# 13. Media-dependent layer specification for interface to IEEE 802.3 Ethernet passive optical network link

## 13.1 Overview

### 13.1.1 General

This clause specifies the service interface primitives, state machines, and message formats that provide accurate synchronized time across IEEE 802.3 Ethernet passive optical network (EPON) links, through the use of the timing process and measurements specified in 64.2.1.1, 64.3.2.4, 77.2.1.1, and 76.1.2 of IEEE Std 802.3-2018. For purposes of this clause, an EPON link is an EPON that contains one optical line terminal (OLT) and associated optical network units (ONUs).

A time-aware system may contain more than one OLT and/or ONU. Each PTP Instance of a time-aware system uses at most one ONU port, but may serve, i.e., provide timing to, more than one OLT port (i.e., each PTP Instance of a time-aware system is a clock slave to at most one EPON link, but can be clock master to more than one EPON link). Two different PTP Instances of a time-aware system may use different ONU ports.

### 13.1.2 Description of the EPON timing process

The timing process in EPON relies on the 32-bit counters (see 64.2.2.2 and 77.2.2.2 of IEEE Std 802.3-2018) at both the OLT and the ONU. The 32-bit counter used by EPON is the LocalClock entity of the PTP Instance that uses the respective OLT or ONU. These counters increment every time_quantum, which is equal to 16 ns (see 64.2.2.1 and 77.2.2.1 of IEEE Std 802.3-2018). IEEE Std 802.3-2018 defines multipoint control protocol (MPCP), which is one of the protocols that enable MAC clients to communicate over a point-to-multipoint optical network. When either the clock master (OLT) or the clock slave (ONU) transmits an MPCP data unit (MPCPDU), its counter value is mapped into the timestamp field. Clause 64 and Clause 77 of IEEE Std 802.3-2018 specify the EPON timing mechanism.

### 13.1.3 Best master selection

#### 13.1.3.1 General

An EPON link contains one OLT and the associated ONUs. The OLT is the clock master and the associated ONUs are clock slaves. The OLT initiates the time synchronization as a requester. The ONUs are the responders of the time synchronization. In other words, the invocation of the BMCA results in the OLT having the PTP Port state MasterPort and the ONU having the PTP Port state SlavePort (see 10.3.1.1 and Table 10-2), for all PTP Instances using these PTP Ports, regardless of the attributes of PTP Instances downstream from the ONU. This behavior is achieved using the acceptable master table feature defined in 17.5 of IEEE Std 1588-2019.

A PTP Instance that contains an ONU port shall maintain a configured table, the acceptableMasterTable, and a per-PTP Port Boolean variable acceptableMasterTableEnabled. The data type of acceptableMasterTable is AcceptableMasterTable (see 13.1.3.2).

#### 13.1.3.2 AcceptableMasterTable

The AcceptableMasterTable type represents a table of AcceptableMaster entries.

```
struct AcceptableMasterTable{
        UInteger16 maxTableSize;
        UInteger16 actualTableSize;
        AcceptableMaster[actualTableSize] acceptableMaster;
}
```

The maxTableSize member is the maximum size of the AcceptableMasterTable. The actualTableSizeMember is the actual size of the AcceptableMasterTable. The AcceptableMaster array contains a list of AcceptableMaster PTP Ports. The value of maxTableSize is implementation specific. actualTableSize shall be less than or equal to maxTableSize.

An AcceptableMasterTable is configurable and may contain a number of AcceptableMaster entries up to maxTableSize.

#### 13.1.3.3 AcceptableMaster

The AcceptableMaster type represents a PTP Port that can be considered, in the execution of the BMCA, as a candidate for master.

```
struct AcceptableMaster{
        PortIdentity acceptablePortIdentity;
        UInteger8 alternatePriority1;
}
```

The acceptablePortIdentity member is the PortIdentity of an acceptable master port. The alternatePriority1 member contains an alternate value for the priority1 attribute of the acceptable master port (see 13.1.3.4).

#### 13.1.3.4 Acceptable master table feature

The acceptable master table feature shall modify the operation of the BMCA (see 10.3) as follows:

a) If acceptableMasterTableEnabled for a PTP Port is FALSE, the BMCA operates as described in 10.3.
b) If acceptableMasterTableEnabled for a PTP Port is TRUE, then the following apply:
    1) The function qualifyAnnounce() of the PortAnnounceReceive state machine (see 10.3.11.2.1) is replaced by the following:

       **qualifyAnnounce (rcvdAnnouncePtr):** qualifies the received Announce message pointed to by rcvdAnnouncePtr as follows:
        i) if the Announce message was sent by the current PTP Instance, i.e., if sourcePortIdentity.clockIdentity (see 10.6.2.2.11 and 8.5.2) is equal to thisClock (see 10.2.4.22), the Announce message is not qualified, and FALSE is returned;
        ii) if the stepsRemoved field is greater than or equal to 255, the Announce message is not qualified, and FALSE is returned;
        iii) if the sourcePortIdentity of the Announce message is not equal to the sourcePortIdentity of one of the entries of the acceptableMasterTable, FALSE is returned;
        iv) if a path trace TLV is present and one of the elements of the pathSequence array field of the path trace TLV is equal to thisClock (i.e., the clockIdentity of the current PTP Instance; see 10.2.4.22), the Announce message is not qualified, and FALSE is returned;

otherwise, the Announce message is qualified, and TRUE is returned. If a path trace TLV is present, it is saved in the per port global variable receivedPathTrace. If a path trace TLV is not present, the per port global variable receivedPathTrace is set to the empty array.

2) If the alternatePriority1 member of the AcceptableMaster array element that corresponds to the sourcePortIdentity of a received Announce message is 0, the alternatePriority1 member has no effect on the operation of the BMCA.
3) If the alternatePriority1 member of the AcceptableMaster array element that corresponds to the sourcePortIdentity of a received Announce message is greater than 0, the value of the grandmasterPriority1 field of the Announce message is replaced by the value of alternatePriority1 of this AcceptableMaster array element for use in the invocation of the BMCA.

#### 13.1.3.5 Default configuration of acceptable master table feature

The default configuration of the acceptable master table feature for a PTP Instance that is attached to an IEEE 802.3 EPON link shall be as follows:

a) If the PTP Instance does not contain an ONU port, the default acceptableMasterTable is empty, i.e., the member actualTableSize is 0 and there are no AcceptableMaster array entries. The variable acceptableMasterTableEnabled for each PTP Port is set to FALSE.
b) If the PTP Instance contains an ONU port, the default acceptableMasterTable contains one element in the AcceptableMaster array. The member actualTableSize is 1. The acceptablePortIdentity of that element is set equal to the portIdentity of the OLT port that the ONU port is attached to, and alternatePriority1 set equal to 244. The variable acceptableMasterTableEnabled for each PTP Port is set to TRUE.

NOTE—These default settings ensure that, with the default priority1 values of 8.6.2.1, Table 8-1, used for all PTP Instances, the PTP Instance that contains the ONU port will consider Announce messages only from the OLT that the ONU port is attached to when invoking the BMCA. The alternatePriority1 value of 244 ensures that the OLT will be considered better than the ONU in the sense of the BMCA, which will cause the OLT port state to be set to MasterPort and the ONU port state to be set to SlavePort. All other PTP Ports of this PTP Instance that are not disabled and for which asCapable is TRUE will have PTP Port states of either MasterPort or PassivePort. If all PTP Instances downstream from the ONU have priority1 greater than 244, then the PTP Port at the other end of each link attached to each non-ONU port that is not disabled and for which asCapable is TRUE will have PTP Port states of either SlavePort or PassivePort; in this case, the downstream network portions will get their timing through the EPON. However, if a downstream PTP Instance has priority1 less than 244, or priority1 equal to 244 and is better than the Grandmaster PTP Instance information contained in the Announce message received by the ONU based on other attributes, then the portion of the network that is downstream of the ONU and includes that better PTP Instance will get its timing from that better downstream PTP Instance. In this case, the endpoints of the link of that network portion attached to the PTP Instance that contains the ONU will both have PTP Port states of MasterPort, and the PTP Ports at each end of the link will send Announce messages. However, the Announce messages sent by the downstream PTP Instance will be ignored by the PTP Instance that contains the ONU because the sourcePortIdentity of those Announce messages will not be contained in the acceptableMasterTable. The Announce messages sent by the PTP Instance that contains the ONU will be used in the invocation of the BMCA at the downstream PTP Instance; however, those Announce messages will not reflect the best master because one of the downstream PTP Instances is better.

### 13.1.4 Time synchronization in EPON

Transmission in the EPON downstream direction (from OLT to ONUs) utilizes time division multiplexing (TDM). In the upstream direction (from ONUs to OLT), time division multiple access (TDMA) is employed. Due to the frame queuing in TDMA, the downstream delay is different from the upstream delay. Asymmetric delay also occurs in the EPON physical layer due to upstream and downstream transmission using different wavelengths. The index of refraction is frequency dependent, which results in the upstream and downstream delays being asymmetric. The accurate time synchronization across the EPON links is operated as follows. It is assumed that the clock master (the OLT) has an accurate synchronized time. The clock master informs the clock slave (the ONU) what the accurate synchronized time will be when the counter of the clock slave reaches a certain value. The information transfer can be accomplished using the organization-specific slow protocol (OSSP) message (see Clause 57 of IEEE Std 802.3-2018).

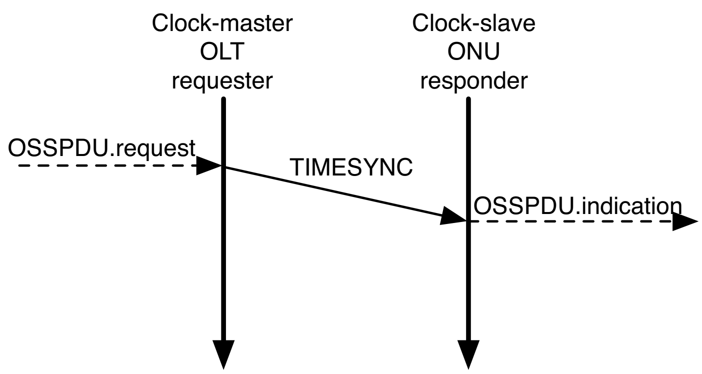


**Figure 13-1—IEEE 802.3 EPON time-synchronization interfaces**

The following reference process, illustrated schematically in Figure 13-1, will result in the clock slave of an ONU being synchronized to the clock master of the OLT:

a) The clock master selects a value *X* of the local MPCP counter that is used as the timing reference. Any value can be chosen, provided it is relative to the current epoch of the MPCP counter.

b) The clock master calculates the $ToD_{X,i}$ based on $ToD_{X,o}$ using Equation (13-1).

$$ToD_{X,i} = ToD_{X,o} + RTT_i \times \frac{\text{ndown}}{(\text{nup} + \text{ndown})} \times \text{rateRatio} \tag{13-1}$$

where $ToD_{X,i}$ is the synchronized time when the MPCP counter at the clock slave *i* reaches a value equal to the timestamp X minus the *onuLatencyFactor*; $ToD_{X,o}$ is the synchronized time when the MPCP counter at the clock master reaches a value equal to the timestamp X plus the *oltLatencyFactor*; $RTT_i$ is the round-trip time measured by the clock master for clock slave *i*, i.e., ONU *i*; nup is the effective refraction index of the light propagating in the upstream channel; ndown is the effective refraction index of the light propagating in the downstream channel; and rateRatio is the rateRatio member of the most recently received MDSyncSend structure. The *onuLatencyFactor* and *oltLatencyFactor* are given in Equation (13-2) and Equation (13-3), respectively. The impact of the worst-case variation in the transmission wavelength for the clock master and clock slave transmitters is examined in appendix VII of ITU-T G.984.3, Amendment 2 (11/2009).

$$\begin{aligned} onuLatencyFactor &= onuIngressLatency - \\ &(onuIngressLatency + onuEgressLatency) \times \frac{\text{ndown}}{(\text{nup} + \text{ndown})} \times \text{rateRatio} \end{aligned} \tag{13-2}$$

$$oltLatencyFactor = oltEgressLatency - (oltIngressLatency + oltEgressLatency) \times \frac{\mathrm{ndown}}{(\mathrm{nup} + \mathrm{ndown})} \times \mathrm{rateRatio} \tag{13-3}$$

c) The clock master sends the pair of values ($X$, $ToD_{X,i}$) to clock slave $i$ via the downstream TIMESYNC message.

NOTE—After the clock slave receives the downstream TIMESYNC message, it can compute the synchronized time, *ToD*, when the value of the local MPCP counter is equal to *S*; *ToD* is given by the following equation:

$$ToD = ToD_{X,\,i} + [(S - X) \bmod (2^{32})](16\ \mathrm{ns})(\mathrm{rateRatio})$$

where ($A$) mod ($B$) is $A$ modulo $B$.

The OSSP message is a general message (see 3.10), analogous to Follow_Up. Note that the preceding synchronized time values correspond to timestamps that are referenced to the MAC control sublayer. Both the clock master and clock slave are responsible for compensating their processing delays (e.g., the ingressLatency and egressLatency, as described in 8.4.3). $RTT_i$ is measured using MPCPDU timestamps, inserted into the frame structure as specified by 64.2.1.1 and 77.2.1.1 of IEEE Std 802.3-2018.

## 13.2 Message attributes

### 13.2.1 Message class

The TIMESYNC message is a general message (see 3.10 and 8.4.2.2). It is transmitted in the downstream direction, from OLT to ONU.

## 13.3 Message format

### 13.3.1 TIMESYNC message

#### 13.3.1.1 General TIMESYNC message specifications

The fields of the body of the TIMESYNC message shall be as specified in Table 13-1 and 13.3.1.2.

#### 13.3.1.2 TIMESYNC message field specifications

##### 13.3.1.2.1 Destination address (Octet6)

The destination address field is equal to 01-80-C2-00-00-02 (see 57A.3 of IEEE Std 802.3-2018).

##### 13.3.1.2.2 Source address (Octet6)

The source address field is the individual MAC address associated with the port through which the TIMESYNC message is transmitted (see 57B.1.1 of IEEE Std 802.3-2018).

##### 13.3.1.2.3 Length/Type (Octet2)

The value of this field is equal to 0x8809 (see 57A.4 of IEEE Std 802.3-2018).

**Table 13-1—TIMESYNC message fields**

| Bits (7 6 5 4 3 2 1 0) | | Octets | Offset |
|---|---|---|---|
| Destination Address | | 6 | 0 |
| Source Address | | 6 | 6 |
| Length/Type | | 2 | 12 |
| Subtype | | 1 | 14 |
| OUI or CID | | 3 | 15 |
| Message Identifier | | 2 | 18 |
| $X$ | | 4 | 20 |
| $ToD_{X,i}$ | | 10 | 24 |
| sourcePortIdentity | | 10 | 34 |
| logMessageInterval | | 1 | 44 |
| rateRatio | | 8 | 45 |
| gmTimeBaseIndicator | | 2 | 53 |
| lastGmPhaseChange | | 12 | 55 |
| scaledLastGmFreqChange | | 4 | 67 |
| domainNumber | | 1 | 71 |
| majorSdoId | reserved | 1 | 72 |
| minorSdoId | | 1 | 73 |
| reserved | | 0 | 74 |
| FCS | | 4 | |

#### 13.3.1.2.4 Subtype (Octet)

The value of this field is equal to 0x0A (see 57A.4 of IEEE Std 802.3-2018).

#### 13.3.1.2.5 OUI or CID (Octet3)

This field contains the OUI or CID that identifies the Organization-Specific Data. The value is 00-80-C2, i.e., the OUI assigned to IEEE 802.1.

#### 13.3.1.2.6 Message identifier (Octet2)

This field is the TIMESYNC message identifier. The value of this field is 1.

#### 13.3.1.2.7 *X* (UInteger32)

The $X$ field is the selected timestamp that will be used as the timing reference as specified in 13.1.4.

#### 13.3.1.2.8 $ToD_{X,i}$ (Timestamp)

$ToD_{X,i}$ is the synchronized time when the MPCP counter at the clock slave $i$ reaches a value equal to $X$ minus the *onuLatencyFactor* (see 13.1.4). $X$ is carried in the respective TIMESYNC message. Synchronization of the MPCP clock is described in detail in 64.2.1.1 and 77.2.1.1 in IEEE Std 802.3-2018, for 1G-EPON and 10G-EPON, respectively.

NOTE—Any subnanosecond portion of synchronized time (in this case, time of day), normally transported in a correction field (see 10.2.2.1.2, 10.2.2.2.2, and 10.2.2.3.5), is not transported over EPON.

#### 13.3.1.2.9 sourcePortIdentity (PortIdentity)

This field is specified as the sourcePortIdentity member of the MDSyncSend structure most recently received from the PortSync entity of the OLT (see 10.2.2.1.4).

#### 13.3.1.2.10 logMessageInterval (Integer8)

This field is specified as the logMessageInterval member of the MDSyncSend structure most recently received from the PortSync entity of the OLT (see 10.2.2.1.5). It is the value of the currentLogSyncInterval for this PTP Port (see 10.7.2.3).

#### 13.3.1.2.11 rateRatio (Float64)

This field is specified as the rateRatio member of the MDSyncSend structure most recently received from the PortSync entity of the OLT (see 10.2.2.1.8).

#### 13.3.1.2.12 gmTimeBaseIndicator (UInteger16)

This field is specified as the gmTimeBaseIndicator member of the MDSyncSend structure most recently received from the PortSync entity of the OLT (see 10.2.2.1.9).

#### 13.3.1.2.13 lastGmPhaseChange (ScaledNs)

This field is specified as the lastGmPhaseChange member of the MDSyncSend structure most recently received from the PortSync entity of the OLT (see 10.2.2.1.10).

#### 13.3.1.2.14 scaledLastGmFreqChange (Integer32)

The value of scaledLastGmFreqChange is the fractional frequency offset of the current Grandmaster Clock relative to the previous Grandmaster Clock, at the time that the current Grandmaster PTP Instance became the Grandmaster PTP Instance, or relative to itself prior to the last change in gmTimeBaseIndicator, multiplied by $2^{41}$ and truncated to the next smaller signed integer. The value is obtained by multiplying the lastGmFreqChange member of MDSyncSend (see 10.2.2.1) whose receipt causes the MD entity to send the TIMESYNC message by $2^{41}$, and truncating to the next smaller signed integer.

NOTE—The above scaling allows the representation of fractional frequency offsets in the range $[-(2^{-10} - 2^{-41}), 2^{-10} - 2^{-41}]$, with granularity of $2^{-41}$. This range is approximately $[-9.766 \times 10^{-4}, 9.766 \times 10^{-4}]$.

#### 13.3.1.2.15 domainNumber (UInteger8)

This field is specified as the gPTP domain number (see 8.1).

#### 13.3.1.2.16 majorSdoId (Nibble)

The value is the same as the value specified in 8.1 for all transmitted PTP messages of a gPTP domain. Any TIMESYNC message received for which the value is not one of the values specified in 8.1 shall be ignored.

NOTE—The nibble that immediately follows majorSdoId is reserved (see 10.6.1).

#### 13.3.1.2.17 minorSdoId (UInteger8)

The value is the same as the value specified in 8.1 for all transmitted PTP messages of a gPTP domain. Any TIMESYNC message received for which the value is not one of the values specified in 8.1 shall be ignored.

#### 13.3.1.2.18 reserved

The reserved field that follows minorSdoId has variable length. The field shall have zero length on transmission. Any bytes between the minorSdoId and the FCS field shall be ignored on reception.

#### 13.3.1.2.19 FCS (Octet4)

This field is the frame check sequence (see 57B.1.1 of IEEE Std 802.3-2018).

## 13.4 Determination of asCapable

The default value of the per-PTP Port, per-domain global variable asCapable shall be TRUE.

The per-PTP Port, per-domain global variable asCapable shall be set to TRUE if the value of neighborGptpCapable for this PTP Port is TRUE.

NOTE—The above conditions ensure backward compatibility with the 2011 edition of this standard. A time-aware system that is compliant with the 2011 edition of this standard will not process the gPTP capable TLV, and asCapable will be determined as specified in the 2011 edition. A PTP Instance of a time-aware system compliant with the current edition of this standard that is attached, via an EPON link, to a node 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, the above ensures that asCapable for this PTP Port and domain (i.e., domain 0) will still be set in a manner consistent with that of the 2011 edition of this standard because the default value of asCapable is TRUE in that edition.

## 13.5 Layering for IEEE 802.3 EPON links

The MD entity is media-dependent and is responsible for translating the media-independent layer to media-dependent PDUs or primitives as necessary for communicating synchronized time over the EPON link from the OLT to a single ONU. This implies that if one OLT port is associated with multiple ONUs, it will require one IEEE 802.1AS PortSync entity and one MD entity per associated ONU. The OSSPDU primitives are used to communicate synchronized time information. Figure 13-2 illustrates how the MD entity interacts with the OSSP sublayer.

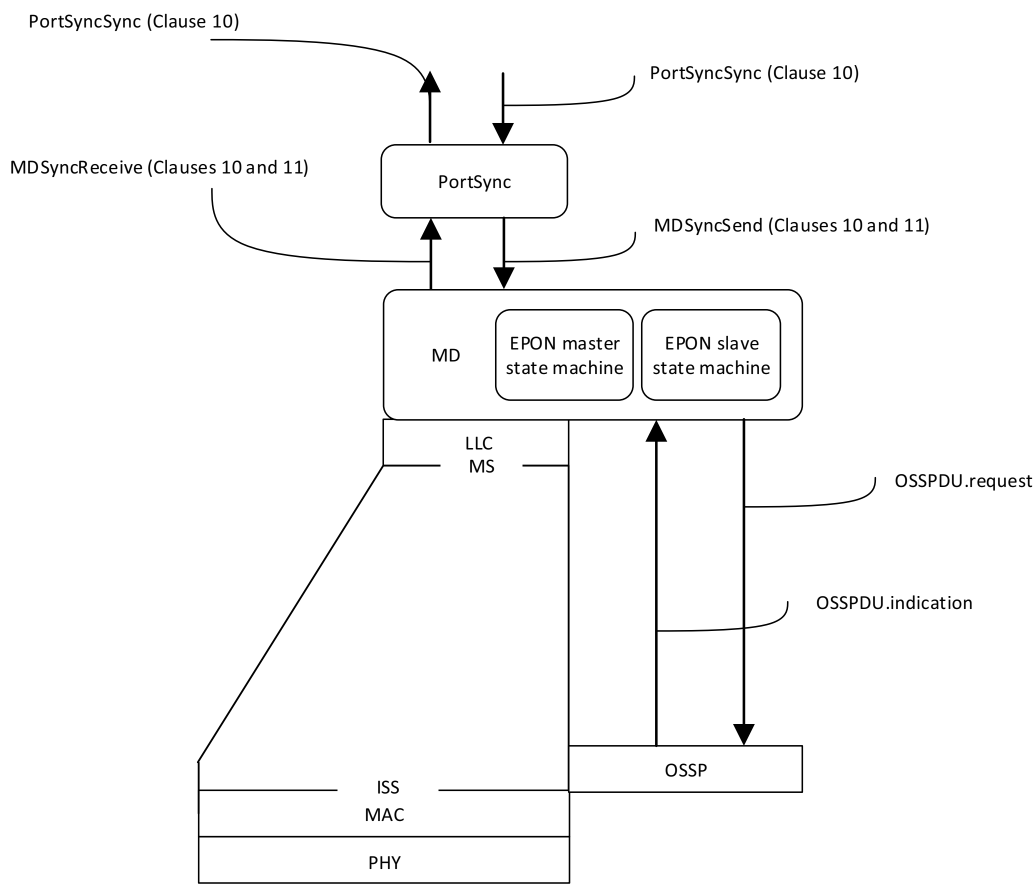


**Figure 13-2—IEEE 802.3 EPON interface model**

## 13.6 Service interface definitions

### 13.6.1 OSSPDU.request

#### 13.6.1.1 General

This service interface primitive is generated periodically by the MD entity of the clock master every sync interval (see 10.7.2.1). It triggers transmission of a TIMESYNC message from the clock master to the clock slave. The values of the parameters of the primitive are sent to the clock slave via the TIMESYNC message.

#### 13.6.1.2 OSSPDU.request parameters

##### 13.6.1.2.1 Syntax of the primitive

OSSPDU.request {
    $X$
    $ToD_{X,i}$
    sourcePortIdentity
    logMessageInterval

```
        rateRatio
        gmTimeBaseIndicator
        lastGmPhaseChange
        scaledLastGmFreqChange
        domainNumber
        sdoId
}
```

#### 13.6.1.2.2 *X* (Integer32)

The *X* field is the selected timestamp that will be used as the timing reference as specified in 13.1.4.

#### 13.6.1.2.3 $ToD_{X,i}$ (Timestamp)

$ToD_{X,i}$ is the synchronized time when the MPCP counter at the clock slave *i* reaches a value equal to *X* minus the *onuLatencyFactor* (see 13.1.4). *X* is carried in the respective TIMESYNC message. Synchronization of the MPCP clock is described in detail in 64.2.1.1 and 77.2.1.1 in IEEE Std 802.3-2018, for 1G-EPON and 10G-EPON, respectively.

#### 13.6.1.2.4 sourcePortIdentity (PortIdentity)

This parameter identifies the sourcePortIdentity value for this PTP Port (see 13.3.1.2.9).

#### 13.6.1.2.5 logMessageInterval (Integer8)

This parameter identifies the currentLogSyncInterval value for this PTP Port (see 13.3.1.2.10).

#### 13.6.1.2.6 rateRatio (Float64)

This parameter identifies the rateRatio value for this PTP Port (see 13.3.1.2.11).

#### 13.6.1.2.7 gmTimeBaseIndicator (UInteger16)

This parameter identifies the gmTimeBaseIndicator value for this PTP Port (see 13.3.1.2.12).

#### 13.6.1.2.8 lastGmPhaseChange (ScaledNs)

This parameter identifies the lastGmPhaseChange value for this PTP Port (see 13.3.1.2.13).

#### 13.6.1.2.9 scaledLastGmFreqChange (Integer32)

This parameter identifies the scaledLastGmFreqChange value for this PTP Port (see 13.3.1.2.14).

#### 13.6.1.2.10 domainNumber

This parameter identifies the domainNumber for this instance of gPTP (see 13.3.1.2.15).

#### 13.6.1.2.11 sdoId

This parameter identifies the sdoId for this instance of gPTP (see 13.3.1.2.16 and 13.3.1.2.17).

#### 13.6.1.3 When generated

This primitive is generated by the clock master every $2^{\text{currentLogSyncInterval}}$ seconds when it is in the MASTER state, as the first phase of synchronized time information transfer.

#### 13.6.1.4 Effect of receipt

Upon receipt of this primitive, a TIMESYNC message is enqueued for transmission.

NOTE—Arrival of the TIMESYNC message at the ONU after the selected time $X$ does not impede proper operation of the synchronization mechanism defined in this clause.

### 13.6.2 OSSPDU.indication

#### 13.6.2.1 General

This service interface primitive is generated on receipt of a TIMESYNC message by the responder, and provides the values contained in the corresponding OSSPDU.request primitive to the clock slave.

#### 13.6.2.2 OSSPDU.indication parameters

OSSPDU.indication {
    $X$
    $ToD_{X,i}$
    sourcePortIdentity
    logMessageInterval
    rateRatio
    gmTimeBaseIndicator
    lastGmPhaseChange
    scaledLastGmFreqChange
    domainNumber
    sdoId
}

The parameters of the OSSPDU.indication are set equal to the corresponding fields of the most recently received TIMESYNC message. Their definitions are given in 13.3.1.2.7 through 13.3.1.2.17, respectively.

#### 13.6.2.3 When generated

This primitive is generated by the receipt of a TIMESYNC message during the phase of synchronized time information transfer.

#### 13.6.2.4 Effect of receipt

Upon receipt, the OSSPDU.indication parameters are used by the MD entity to compute the parameters of the MDSyncReceive structure that will be transmitted to the PortSync entity of this PTP Port.

## 13.7 MD entity global variables

**13.7.1 $RTT_i$:** Is used only by the OLT MD entity. $RTT_i$ is the RTT between the clock master and clock slave. The data type for $RTT_i$ is UInteger32.

NOTE—RTT is measured and updated by the MPCP using the mechanism specified in IEEE Std 802.3-2018 and stored in $RTT_i$ when measured and updated. $RTT_i$ is not used by the ONU and is set to zero in an ONU MD entity.

## 13.8 State machines

### 13.8.1 Requester state machine

#### 13.8.1.1 Function

This state machine generates and consumes primitives, at the requester, used to provide accurate synchronized time across EPON links to the responder.

#### 13.8.1.2 State machine variables

The following variables are used in the state diagram in Figure 13-3 (in 13.8.1.4):

**13.8.1.2.1 ndown:** The effective index of the light propagating in the downstream channel. The data type for ndown is Float64.

**13.8.1.2.2 nup:** The effective index of the light propagating in the upstream channel. The data type for ndown is Float64.

**13.8.1.2.3 rcvdMDSyncEponReq:** A Boolean variable that notifies the current state machine when an MDSyncSend structure is received. This variable is reset by the current state machine.

**13.8.1.2.4 rcvdMDSyncPtrEponReq:** A pointer to the received MDSyncSend structure.

**13.8.1.2.5 registered:** A Boolean variable that indicates an ONU has registered to EPON.

**13.8.1.2.6 $ToD_{X,i}$:** The synchronized time when the MPCP counter at the clock slave *i* reaches a value equal to *X* (see 13.8.1.2.8) minus the *onuLatencyFactor* (see 13.1.4). The data type for $ToD_{X,i}$ is Timestamp.

**13.8.1.2.7 $ToD_{X,o}$:** The synchronized time when the MPCP counter at the clock master reaches a value equal to *X* (see 13.8.1.2.8) plus the *oltLatencyFactor* (see 13.1.4). The data type for $ToD_{X,o}$ is Timestamp.

**13.8.1.2.8 *X*:** The value of the timestamp [see item a) of 13.1.4] that is selected as the reference time. The data type for *X* is UInteger32.

#### 13.8.1.3 State machine functions

**13.8.1.3.1 setToDXo():** Computes the state machine variable $ToD_{X,o}$ (see 13.8.1.2.7) as the sum of the following:

a) The preciseOriginTimestamp member of the most recently received MDSyncSend structure
b) The followUpCorrectionField of the most recently received MDSyncSend structure
c) The quantity in Equation (13-4)

$$\mathrm{rateRatio} \times (X \times (16\ \mathrm{ns}) - \mathrm{upstreamTxTime}) \tag{13-4}$$

where

| | |
|---|---|
| rateRatio | is the rateRatio member of the most recently received MDSyncSend structure |
| upstreamTxTime | is the upstreamTxTime member of the most recently received MDSyncSend structure |
| *X* | is defined in 13.8.1.2.8 |

#### 13.8.1.4 State diagram

The requester state machine shall implement the function specified by the state diagram in Figure 13-3, the local variables specified in 13.8.1.2, the function specified in 13.8.1.3, the service interface primitives specified in 13.6, the structure specified in 10.2.2.1, the message specified in 13.3, and the relevant global variables specified in 10.2.5 and 13.7. The state machine receives an MDSyncSend structure from the PortSyncSyncSend state machine of the PortSync entity of this PTP Port and transmits an OSSPDU.request primitive to cause a TIMESYNC message to be sent to the responder (ONU).

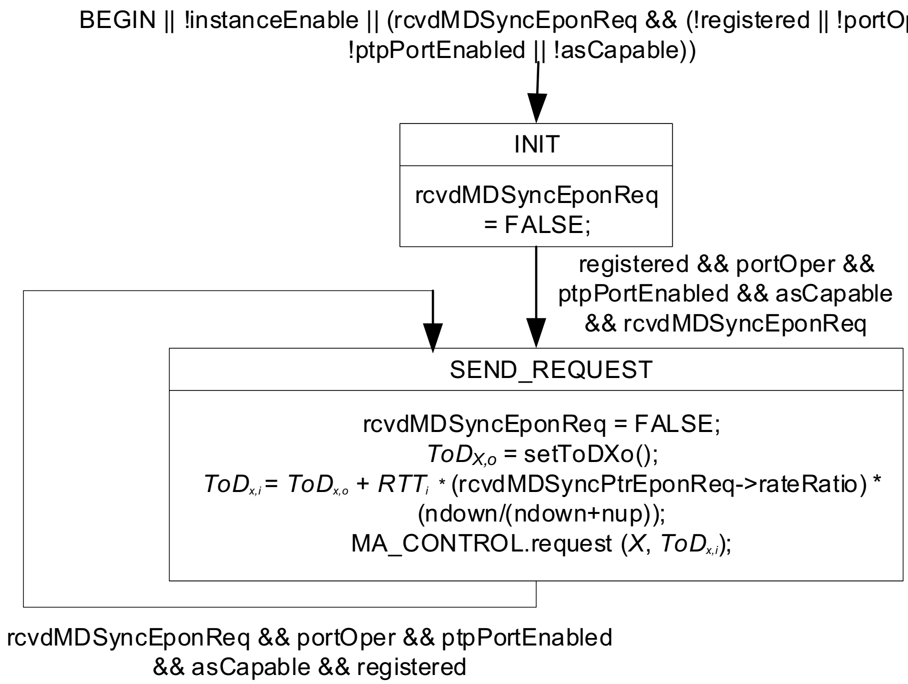


**Figure 13-3—State machine for IEEE 802.3 EPON requester**

### 13.8.2 Responder state machine

#### 13.8.2.1 Function

This state machine responds to EPON-specific primitives generated by receipt of a TIMESYNC message from the requester.

#### 13.8.2.2 State machine variables

The following variables are used in the state diagram in Figure 13-4 (in 13.8.2.4):

**13.8.2.2.1 rcvdOSSPDUind:** a Boolean variable that notifies the responder state machine when a TIMESYNC message is received and the OSSPDU.indication primitive is generated.

**13.8.2.2.2 txMDSyncReceivePtrEponResp:** a pointer to a structure whose members contain the values of the parameters of an MDSyncReceive structure to be transmitted.

**13.8.2.2.3 rcvdOSSPDUptr:** a pointer to a structure whose members contain the values of the parameters of the OSSPDU.indication primitive whose receipt is indicated by rcvdOSSPDUind (see 13.8.2.2.1).

### 13.8.2.3 State machine functions

**13.8.2.3.1 setMDSyncReceiveEponResp():** creates an MDSyncReceive structure (see 10.2.2.2) using members of the structure pointed to by rcvdOSSPDUptr (see 13.8.2.2.3), and returns a pointer to this structure. The members of this structure are set as follows:

a) followUpCorrectionField is set equal to 0.
b) sourcePortIdentity is set equal to the sourcePortIdentity field of the most recently received TIMESYNC message (see 13.3.1.2.9).
c) logMessageInterval is set equal to the logMessageInterval of the most recently received TIMESYNC message (see 13.3.1.2.10).
d) preciseOriginTimestamp is set equal to the $ToD_{X,i}$ field of the most recently received TIMESYNC message (see 13.3.1.2.8).
e) rateRatio is set to the rateRatio of the most recently received TIMESYNC message (see 13.3.1.2.11).
f) upstreamTxTime is set equal to $X$ multiplied by 16 ns, where $X$ is the value of the $X$ field of the most recently received TIMESYNC message (see 13.3.1.2.7).
g) gmTimeBaseIndicator is set equal to the gmTimeBaseIndicator of the most recently received TIMESYNC message (see 13.3.1.2.12).
h) lastGmPhaseChange is set equal to the lastGmPhaseChange of the most recently received TIMESYNC message (see 13.3.1.2.13).
i) lastGmFreqChange is set equal to the scaledLastGmFreqChange of the most recently received TIMESYNC message (see 13.3.1.2.14), divided by $2^{41}$.
j) domainNumber is set equal to the domainNumber of the most recently received TIMESYNC message (see 13.3.1.2.15).

**13.8.2.3.2 txMDSyncReceive (txMDSyncReceivePtrEponResp):** transmits an MDSyncReceive structure to the PortSyncSyncReceive state machine of the PortSync entity of this PTP Port.

### 13.8.2.4 State diagram

The responder state machine shall implement the function specified by the state diagram in Figure 13-4, the local variables specified in 13.8.2.2, the functions specified in 13.8.2.3, the service interface primitives specified in 13.6, the structure specified in 10.2.2.2, the message specified in 13.3, and the relevant global variables specified in 10.2.5 and 13.7. The state machine receives an OSSPDU.indication primitive in response to its having received a TIMESYNC message from the requester (OLT), and transmits an MDSyncReceive structure to the PortSync entity of this PTP Port.

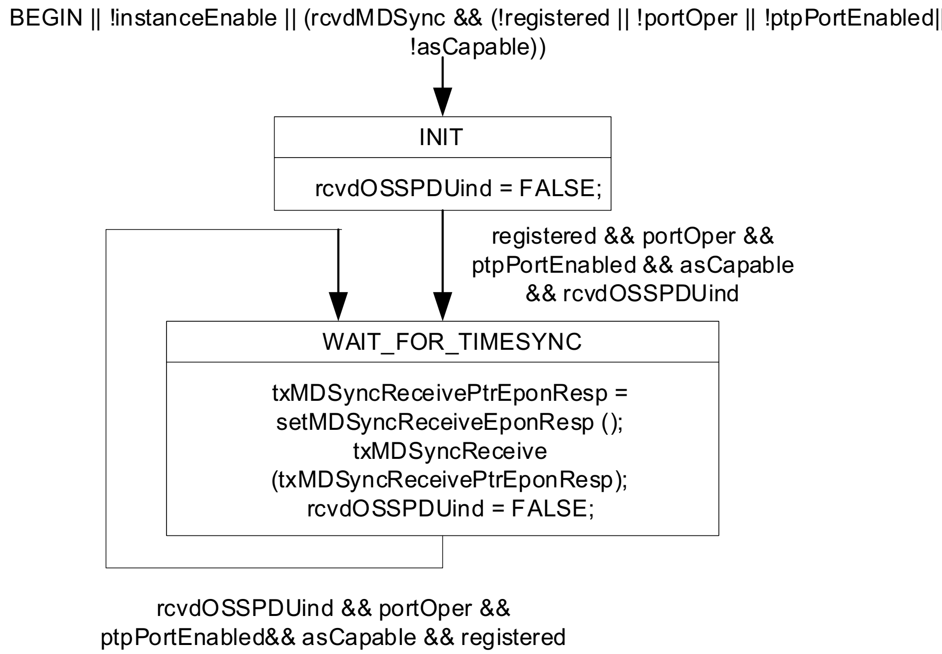


**Figure 13-4—State machine for IEEE 802.3 EPON responder**

## 13.9 Message transmission intervals

### 13.9.1 General interval specification

The mean time interval between successive TIMESYNC messages shall be as specified in 10.7.2.1, 10.7.2.3, and 13.9.2.

### 13.9.2 TIMESYNC message transmission interval default value

The default value of initialLogSyncInterval (see 10.7.2.4) is –3. Every PTP Port supports the value 127; the PTP Port does not send TIMESYNC messages when currentLogSyncInterval has this value. A PTP Port may support other values, except for the reserved values indicated in Table 10-16.

Processing of the message interval request TLV carried in a Signaling message (see 10.6.4) shall be supported, as specified by the SyncIntervalSetting state machine of 10.3.18 (see Figure 10-20), except that the logLinkDelayInterval (which is not relevant to IEEE 802.3 EPON ports) is set to 128 by the sender of the Signaling message, the logLinkDelayInterval is ignored by the receiver, and unsupported values of logTimeSyncInterval are ignored by the receiver.