1 19.1 12.1	Yes [ ] No [ ] Yes [ ] No [ ] Yes [ ] No [ ]
MAC-1	Has a PICS been completed for each of the MAC methods implemented as required by the relevant MAC Standards?	M		Yes [ ]
MAC-2	Do all the MAC methods implemented support the MAC Timing aware Service as specified?	M	Clause 11 Clause 12 Clause 13 Clause 19	Yes [ ]

[3] *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.

Change A.21 as follows:

A.21 External port configuration

Item	Feature	Status	References	Support
	If item EXT is not supported, mark N/A.			NA[ ]
EXT-1	Does the PTP Instance support the specifications for externalPortConfigurationEnabled value of true?	EXT:M	10.3.1 19.8	Yes [ ]
EXT-2	Does the PTP Instance support the PortAnnounceInformationExt state machine?	EXT:M	10.3.14	Yes [ ]
EXT-3	Does the PTP Instance support the PortStateSettingExt state machine?	EXT:M	10.3.15	Yes [ ]

<<Editor's note: Table A.22 is based on Table A.13 for full-duplex point-to-point link. Please, check.>

Insert Table A.22 as follows:

A.22 Media-dependent, HDE link

Item	Feature	Status	References	Support
MDHDE-1	Does this PTP Port implement the functionality of the MDSyncReceiveSM state machine in compliance with the requirements of 19.2.14, 11.2.14 and Figure 11-6?	MDHDE:M	19.2.14, 11.2.14	Yes [ ]
MDHDE-2	Does this PTP Port implement the functionality of the MDSyncSendSM state machine in compliance with the requirements of 19.2.15, 11.2.15 and Figure 11-7?	MIMSTR and MDHDE:M	19.2.15, 11.2.15	Yes [ ]
MDHDE-3	Does this port implement the functionality of the MDPdelayRequest state machine in compliance with the requirements of 19.1.2, 19.2.19, 11.2.19 and Figure 11-9?	MDHDE:M	19.1.2, 19.2.19, 11.2.19	Yes [ ]
MDHDE-4	Does this port implement the functionality of the MDPdelayResponse state machine in compliance with the requirements of 19.1.2, 19.2.20, 11.2.20 and Figure 11-10?	MDHDE:M,	19.2.20 19.1.2 11.2.20	Yes [ ]
MDHDE-5	Does this PTP Port timestamp Sync messages on ingress with respect to the LocalClock in compliance with 19.3, 11.3.2.1 and 11.3.9?	MDHDE:M	19.3, 11.3.2.1	Yes [ ]
MDHDE-6	Does this PTP Port timestamp Sync messages on egress with respect to the LocalClock in compliance with the requirements of 19.3, 11.3.2.1 and 11.3.9?	MIMSTR and MDHDE:M	19.3 11.3.2.1	Yes [ ]
MDHDE-7	Does this port timestamp Pdelay_Req messages on ingress and egress with respect to the LocalClock in compliance with the requirements of 19.3, 11.3.2.1 and 11.3.9?	MDHDE:M	19.3, 11.3.2.1	Yes [ ]

A.22 Media-dependent, HDE link *(continued)*

Item	Feature	Status	References	Support
MDHDE-8	Does this port timestamp Pdelay_Resp messages on ingress and egress with respect to the LocalClock in compliance with the requirements of 19.3, 11.3.2.1 and 11.3.9?	MDHDE:M	19.3, 11.3.2.1	Yes [ ]
MDHDE-9	Are all IEEE 802.1AS messages on this port sent without a Q-tag in compliance with the requirements of 19.3, 11.3.3?	MDHDE:M	19.3, 11.3.3	Yes [ ]
MDHDE-10	Do all media-dependent messages transmitted on this port use a destination MAC address taken from Table 11-3 in compliance with the requirements of 19.3 and 11.3.4 [01-80-C2-00-00-0E]?	MDHDE:M	19.3, 11.3.4	Yes [ ]
MDHDE-11	Do all media-dependent messages transmitted on this port use a source MAC address that is assigned to that port in compliance with the requirements of 19.3 and 11.3.4?	MDHDE:M	19.3, 11.3.4	Yes [ ]
MDHDE-12	Do all media-dependent message tranmitted on this port us an EtherType specified in Table 11-4 [88-F7]?	MDHDE:M	19.3, 11.3.5	Yes [ ]
MDHDE-13	Does the header of all the media-dependent messages on this port comply with the requirements of 19.4, 11.4.2 and Table 10-7?	MDHDE:M	19.4, 11.4.2	Yes [ ] N/A [ ]
MDHDE-14	Does the body of Sync messages sent on this PTP Port comply with the requirements of 19.4, 11.4.3, Table 11-8, and Table 11-9?	MDHDE:M	19.4, 11.4.3	Yes [ ]
MDHDE-15	Does the body of Follow_Up messages sent on this PTP Port comply with the requirements of 19.4, 11.4.4, 6.4.3.3 (lastGmPhaseChange), and Table 11-10?	MDHDE:M	19.4, 11.4.4, 6.4.3.3	Yes [ ]
MDHDE-16	Does the body of Pdelay_Req messages sent on this port comply with the requirements of 19.4, 11.4.5 and Table 11-12?	MDHDE:M	19.4, 11.4.5	Yes [ ]
MDHDE-17	Does the body of Pdelay_Resp messages sent on this port comply with the requirements of 19.4, 11.4.6 and Table 11-13?	MDHDE:M	19.4, 11.4.6	Yes [ ]
MDHDE-18	Does the body of Pdelay_Resp_Follow_Up messages sent on this port comply with the requirements of 19.4, 11.4.7 and Table 11-14?	MDHDE:M	19.4, 11.4.7	Yes [ ]
MDHDE-19	Are all reserved fields in media-dependent messages sent on this port set to 0 in compliance with the requirements of 19.4, 11.4.1?	MDHDE:M	19.4, 11.4.1	Yes [ ]
MDHDE-20	Do the Sync message sequence numbers comply with the requirements of 19.3, 11.3.8?	MIMSTR and MDHDE:M	19.3, 11.3.8	Yes [ ] N/A [ ]

A.22 Media-dependent, HDE link *(continued)*

Item	Feature	Status	References	Support
MDHDE-21	Do the Pdelay_Req message sequence numbers comply with the requirements of 19.3 and 11.3.8?	MDHDE:M	19.3, 11.3.8	Yes [ ]
MDHDE-22	Does the Pdelay mean request transmission interval comply with the requirements of 19.5.2.2 and 11.5.2.2?	MDHDE:M	19.5.2.2, 11.5.2.2	Yes [ ]
MDHDE-23	Does the Sync mean transmission interval comply with the requirements of 19.5.2.3 and 11.5.2.3?	MDHDE:M	19.5.2.3, 11.5.2.3	Yes [ ]
MDHDE-24	Does HDE media-dependent layer set the asCapable global variable in the media-independent PortSync entity in compliance with the requirements of 19.2.2 and 11.2.2?	MDHDE:M	19.2.2, 11.2.2	Yes [ ]
MDHDE-25	Does the PTP Instance consider the PTP Port or Link Port, respectively, to not be exchanging Pdelay messages when a valid response is not received in compliance with the requirements of 19.5.3 and 11.5.3?	MDHDE:M	19.5.3, 11.5.3	Yes [ ]
MDHDE-26	Does the PTP Instance ignore TLVs, of PTP messages, that it cannot parse and attempt to parse the next TLV, in compliance with the requirements of 19.4 and 11.4.1?	MDHDE:M	19.4, 11.4.1	Yes [ ]
MDHDE-27	Does the time-aware system initialize meanLinkDelayThresh as specified in19.2.2 and 11.2.2?	MDHDE:M	19.2.2, 11.2.2	Yes [ ]
MDHDE-28	Does this port support propagation delay averaging?	MDHDE:O	19.2.19, 11.2.19.3.4	Yes [ ] No [ ]
MDHDE-29	Does this port support two-step capability on receive?	MDHDE-M	19.2.14, 11.2.14, item d) of 5.5	Yes [ ] No [ ]
MDHDE-30	Does this port support two-step capability on transmit?	MDHDE-M	19.2.15, 11.2.15, item e) of 5.5	Yes [ ] No [ ]
MDHDE-30	Doesn’t HDE link support CMLDS?	MDHDE-M	19.2.17	Yes [ ] No [ ]

Annex Z

COMMENTARY

<<Editor's Note: This is a temporary Annex intended to record issues/resolutions thereof as the project proceeds. It also documents the revision history. It will be removed prior to Sponsor ballot, and should be ignored for the purpoess of TG/WG ballot.>>

Z.1 Revision history

Z.1.1 Revision 0.1

This is the initial version, prepared by the editor.

Z.1.1.1 CMLDS for HDE

Comment #45 against P802.1ASds/D0.2 proposed to consider CMLDS for HDE. There is a need to look at use-cases, as this may introduce unnecessary complexity. If only 2 domains are used, then transport-specific peer-to-peer mechanism is still viable.