# Definitions, acronyms, and abbreviations

## Notation for PICS

### Abbreviations and special symbols

The following symbols are used in the PICS proforma:

|  |  |
| --- | --- |
| M | mandatory field/function |
| ! | negation |
| O | optional field/function |
| O.<n> | optional field/function, but at least one of the group of options labeled by the same numeral <n> is required |
| O/<n> | optional field/function, but one and only one of the group of options labeled by the same numeral <n> is required |
| X | prohibited field/function |
| <item>: | simple-predicate condition, dependent on the support marked for <item> |
| <item1>\*<item2>: | AND-predicate condition, the requirement needs to be met if both optional items are implemented |
| <item1>+<item2>: | OR-predicate condition, the requirement needs to be met if at least one of optional item is implemented |

# Specification packages

## SIEPON packages

Sets of features comprising Package A, Package B, and Package C are summarized in Table 4‑1. Detailed specifications of each feature and the associated mandatory and optional requirements are provided in the subsequent clauses, as referenced in Table 4‑1.

Table 4‑1—Definition of SIEPON packages a

| **Item** | **Feature** | **Package** |
| --- | --- | --- |
| **A** | **B** | **C** |
| TVM | OLT VLAN modes | OLT shall support VLAN modes defined in 7.2.2.3 | OLT shall support VLAN modes defined in 7.2.2.1.1, 7.2.2.1.3, and 7.2.2.1.5 | OLT shall support VLAN modes defined in 7.2.2.2.1 – 7.2.2.2.7  |
| UVM | ONU VLAN modes | ONU shall support VLAN modes defined in 7.2.2.3 | ONU shall support VLAN modes defined in 7.2.2.1.2, 7.2.2.1.4, and 7.2.2.1.6 | ONU shall support VLAN modes defined in 7.2.2.2.1 – 7.2.2.2.7 |
| MA | MAC aging | N/A | N/A | shall implement MAC aging function as defined in 7.2.2.2.8 |
| TTM | OLT tunneling modes | OLT shall support tunneling modes defined in 7.3.2 | N/A | N/A |
| UTM | ONU tunneling modes | ONU shall support tunneling modes defined in 7.3.2 | N/A | N/A |
| MCC | multicast connectivity, coexistence | shall support multicast connectivity, coexistence per 7.4.1.1.2 |
| MC | multicast connectivity | shall support multicast operation as defined in 7.4.5 | shall support multicast operation as defined in 7.4.2 | shall support multicast operation as defined in 7.4.3 and 7.4.4 |
| QSD | queue service discipline | shall implement queue service discipline per 8.4.1.1 | shall implement queue service discipline per 8.4.3.1 | shall implement queue service discipline per 8.4.2.1 |
| RLC | report queue length calculation | shall implement queue length calculation per 8.4.1.2 | shall implement queue length calculation per 8.4.3.2 | shall implement queue length calculation per 8.4.2.2 |
| RF | *REPORT* MPCP format  | shall implement *REPORT* MPCPDU format per 8.4.1.3 | shall implement *REPORT* MPCPDU format per 8.4.3.3 | shall implement *REPORT* MPCPDU format per 8.4.2.3 |
| DCQ | discovery and configuration of queue parameters | N/A | should implement discovery and configuration of queue parameters per 8.4.3.4 | N/A |
| PM | performance monitoring | N/A | N/A | shall implement performance monitoring per 8.5 |
| USM | ONU transceiver status monitoring | shall implement transceiver status monitoring per 9.1.3 | should implement transceiver status monitoring per 9.1.5 | shall implement ONU transceiver status monitoring per 9.1.4, associated alarms and warnings per 9.1.6  |
| TSM | OLT transceiver status monitoring | shall implement OLT transceiver status monitoring per 9.1.4 |
| PLD | UNI port loop detection | N/A | N/A | shall implement UNI port loop detection per 9.1.8 |
| PSL | Port Selective Loopback | shall support Port Selective Loopback per 9.1.9 | N/A | N/A |
| E | events | shall implement events per 9.2.6 | shall implement events per 9.2.6, 9.2.7, and 9.2.8 | shall implement events per 9.2.3, 9.2.4, 9.2.4.5, and 9.2.6 |
| LPTK | optical link protection, trunk type | should implement trunk optical link protection per 9.3.3 and 9.3.5.2 | should implement trunk optical link protection per 9.3.5 | should implement trunk optical link protection per 9.3.3 and 9.3.5.1 |
| LPTE | optical link protection, tree type | should implement tree optical link protection per 9.3.4 and 9.3.5.2 | N/A | should implement tree optical link protection per 9.3.4 and 9.3.5.1 |
| RPC | remote ONU transmitter power supply control | N/A | N/A | shall implement remote ONU transmitter power supply control function per 9.4 |
| PS | power saving | shall support power saving per 10.4 and 10.5.2 | should support power saving per 10.4 and 10.5.3 | shall support power saving per 10.4 and 10.5.4 |
| DE | data encryption  | shall implement data encryption and integrity protection mechanism per 11.2.2 | shall implement data encryption and integrity protection mechanism per 11.2.3 | N/A |
| AU | ONU authentication  | shall implement ONU authentication and secure provisioning per 11.3.3 | shall implement ONU authentication and secure provisioning per 11.3.4 | shall implement ONU authentication and secure provisioning per 11.3.2 |
| MG | management | shall implement eOAM-based management per 13.4 | shall implement eOAM-based management per 13.3 | shall implement eOAM-based management per 13.2 |
| DCD | device and capability discovery | shall implement device discovery and capability discovery per 12.2.3 | shall implement device discovery and capability discovery per 12.2.2 | shall implement device discovery and capability discovery per 12.2.1 |
| SU | software update | shall implement software update mechanism per 12.3.3 | shall implement software update mechanism per 12.3.2 | shall implement software update mechanism per 12.3.1 |
| ME | management entities | shall implement management entities per 14.4 | shall implement management entities per 14.3 | shall implement management entities per 14.2 |
| EDP | EPON Data Path | N/A | N/A | shall implement EDP per Annex 7A |

a N/A – Not Applicable

# Service availability

Clause 9 describes functional requirements to achieve interoperable service availability guarantees in EPON systems. Clause 9 specifically addresses functions and requirements related to device and transceiver monitoring, definitions of associated alarms and warnings, optical link protection, and remote ONU transmitter power supply control.

## Optical link protection

### Introduction

This subclause defines optical link protection mechanisms, their functional description, and the associated OLT and ONU requirements. Two types of optical link protection are introduced, namely, a trunk protection (see 9.3.3 and 9.3.5) and a tree protection (see 9.3.4), each addressing a different application space and providing different types of functionality.

#### Terminology

In the remainder of this subclause, the terms *primary* and *backup* are used to describe the physical modules involved in the protection scheme whereas the terms *working* and *standby* describe the state of the physical modules. The working module refers to the module currently carrying subscriber traffic, and the standby module is not carrying subscriber traffic. During the actual switch event, both the primary and backup modules may be carrying active traffic, depending on the actual implementation; however, this condition is transient.

The switching time between the working OLT and the standby OLT is defined as the time between the last bit of the last frame transmitted on the working OLT\_MDI and the first bit of the first frame transmitted on the standby OLT\_MDI, assuming continuous flow of data to a single connected ONU. The time taken by the switching condition detection process is accounted for in the switching time. Note that the switching time measurement may not be accurate with multiple connected ONUs.

The switching time between the working L-ONU and the standby L-ONU is defined as the maximum time interval among the following:

* + - Time interval between reception of the last bit of the control message (*PON Interface Administrate* TLV, defined in 9.3.5, or *HOLDOVER* message, defined in 9.3.6.2) by the working L-ONU, requesting the ONU to perform switchover, and the first bit of a *REPORT* MPCPDU reflecting the nonzero queue length transmitted by the standby L-ONU.
		- Time interval between the detection of loss of signal by the working L-ONU and the first bit of a *REPORT* MPCPDU reflecting the nonzero queue length transmitted by the standby L-ONU.
		- Time interval between the reception of the first bit of a data frame by the standby L-ONU and the first bit of a *REPORT* MPCPDU reflecting the nonzero queue length transmitted by the standby L-ONU.
1. The above time intervals are measured under continuous flow of data to a single connected ONU.

### Trunk protection scheme

In the trunk protection scheme, the ODN span between the C-OLT and the 2:*N* optical splitter, used to join the two trunk segments, is protected. The C-ONU and the branch fiber (ODN span between the splitter and the ONU) are not protected. There are two types of trunk protection schemes, as shown in Figure 9‑8 and Figure 9‑9.

Figure 9‑8 presents a trunk protection scheme with redundant L-OLT and trunk segments. In this scheme, the MAC, MAC Control, and OAM Clients in the C-OLT are shared by the primary and the backup L-OLTs and are not protected against failures. This trunk protection scheme reduces the implementation cost and targets protection only against the failures having highest potential impact: OLT optical transceiver failures and trunk fiber cuts. In this scheme, the OLT uses a line protection architecture (see 9.3.2.1.1).

The trunk protection with redundant L-OLT scheme supports only the *intra-chassis* protection scheme, where the primary L-OLT and backup L-OLT are located within the same chassis (either on the same line card or on separate line cards.

1. 

Figure 9‑8—Trunk protection with redundant L-OLT

An alternative configuration of the trunk protection scheme is shown in Figure 9‑9. This scheme provides added robustness as the whole C-OLT is duplicated, including the L-OLT and all MAC Clients.

In addition to intra-chassis protection, the trunk protection with redundant C-OLT scheme supports the inter-chassis protection, where the primary C-OLT and backup C-OLT are located in different chassis (either within the same central office or geographically different locations). The inter-chassis protection scheme requires coordination of the protection states and functions among the primary and backup C-OLTs comprising the trunk protection group and may require communication over LANs and/or wide area networks (WANs) using public or proprietary protocols. The nature of information, data formats, and communications protocols used to coordinate protection functions among the primary and backup C-OLTs are outside the scope of this standard.

1. 

Figure 9‑9—Trunk protection with redundant C-OLT

In the trunk protection scheme, the backup C-OLT acquires the round-trip time (RTT) values for individual ONUs without executing the MPCP discovery and registration process. Two possible approaches to acquire RTT are covered in Annex 9A; however, their selection and implementation details are outside the scope of this standard.

There are no ONU configuration differences between the trunk protection schemes shown in Figure 9‑8 and Figure 9‑9. Connected C-ONUs are configured in precisely the same manner.

The following subclauses provide technical requirements for the C-ONU and C-OLT devices participating in this protection scheme.

#### Functional requirements

Trunk protection in EPON requires support for the following basic functionalities:

* + - Ability to measure the standby path RTT (bRTT) in a way that does not affect live services. While the measurement of bRTT through re-registration of the affected ONUs is certainly possible, it would have a high impact on services (i.e., longer interruption) and is, therefore, not recommended. Annex 9A presents examples of dynamic bRTT measurement mechanisms.
		- Ability to switch the ONU between working and standby paths dynamically, without requiring an extended period of downtime, thus minimizing the impact on the operating services. The switching time between working OLT and standby OLT shall be lower than or equal to 150 ms. The definition of the switching time can be found in 9.3.1.1.

The process of protection switching in the trunk protection scheme may be executed in the following ways:

* + - Automatically, when both the OLT and the ONU detect the fault condition on the working optical line using any of the mechanisms specified in the following subclauses; or
		- On-demand, when the OLT is requested by the NMS to switch to the standby path. This protection switch is executed typically for operational reasons, e.g., fiber repairs, maintenance of OLT cards.

#### C-OLT requirements

In the trunk protection mechanism, as defined in 9.3.3, the OLT is connected to two optical links, the primary and backup link, from which only one is active at any time, carrying OAM, eOAM, and MPCP control frames together with subscriber traffic.

The protection function present in the Operation, Administration, and Management block is responsible for switching between the primary and backup paths for subscriber and control frames. Both the Line ONU/OLT protection and Client ONU/OLT protection schemes can be supported by the OLT in the case of trunk protection, as defined in 9.3.2.1.1 and 9.3.2.1.2, respectively.

The protection function additionally instantiates the state diagram per Figure 9‑10, controlling the operation of the MAC Client and L-OLTs.

The standby OLT and the working OLT participating in the trunk protection group exchange configuration details continuously, i.e., the standby OLT is informed by the working OLT of any changes in its configuration, registration, and authentication status of individual ONUs, etc. The specific method of communication between the standby OLT and the working OLT is outside the scope of this standard.

The primary OLT and backup OLT may be provisioned by the NMS in exactly the same manner, using the same configuration parameters, except that one OLT is provisioned as working and the other OLT is provisioned as standby to minimize the preparation time for the backup OLT to come online after the protection switchover.

The standby OLT may be in cold standby mode or in warm standby mode. In the first mode, the standby OLT remains powered off until protection switching is requested. In the second mode, the standby OLT remains powered on with minimum functions enabled and operational, i.e., the OLT has the capability of receiving and parsing upstream transmissions from the PON branch it is connected to, but does not send any data downstream. It is recommended that the standby OLT operates in the warm standby mode to facilitate fast response times to the optical protection switchover events:

* + - Electronic subsystems are fully operational.
		- Optical subsystem is partially active, i.e., transmitter is powered down (no downstream transmission is needed), while receiver is powered up (receiving upstream transmissions from connected ONUs).

Assume the initial state of the network is such that the primary OLT is in the working state and the backup OLT is in the standby state in the following discussion. The working OLT monitors the status of the optical line according to 9.3.2.2.1, and once any of the line fault conditions are detected, the working OLT disables its optical transmitter and stops any downstream transmission. The working OLT then causes the standby OLT to enter into the full operating mode. To complete the switchover process, the working OLT informs the NMS about the switchover event. It is recommended that the time between the events of the working OLT’s switching its laser off and the standby OLT’s switching its laser on be at least equal to the largest value of TLoS\_Optical for all connected ONUs, as defined in 9.3.2.2.2, to guarantee that connected ONUs can properly detect the line fault condition.

Information, notification, and alarms/warnings delivered by the working OLT to the NMS in the switchover condition, as well as message formats, are outside the scope of this standard.

The new working OLT, once the switchover process is complete, shall send one or more *GATE* MPCPDUs to force each registered ONU to resynchronize to the MPCP clock. The transmission of such *GATE* MPCPDU is recommended to take place as soon after the end of the switchover event as possible to minimize frame loss during the switchover event.

#### C-ONU requirements

In the trunk protection mechanism, as defined in 9.3.3, the ONU is connected to a single optical link. In this case, the C-ONU does not contain primary and backup ESPs and typically remains registered throughout the switchover event. All the necessary changes take place on the OLT side, and the ONU is required only to suspend upstream transmissions for a specific period of time and remain in the HOLD\_OVER\_START state (per Figure 9‑11) until a *GATE* MPCPDU is received.

As a result, only one instance of the OAM Client and MAC Control Client is needed on the ONU side, and the protection function present in the Operation, Administration, and Management block instantiates the state diagram per Figure 9‑11, controlling the operation of the MAC Client and L-ONU(s).

Upon detection of a line fault, the C-ONU enters the HOLD\_OVER\_START state per Figure 9‑11, where all currently stored upstream transmission grants are purged and the transmission of data from the ONU to the OLT is suspended. All incoming subscriber upstream data frames are queued. Frame loss is allowed in trunk protection when the local ONU queues overflow.

The C-ONU leaves the HOLD\_OVER\_START state upon the reception of the first *GATE* MPCPDU after entering the HOLD\_OVER\_START state. The upstream transmission is resumed using the newly allocated upstream transmission slots.

If the C-ONU fails to receive the *GATE* MPCPDU within the provisioned duration of the HOLD\_OVER\_START state (expressed by the periodHoldOver variable), the ONU enters the local deregistration state by sending the MACR(DA, REGISTER\_REQ, status = deregister) primitive to the underlying MPCP sublayer, per Figure 9‑11. The OLT deregisters the ONU independently, based on the observed link status.

#### Trunk switching process

##### Variables

backupLoS

TYPE: Boolean

This variable indicates whether the MAC LoS or optical LoS condition is observed by the backup L-OLT, as defined in 9.3.2.2.1, or by the backup L-ONU (only in tree protection case), as defined in 9.3.2.2.2. The value of true indicates that the LoS condition is observed, and false indicates that the LoS condition is not observed. By default, this variable has the value of false.

primaryLoS

TYPE: Boolean

This variable indicates whether the MAC LoS or optical LoS condition is observed by the primary L-OLT, as defined in 9.3.2.2.1, or by the primary L-ONU, as defined in 9.3.2.2.2. The value of true indicates that the LoS condition is observed, and false indicates that the LoS condition is not observed. By default, this variable has the value of false.

periodHoldOver

TYPE: 32-bit unsigned integer

This variable represents the maximum period of time that the ONU may remain in the HOLD\_OVER\_START state. If the ONU does not receive at least one *GATE* MPDPDU within the periodHoldOver, it deregisters. This variable is expressed in units of milliseconds, and its value is provisioned using the management scheme specific for the given profile.

registered

This variable holds the current result of the discovery process. It is set to true once the discovery process is completed and registration is acknowledged. This variable is defined in IEEE Std 802.3, 64.3.3.2 for 1G-EPON and 77.3.3.2 for 10G-EPON.

##### Timers

timerHoldOver

This timer is used to force the ONU leave the HOLD\_OVER\_START state if the period of time spent in the HOLD\_OVER\_START state is longer than the provisioned value of periodHoldOver. Once this timer expires, the ONU deregisters.

##### Functions

activateDataPath( portId )

This function controls the flow of subscriber data frames egressing the port identified by portId parameter, which can take the following values:

* primaryPonIF identifies the primary physical port associated with OLT\_MDI or ONU\_MDI.
* backupPonIF identifies the backup physical port associated with OLT\_MDI or ONU\_MDI.
* primaryMacPort identifies the primary virtual port associated with OLT\_LI. This port is identified by an LLID.
* backupMacPort identifies the backup virtual port associated with OLT\_LI. This port is identified by an LLID.

When the function is called with the argument set to primaryPonIF or primaryMacPort, the identified primary port becomes the working port, and the corresponding backup port becomes the standby port. Similarly, when the function is called with the argument set to backupPonIF or backupMacPort, the identified backup port becomes the working port, and the corresponding primary port becomes the standby port. Implementations may choose to accomplish this switching by modifying the rules or reconfiguring the association between the CrossConnect entries and the queues.

opticalTX( portId, param )

This function controls the status of the optical transmitter associated with the port identified by portId parameter. The portId parameter can take values as defined in the activateDataPath( portId ) function. When the param variable has the value of enable, the optical transmitter is enabled, allowing the data transmission across the OLT\_MDI or ONU\_MDI. When the param variable has the value of disable, the optical transmitter is disabled (either powered down or disabled administratively), resulting in no frames being transmitted across the OLT\_MDI or ONU\_MDI.

purgeGrants()

This function causes an L-ONU to discard all stored (pending) grants.

sendResyncGates( portId )

This function is responsible for transmission of refresh *GATE* MPCPDUs to all L-ONUs connected to a port identified by portId parameter. The portId parameter can take values as defined in the activateDataPath( portId ) function. Reception of these *GATE* MPCPDUs forces the ONUs to leave the HOLD\_OVER\_START state, as defined in Figure 9‑11.

##### Primitives

MACI( GATE )

1. An acronym for MACI( GATE, start, length, force\_report, discovery, status ). It represents a reception of a nondiscovery *GATE* MPCPDU at the ONU as defined in IEEE Std 802.3, 64.3.5.5 for 1G-EPON and 77.3.5.5 for 10G-EPON. The MACI acronym is defined in 3.4.

MACR( DA, REGISTER\_REQ, status )

This primitive represents the transmission of a *REGISTER\_REQ* MPCPDU by the ONU, as defined in IEEE Std 802.3, 64.3.3.5 for 1G-EPON and 77.3.3.5 for 10G-EPON. The MACR acronym is defined in 3.4.

NMSI( messageId, failureCode)

This primitive is used to inform the NMS about the protection switching event, during which the previously working and standby L-OLTs exchange their functions. It uses the following parameters:

* messageId identifies whether the switching event was initiated by the OLT or the ONU and what the new working port is. The following messages are defined:
	+ MSG1: The switching event was initiated at the OLT, and the primaryPonIF is in the working state.
	+ MSG2: The switching event was initiated at the OLT, and the backupPonIF is in the working state.
* failureCode identifies the reason for the protection switching, per 9.2.4.8.

NMSR( protection, switch )

This primitive is used by the NMS to request the working OLT to initiate a protection switch, during which the previously working and standby OLTs exchange their functions.

##### State diagrams

The C-OLT shall instantiate the switching process state diagram as defined in Figure 9‑10. In case Client protection is implemented at the OLT (i.e., when two C-OLTs are used as shown in Figure 9‑9), the combined operation of both C-OLTs shall be as defined in Figure 9‑10. The C-ONU shall instantiate the switching process state diagram as defined in Figure 9‑11.



Figure 9‑10—Trunk protection process operating on the OLT



Figure 9‑11—Trunk protection process operating on the ONU

### Tree protection scheme

In the tree protection scheme, the entire ODN (trunk segment and branch segments) is protected against failure. There are two types of tree protection schemes, as shown in Figure 9‑12 and in Figure 9‑13.

Figure 9‑12 presents a tree protection scheme with redundant L-OLT, L-ONU, and ODN. In this scheme, the OLT and ONUs use a line protection architecture (see 9.3.2.1.1) sharing the MAC, MAC Control, and OAM Clients among the primary and the backup L-OLTs and primary and backup L-ONUs. This scheme reduces data loss during the protection switchover event since the data frames stored in MAC Client queues are redirected to another path. However, in this scheme the MAC, MAC Control, and OAM Clients are not protected against failures.

1. 

Figure 9‑12—Tree protection with redundant L-OLT

An alternative configuration of the tree protection scheme is shown in Figure 9‑13. This scheme provides added robustness as the whole C-OLT is duplicated, including the L-OLT and all MAC Clients. Similarly to the trunk protection scheme with redundant C-OLT, the tree protection scheme with redundant C-OLT supports the inter-chassis protection, where the primary C-OLT and backup C-OLT are located in different chassis (either within the same central office or geographically different locations). The inter-chassis protection scheme requires coordination of the protection states and functions among the primary and backup C-OLTs comprising the trunk protection group and may require communication over LANs/WANs using public or proprietary protocols. The nature of information, data formats, and communications protocols used to coordinate protection functions among the primary and backup C-OLTs are outside the scope of this standard.

ONUs participating in tree protection schemes may also implement Client ONU protection, in which MAC, MAC Control, and OAM Clients in the ONU are duplicated. Such schemes may have increased robustness due to added protection against ONU Client failures, at the expense of increased frame loss during the protection switchover event, as explained in 9.3.2.1.2. The nature of information, data formats, and communications protocols used to coordinate protection functions among the primary and backup C-ONUs are outside the scope of this standard.



Figure 9‑13—Tree protection with redundant C-OLT

The following subclauses provide technical requirements for the C-ONU and C-OLT devices participating in this protection scheme.

#### Functional requirements

Under the tree protection scheme, upon detecting a line fault condition, any ONU may be selectively switched from the working path to the standby path.

The switching time between the working OLT and standby OLT shall be less than or equal to 50 ms. The definition of the switching time is given in 9.3.1.1.

The switching time between the working ONU and standby ONU shall be less than or equal to 50 ms. The definition of the switching time is given in 9.3.1.1.

The protection switching process in the tree protection scheme may be initiated in the following ways:

* + - Automatically, when either the OLT or the ONU detect any of the fault conditions on the working optical line using any of the mechanisms specified in the following subclauses; or
		- On-demand, when the NMS issues the request to the OLT for a particular ONU to be switched to the standby path. This protection switching process is executed typically for operational reasons, e.g., fiber repairs, maintenance of OLT cards.

An OLT may serve as a working OLT for one group of ONUs (working ONUs) and simultaneously serve as a standby OLT for another group of ONUs (standby ONUs). Therefore, the same PON port in the OLT may serve as a working PON port for a group of L-ONUs and as a standby PON port for another group of L-ONUs.

The working L-ONU shall be registered at the working L-OLT and remain fully active (including MPCP, OAM, and subscriber data flows) as long as the link between the working L-ONU and working L-OLT remains functional.

The standby L-ONU shall be registered at the standby L-OLT and remain fully active (including MPCP and OAM flows) as long as the link between the standby L-ONU and the standby L-OLT remains functional. The link between the standby L-ONU and the standby L-OLT shall not carry any subscriber traffic as long as the link between the working L-ONU in the same C-ONU and the working L-OLT remains active.

The OLT and ONU shall execute the MPCP discovery and registration processes, basic OAM discovery (per IEEE Std 802.3, Clause 57), extended OAM discovery (profile-specific, see 12.2.1 or 12.2.3), and ONU authentication process (profile-specific, see 11.3.2 or 13.3.3) if it is enabled, independently for the working and standby L-ONUs.

A pair of L-ONUs comprising a protection group may be provisioned using the same configuration parameters, with the exception of their protection role: one L-ONU is designated as primary L-ONU (PON port instance 0) and the other is designated as backup L-ONU (PON port instance 1).

The OLT discovers the PON port instance number for a registered L-ONU and sets the corresponding OLT PON port (LLID) to primary if the ONU PON port instance is 0 and to backup if the ONU PON port instance is 1. Therefore, all ONU PON ports designated as primary are connected to the primary OLT ports (LLIDs), and all ONU PON ports designated as backup are connected to the backup OLT ports (LLIDs).

After designating the primary and backup LLIDs, the OLT discovers the PON port instance that is currently in the working (active) state. The OLT does so by reading the value of the *aOnuConfigPonActive* attribute using the *PON Interface Administrate* TLV (see 9.3.5). The OLT then sets the corresponding LLID to the working (active) state.

#### C-OLT requirements

In the tree protection mechanism, the C-OLT is connected to two optical links: the primary and backup link. Both the primary and the backup links are active and carry OAM, eOAM, and MPCP control frames. The working link also carries subscriber data frames.

The protection function present in the Operation, Administration, and Management block is responsible for switching between the primary and backup paths for subscriber data frames. Both the L-OLT and C-OLT protection can be supported in the case of tree protection, as defined in 9.3.2.1.1 and 9.3.2.1.2, respectively. In the case of L-OLT protection, the same C-OLT is connected to two optical links: the primary and the backup link. Both the primary and the backup links are active and carry OAM, eOAM, and MPCP control frames. The working link also carries subscriber data frames.

The protection function instantiates the state diagram per Figure 9‑18, controlling the operation of the MAC Client and L-OLTs.

The primary OLT and backup OLT may be provisioned by the NMS in exactly the same manner, using the same configuration parameters, except that different LLIDs in each OLT are provisioned as working or as standby. During the switchover event, there are no changes in the operation of the OAM and MAC Control client interfaces, i.e., only their status as working and standby changes.

The standby OLT remains fully powered on with a complete set of transport functions enabled and operational, i.e., the OLT has the capability of receiving and parsing upstream transmissions from the EPON to which it is connected and may send data downstream to connected ONUs as required by the current configuration of the given EPON branch.

The standby OLT shall allow for configuration of individual standby ONUs connected to it. The standby OLT shall enable all necessary MPCP and OAM/eOAM mechanisms defined in this standard as well as in IEEE Std 802.3 in order to maintain data link connectivity with individual standby ONUs. The standby OLT shall disallow any downstream user traffic prior to the switchover event.

The standby OLT shall issue grants to the standby ONUs to ensure normal operation of the MPCP. The standby OLT shall suppress generation of any alarms and warnings associated with the arrival of empty/underutilized upstream transmission slots.

The working OLT monitors the status of the optical line. Several failure scenarios are possible as presented in 9.3.4.4. Unlike the trunk protection case, where all ONUs are switched from working L-OLT to standby L-OLT together, in the tree protection scheme, ONUs are switched to standby L-OLT selectively. When a line failure is detected for a particular working ONU, that ONU is switched to the standby optical path, while the working L-OLT continues operation for all remaining registered working ONUs.

The working OLT notifies the NMS about the detected line failure condition(s) and the line switch event for a particular ONU. This allows the operator to undertake any necessary repair/replacement tasks.

To request working ONUs connected to the working data path to switch traffic to the standby data path, the working OLT sends to these ONUs the *PON Interface Administrate* TLV, as defined in 9.3.5. The tree protection state diagrams are defined in 9.3.4.6.

Given that the standby L-ONU remains at all times registered at the standby OLT and synchronized to the respective MPCP domain clock, the transmission of the forced synchronization *GATE* MPCPDUs as defined for the trunk protection scheme is not required (see 9.3.3.2).

#### C-ONU requirements

In the tree protection mechanism, the C-ONU contains two L-ONUs: a primary L-ONU and a backup L-ONU. The primary L-ONU is connected to its primary L-OLT and remains at all times registered at this L-OLT and synchronized to the respective MPCP domain clock. The backup L-ONU is connected to its backup L-OLT and remains at all times registered at this L-OLT and synchronized to the respective MPCP domain clock. At all times, one of the L-ONUs is in a working state, while the other one is in the standby state. Both the working and the standby links carry OAM, eOAM, and MPCP control frames; however, the subscriber traffic is carried only on the working link.

During the switchover event, there are no changes in the registration status or operation of the primary and backup L-ONUs, except the reversing of their working and standby roles, i.e., the L-ONU previously in standby state becomes the working L-ONU and starts carrying subscriber traffic, while the L-ONU previously in working state becomes the standby L-ONU.

The protection function present in the Operation, Administration, and Management block is responsible for switching between the primary and backup paths for subscriber data frames. Both the L-ONU and C-ONU protection can be supported in the case of tree protection, as defined in 9.3.2.1.1 and 9.3.2.1.2, respectively.

The protection function instantiates the state diagram per Figure 9‑19, controlling the operation of the MAC Client and L-ONUs.

In the case of an mL-ONU device supporting the tree protection mechanism, one of the L-ONUs connected to the primary optical path is designated as base L-ONU, and one of the L-ONUs connected to the backup optical path is designated as base L-ONU (see 12.2.1.4). The primary C-ONU and backup C-ONU independently go through the MPCP discovery and registration, OAM and eOAM discovery, and configuration and optional authentication on their optical link (primary and backup, respectively), as defined in 12.2.1.4.

The working L-ONU monitors the status of the upstream and downstream optical links. When the working L-ONU detects a downstream line failure using any of the mechanisms defined in 9.3.2.2.2, the working and the standby L-ONUs switch roles, and all subscriber flows are forwarded to the new working L-ONU. After the switchover completes, the new working L-ONU sends the PON\_IF\_Switch event as defined in 9.2.4.8, carrying the information about the type of detected failure source. This improves the reaction time of the working L-OLT to the downstream line failure condition. No automatic switchback to the original working L-ONU is performed; the working L-ONU continues forwarding subscriber traffic until it is instructed by the NMS to perform a switchover or a failure detected on its new working path.

#### Examples of tree protection switching

This subclause contains examples of the tree protection switching scenarios.

##### NMS-driven tree line switchover event

Figure 9‑14 represents the NMS-driven protection switching scenario, where the decision to switch user traffic from the working path to the standby path is taken by the NMS, e.g., to perform routine maintenance tasks or replace line cards in the OLT shelf. In such a situation, the NMS requests the OLT to switch traffic from the working to the standby data path. The OLT performs the necessary local actions and also transmits the *PON Interface Administrate* TLV, as defined in 9.3.5, to the working C-ONU requesting it to perform the protection switching.

1. 

Figure 9‑14—An example of tree protection switching: NMS driven request

##### Automated tree line switching with line failure detection

When both the downstream and upstream data paths fail, both the working OLT and working ONU can detect the link fault condition. In such a case, both the working OLT and working ONU perform protection switching, as shown in Figure 9‑15.



Figure 9‑15—An example of tree protection switching:
link failure detected by working OLT and working C-ONU

##### Automated tree line switching with upstream line failure detection

When the upstream data path suffers a failure (e.g., ONU transmitter fails or OLT receiver fails), the working OLT can detect such an occurrence and initiate the protection switching process. As indicated before, the working OLT sends the *PON Interface Administrate* TLV, as defined in 9.3.5, downstream to the working ONU, forcing it to switch all its traffic to the standby data path. Once the process is complete, the new working ONU sends the PON\_IF\_Switch event notification, allowing the OLT to confirm that the process was successfully completed on the ONU side. This scenario is shown in Figure 9‑16.



Figure 9‑16—An example of tree protection switching:
upstream link failure detected by working OLT

##### Automated tree line switching with downstream line failure detection

In a scenario when the downstream data path suffers a failure (e.g., ONU receiver fails or OLT transmitter fails), only the working ONU can detect such an occurrence and initiate the protection switching process. In this case, it is the working ONU that starts the protection switching by suspending any upstream transmissions to the working OLT once the downstream channel is found to be defective. At this stage, the working ONU switches the traffic to the standby ONU and transmits the PON\_IF\_Switch event notification to the working OLT. Upon reception of the PON\_IF\_Switch event notification from its current standby MAC port, the OLT suspends the data transmission to the corresponding working MAC port and activates the standby MAC port. This scenario is shown in Figure 9‑17.



Figure 9‑17—An example of tree protection switching:
downstream link failure detected by working ONU

#### Tree protection process

##### Constants

backupPort

TYPE: 8-bit unsigned integer

This constant identifies the backup port in the OLT or in the ONU. The backup port in the OLT (MAC in L-OLT) is connected to the backup port in the ONU (L-ONU), i.e., both ports are attached to the same physical media.

VALUE: 0x01

primaryPort

TYPE: 8-bit unsigned integer

This constant identifies the primary port in the OLT or in the ONU. The primary port in the OLT (MAC in L-OLT) is connected to the primary port in the ONU (L-ONU), i.e., both ports are attached to the same physical media.

VALUE: 0x00

##### Variables

backupPortStatus

TYPE: Enumerated

This variable represents current status of the backup port in the OLT or in the ONU. It can take the following values:

* OK (0x00-00-00-00) – backup port operates normally.
* LOS (0x00-00-00-01) – indicates that the MAC LoS or optical LoS condition is observed by the backup port at the OLT, as defined in 9.3.2.2.1, or by the backup port at the ONU, as defined in 9.3.2.2.2.
* MPCP (0x00-00-00-02) – indicates that the mpcp\_timeout condition, as defined in IEEE Std 802.3, 64.3.4.2, is observed by the backup L-OLT or by the backup L-ONU.
* BER (0x00-00-00-03) – indicates that the BER of the signal received by the backup port at the OLT or at the ONU exceeds a certain, operator-defined threshold.
* PORT (0x00-00-00-04) – indicates that the power levels of the signal received by the backup port at the OLT or at the ONU exceeds a certain, operator-defined high or low threshold.
* OLT\_REQ (0x00-00-00-05) – indicates that the backup port is placed in the standby mode (deactivated) based on OLT (NMS) request. At the OLT, backupPortStatus is set to OLT\_REQ upon the reception of NMSR( switch, primaryPort, indexONU ) primitive defined in 9.3.4.6.4. At the ONU, backupPortStatus is set to OLT\_REQ upon the reception of eOAMI\_Switch\_Request( primaryPort ) primitive on either the primary or the backup port.
* ONU\_REQ (0x00-00-00-06) – indicates that the OLT’s backup port is placed in the standby mode (deactivated) based on the ONU’s request.

dataFrameReceived

TYPE: Boolean

This variable indicates that a frame other than the OAMPDU or MPCPDU is received at the given port. When the data frame is received, this variable is set to true. It retains the value until explicitly reset.

primaryPortStatus

TYPE: Enumerated

This variable represents current status of the primary port in the OLT or in the ONU. It can take the following values:

* OK (0x00-00-00-00) – primary port operates normally.
* LOS (0x00-00-00-01) – indicates that the MAC LoS or optical LoS condition is observed by the primary port at the OLT, as defined in 9.3.2.2.1, or by the primary port at the ONU, as defined in 9.3.2.2.2.
* MPCP (0x00-00-00-02) – indicates that the mpcp\_timeout condition, as defined in IEEE Std 802.3, 64.3.4.2, is observed by the primary L-OLT or by the primary L-ONU.
* BER (0x00-00-00-03) – indicates that the BER of the signal received by the primary port at the OLT or at the ONU exceeds a certain, operator-defined threshold.
* PORT (0x00-00-00-04) – indicates that the power levels of the signal received by the primary port at the OLT or at the ONU exceeds a certain, operator-defined high or low threshold.
* OLT\_REQ (0x00-00-00-05) – indicates that the primary port is placed in the standby mode (deactivated) based on OLT (NMS) request. At the OLT, primaryPortStatus is set to OLT\_REQ upon the reception of NMSR( switch, backupPort, indexONU ) primitive defined in 9.3.4.6.4. At the ONU, primaryPortStatus is set to OLT\_REQ upon the reception of eOAMI\_Switch\_Request( backupPort ) primitive on either the primary or the backup port.
* ONU\_REQ (0x00-00-00-06) – indicates that the OLT’s primary port is placed in the standby mode (deactivated) based on the ONU’s request.

workingPort

TYPE: 8-bit unsigned integer

This variable represents the currently working port in the OLT or in the ONU. It can take values primaryPort or backupPort (see 9.3.4.6.1). In the ONU, this variable retains its value across the reset or reboot. By default, this variable has the value of primaryPort.

##### Functions

activateDataPath( portId )

This function activates, i.e., places into the working state, the port identified by the portId parameter. In the working state, a port is able to transmit MPCPDUs, OAMPDUs, and subscriber data frames.

deactivateDataPath( portId )

This function deactivates, i.e., places into the standby state, the port identified by the portId parameter. In the standby state, a port is able to transmit MPCPDUs and OAMPDUs, but not subscriber data frames.

##### Primitives

eOAMI\_Switch\_Event()

This primitive is defined in 9.3.5.

eOAMI\_Switch\_Request( portId )

This primitive is defined in 9.3.5.

eOAMR\_Switch\_Event( failureCode )

This primitive is defined in 9.3.5.

eOAMR\_Switch\_Request( portId )

This primitive is defined in 9.3.5.

NMSI\_1( failureCode, indexONU )

This primitive informs the NMS about the protection switching event, initiated by the OLT, that placed the primaryPort in the working state. This primitive uses the following parameters:

* failureCode identifies the reason for the protection switching, per 9.2.4.8;
* indexONU identifies the affected L-ONU.

NMSI\_2( failureCode, indexONU )

This primitive informs the NMS about the protection switching event, initiated by the ONU, that placed the primaryPort in the working state. This primitive uses parameters identical to the parameters defined for the NMSI\_1 primitive.

NMSI\_3( failureCode, indexONU )

This primitive informs the NMS about the protection switching event, initiated by the OLT, that placed the backupPort in the working state. This primitive uses parameters identical to the parameters defined for the NMSI\_1 primitive.

NMSI\_4( failureCode, indexONU )

This primitive informs the NMS about the protection switching event, initiated by the ONU, that placed the backupPort in the working state. This primitive uses parameters identical to the parameters defined for the NMSI\_1 primitive.

NMSR( switch, portId, indexONU )

This primitive is used by the NMS to perform the protection switching of the L-ONU, identified by the indexONU parameter, from its current working port to the port indentified by the portId parameter.

##### State diagrams

Each C-OLT shall instantiate the tree protection process state diagram as defined in Figure 9‑18 for each primary port (LLID) associated with the connected and registered L-ONUs, and it shall instantiate the tree protection process state diagram as defined in Figure 9‑18 for each backup port (LLID) associated with the connected and registered L-ONUs. In the case where Client OLT protection is implemented (i.e., when two C-OLTs are used as shown in Figure 9‑13), the combined operation of both C-OLTs shall be as defined in Figure 9‑18.

The C-ONU shall instantiate the tree protection process state diagram as defined in Figure 9‑19 for the primary L-ONU instantiated in this C-ONU, and it shall instantiate the tree protection process state diagram as defined in Figure 9‑19 for the backup L-ONU instantiated in this C-ONU. In the case where Client ONU protection is implemented (i.e., when two C-ONU are used), the combined operation of both C-ONUs shall be as defined in Figure 9‑19.



Figure 9‑18—Tree protection process operating on the OLT



Figure 9‑19—Tree protection process operating on the ONU

### Profile-specific messages

The trunk protection scheme defined in 9.3.3 and the tree protection scheme defined in 9.3.4 may be used in multiple profiles. This clause references the profile-specific messages to be used in non-SNMP-optimized eOAM profile and in DPoE eOAM profile.

#### Messages for non-SNMP-optimized eOAM profile

Table 9-xx1 specifies the messages that shall be used for trunk and tree protection in non-SNMP-optimized eOAM profile.

**Table 9-xx1 —** **Non-SNMP-optimized eOAM profile-specific messages**

| 1. **TLV**
 | 1. **Branch**
 | 1. **Leaf**
 | 1. **Defined in**
 |
| --- | --- | --- | --- |
| 1. ONU Capabilities
 | 1. 0xC7
 | 1. 0x00-07
 | 1. 14.2.2.5
 |
| 1. ONU Protection Configuration
 | 1. 0xC7
 | 1. 0x00-0F
 | 1. 14.2.2.13
 |
| 1. PON Interface Administrate
 | 1. 0xC7
 | 1. 0x00-0B
 | 1. 14.2.2.9
 |
| 1. ONU Timestamp Drift Prevention Mechanism
 | 1. 0xC7
 | 1. 0x00-08
 | 1. 14.2.2.6
 |

##### ONU Capability Discovery

The OLT may discover the capability of the connected ONU to support tree protection using the *aOnuCapabilities.sProtection* sub-attribute, carried in the *ONU Capabilities* TLV (0xC7/0x00-07).

##### Configuration of line fault detection parameters

To configure the values for TLoS\_Optical and TLoS\_MAC parameters in the C-ONU (see 9.3.2.2.2), the C-OLT uses the *ONU Protection Configuration* TLV (0xC7/0x00-0F) per 14.2.2.13. The C-ONU shall be able to process the eOAMPDU with the *ONU Protection Configuration* TLV (0xC7/0x00-0F) and set the values for TLoS\_Optical and TLoS\_MAC parameters accordingly.

##### Configuration of hold-over interval

To configure the value for the timerHoldOver timer (defined in 9.3.3.5.2) in the C-ONU, the C-OLT uses the *ONU Timestamp Drift Prevention Mechanism* TLV (0xC7/0x00-08) per 14.2.2.6. The C-ONU shall be able to process the eOAMPDU with the *ONU Timestamp Drift Prevention Mechanism* TLV (0xC7/0x00-08) and set the value for the timerHoldOver timer accordingly.

##### Primitives used in tree protection state diagram

eOAMI\_Switch\_Event()

1. This primitive represents the reception of an eOAMPDU containing a PON\_IF\_Switch event, as defined in 9.2.4.8. SIEPON\_Event\_TLV represents the SIEPON-specific *Event Notification* TLV as defined in 13.2.2.3.2. This primitive replaces the following code:
2. OPI( source\_address, flags, code, sequence\_number | SIEPON\_Event\_TLV ) AND
3. source\_address == ONU\_MAC AND
4. code == 0x01 AND
5. SIEPON\_Event\_TLV.Type == 0xFE AND
6. SIEPON\_Event\_TLV.Length == 0x12 AND
7. SIEPON\_Event\_TLV.OUI == OUI\_C AND
8. SIEPON\_Event\_TLV.ObjectType == 0xFF-FF AND
9. SIEPON\_Event\_TLV.ObjectInstance == 0xFF-FF-FF-FF AND
10. SIEPON\_Event\_TLV.EventID == 0x00-0C AND
11. SIEPON\_Event\_TLV.EventState == 0x00
12. The eOAMPDU containing a PON\_IF\_Switch event may also contain other *Link Event* TLVs, as defined in IEEE Std 802.3, 57.4.3.2.

eOAMI\_Switch\_Request( portId )

1. This primitive represents the reception of an eOAMPDU containing the *PON Interface Administrate* TLV (0xC7/0x00-0B), as defined in 14.2.2.9. This primitive replaces the following code:
2. OPI( source\_address, flags, code, OUI\_C | Opcode | PON\_IF\_TLV ) AND
3. source\_address == OLT MAC AND
4. code == 0xFE AND
5. Opcode == 0x03 AND
6. PON\_IF\_TLV.Branch == 0xC7 AND
7. PON\_IF\_TLV.Leaf == 0x00-0B AND
8. PON\_IF\_TLV.Length == 0x01 AND
9. PON\_IF\_TLV.PonPortActive == portId

eOAMR\_Switch\_Event( failureCode )

1. This primitive represents the transmission of an eOAMPDU containing a PON\_IF\_Switch event as defined in 9.2.4.8. SIEPON\_Event\_TLV represents the SIEPON-specific *Event Notification* TLV as defined in 13.2.2.3.2. This primitive replaces the following code:
2. source\_address = ONU\_MAC
3. code = 0x01
4. SIEPON\_Event\_TLV.Type = 0xFE
5. SIEPON\_Event\_TLV.Length = 0x12
6. SIEPON\_Event\_TLV.OUI = OUI\_C
7. SIEPON\_Event\_TLV.ObjectType = 0xFF-FF
8. SIEPON\_Event\_TLV.ObjectInstance = 0xFF-FF-FF-FF
9. SIEPON\_Event\_TLV.EventID = 0x00-0C
10. SIEPON\_Event\_TLV.EventState = 0x00
11. SIEPON\_Event\_TLV.EventInfo = failureCode
12. OPR( source\_address, flags, code, sequence\_number | SIEPON\_Event\_TLV )
13. The eOAMPDU containing a PON\_IF\_Switch event may also contain other *Link Event* TLVs, as defined in IEEE Std 802.3, 57.4.3.2.

eOAMR\_Switch\_Request( portId )

1. This primitive represents the transmission of an eOAMPDU containing the *PON Interface Administrate* TLV (0xC7/0x00-0B), as defined in 14.2.2.9. This primitive replaces the following code:
2. source\_address = OLT\_MAC
3. code = 0xFE
4. Opcode = 0x03
5. PON\_IF\_TLV.Branch = 0xC7
6. PON\_IF\_TLV.Leaf = 0x00-0B
7. PON\_IF\_TLV.Length = 0x01
8. PON\_IF\_TLV.PonPortActive = portId

OPR( source\_address, flags, code, OUI\_C | Opcode | PON\_IF\_TLV )

#### Messages for DPoE eOAM profile

Table 9-xx2 specifies the messages that shall be used for trunk and tree protection in DPoE eOAM profile.

**Table 9-xx2—** **DPoE eOAM profile-specific messages**

| 1. **TLV**
 | 1. **Branch**
 | 1. **Leaf**
 | 1. **Defined in**
 |
| --- | --- | --- | --- |
| 1. ONU Protection Capability
 | 1. 0xD7
 | 1. 0x09-00
 | 1. 14.4.1.9.1
 |
| 1. ONU Protection Configuration
 | 1. 0xD7
 | 1. 0x09-01
 | 1. 14.4.1.9.2
 |
| 1. PON Interface Administrate
 | 1. 0xD7
 | 1. 0x09-02
 | 1. 14.4.1.9.3
 |
| 1. ONU Config HoldOver Period
 | 1. 0xD7
 | 1. 0x09-03
 | 1. 14.4.1.9.4
 |

##### ONU Capability Discovery

The OLT may discover the capability of the connected ONU to support trunk or tree protection using the *aOnuProtectionCapability* attribute, carried in the *ONU Protection Capability* TLV (0xD7/0x09-00). The ONU may support trunk protection, L-ONU tree protection, or C-ONU tree protection in any combination, depending on the capabilities of the given ONU.

##### Configuration of line fault detection parameters

To configure the values for TLoS\_Optical and TLoS\_MAC parameters in the C-ONU (see 9.3.2.2.2), the C-OLT uses the *ONU Protection Configuration* TLV (0xD7/0x09-01) per 14.4.1.9.2. The C-ONU shall be able to process the eOAMPDU with the *ONU Protection Configuration* TLV (0xD7/0x09-01) and set the values for TLoS\_Optical and TLoS\_MAC parameters accordingly.

##### Configuration of hold-over interval

1. To configure the value for the timerHoldOver timer (defined in 9.3.3.5.2) in the C-ONU, the C-OLT uses the *ONU Config HoldOver Period* TLV (0xD7/0x09-03) per 14.4.1.9.4. The C-ONU shall be able to process the eOAMPDU with the *ONU Config HoldOver Period* TLV (0xD7/0x09-03) and set the value for the timerHoldOver timer accordingly.

##### Primitives used in tree protection state diagram

eOAMI\_Switch\_Event()

This primitive represents the reception of an eOAMPDU containing a PON\_IF\_Switch event, as defined in 9.2.4.8. SIEPON\_Event\_TLV represents the SIEPON-specific *Event Notification* TLV as defined in 13.4.1.3.2. This primitive replaces the following code:

OPI( source\_address, flags, code, sequence\_number | SIEPON\_Event\_TLV ) AND

source\_address == ONU\_MAC AND

code == 0x01 AND

SIEPON\_Event\_TLV.Type == 0xFE AND

SIEPON\_Event\_TLV.Length == 0x06 AND

SIEPON\_Event\_TLV.OUI == OUI\_A AND

SIEPON\_Event\_TLV.EventCode == 0x84 AND

SIEPON\_Event\_TLV.EventRaised == 0x00 AND

SIEPON\_Event\_TLV.ObjectType == 0x00-00 AND

SIEPON\_Event\_TLV.ObjectInstance == 0x00-00

The eOAMPDU containing a PON\_IF\_Switch event may also contain other *Link Event* TLVs, as defined in IEEE Std 802.3, 57.4.3.2.

eOAMI\_Switch\_Request( portId )

This primitive represents the reception of an eOAMPDU containing the *PON Interface Administrate* TLV (0xD7/0x09-02), as defined in 14.4.1.9.3. This primitive replaces the following code:

OPI( source\_address, flags, code, OUI\_A | Opcode | PON\_IF\_TLV ) AND

source\_address == OLT MAC AND

code == 0xFE AND

Opcode == 0x03 AND

PON\_IF\_TLV.Branch == 0xD7 AND

PON\_IF\_TLV.Leaf == 0x00-16 AND

PON\_IF\_TLV.Length == 0x01 AND

PON\_IF\_TLV.PonPortActive == portId

eOAMR\_Switch\_Event( failureCode )

This primitive represents the transmission of an eOAMPDU containing a PON\_IF\_Switch event as defined in 9.2.4.8. SIEPON\_Event\_TLV represents the SIEPON-specific *Event Notification* TLV as defined in 13.4.1.3.2. This primitive replaces the following code:

source\_address = ONU\_MAC

code = 0x01

SIEPON\_Event\_TLV.Type = 0xFE

SIEPON\_Event\_TLV.Length = 0x06

SIEPON\_Event\_TLV.OUI = OUI\_A

SIEPON\_Event\_TLV.EventCode = 0x84

SIEPON\_Event\_TLV.EventRaised = 0x00

SIEPON\_Event\_TLV.ObjectType = 0x00-00

SIEPON\_Event\_TLV.ObjectInstance = 0x00-00

OPR( source\_address, flags, code, sequence\_number | SIEPON\_Event\_TLV )The eOAMPDU containing a PON\_IF\_Switch event may also contain other *Link Event* TLVs, as defined in IEEE Std 802.3, 57.4.3.2.

eOAMR\_Switch\_Request( portId )

This primitive represents the transmission of an eOAMPDU containing the *PON Interface Administrate* TLV (0xD7/0x09-02), as defined in 14.4.1.9.3. This primitive replaces the following code:

source\_address = OLT\_MAC

code = 0xFE

Opcode = 0x03

PON\_IF\_TLV.Branch = 0xD7

PON\_IF\_TLV.Leaf = 0x00-16

PON\_IF\_TLV.Length = 0x01

PON\_IF\_TLV.PonPortActive = portId

OPR( source\_address, flags, code, OUI\_A | Opcode | PON\_IF\_TLV )

# Extended OAM for EPON

## DPoE eOAM management

### eOAMPDU structure

1. This subclause defines the internal structure of the eOAMPDU frame, i.e., the size and meaning of individual fields, and describes a TLV-oriented approach to packaging data in the eOAMPDU. Two specific types of the TLVs are also specified, namely the Variable Descriptor and the Variable Container.
2. The eOAMPDU format is derived from the IEEE 802.3 (Clause 57) OAM frame format, through the use of Organization Specific Extension mechanism, as described in detail in IEEE Std 802.3, 57.4.2 (Figure 57-9), and further extended in the following subclauses.

#### TLVs for 802.3 OAMPDUs

##### *Event Notification* TLV

1. The basic structure of the *Organization Specific Event* TLV shall be as specified in IEEE Std 802.3, 57.5.3.5. Specific fields in the *Organization Specific Event* TLV shall be as shown in Figure 13‑8 and specified below:
2. 

Figure 13‑1—Relationship between *Organization Specific Event* TLV and the *Event Notification* OAMPDU

* 1. Event Type = 0xFE, according to the encoding of this field as defined in IEEE Std 802.3, Table 57–12.
	2. Event Length. This one-octet field indicates the length (in octets) of this TLV-tuple.
	3. OUI for Package A, equal to OUI\_A.
	4. Organization Specific Value carries the specific set of event-associated information. Further, the structure of the Organization Specific Value shall be as specified in Table 13‑84 and described below.

Table 13‑5—Internal structure of the Organization Specific Value field

| 1. **Octet(s)**
 | 1. **Field**
 | 1. **Notes**
 |
| --- | --- | --- |
| 1. 1
 | 1. EventCode
 | 1. This field identifies the type of alarm that was identified by the source OAM client. See Table 13‑85 for definition of individual values for the EventCode field. These alarm codes are grouped into link faults, critical events, and Dying Gasp alarm types, with code values numbered accordingly. Only the values listed in the table are supported. Other values are reserved and ignored on reception.
 |
| 1. 1
 | 1. EventRaised
 | 1. This field indicates whether the given event was raised. The following values are supported:
2. 0x00: The given event was cleared.
3. 0x01: The given event was raised.
4. Other values are reserved and ignored on reception.
 |
| 2 | ObjectType | 1. This field identifies the object element generating the alarm in question.
 |
| 2 | ObjectInstance | 1. This field identifies the object element instance generating the alarm in question.
 |

* ObjectType field identifies the object that generated the given event, as defined in 14.4.1.1.1. Other values of the ObjectType are reserved and ignored on reception.
* ObjectInstance field identifies the specific instance of the object that generated the given event, as defined in 14.4.1.1.2.

Table 13‑6—Code points for the EventCode field

| Event Code | Value | Description |
| --- | --- | --- |
| Link Fault Alarms |
| LoS | 11 | Loss of received optical power by the transceiver (ONU EPON port). Link down on Ethernet PHY (ONU UNI port). |
| Key Exchange Failure | 12 | ONU did not observe a switch to a new key after key exchange. |
| Critical Event Alarms |
| Port Disabled | 21 | Ethernet port is disabled by management action. |
| Dying Gasp Alarms |
| Power Failure | 41 | Loss of power at the ONU (Dying Gasp). |
| Other Alarms |
| Statistics Alarm | 81 | Statistic has crossed defined alarm thresholds. |
| ONU Busy | 82 | ONU is busy and unable to acknowledge or process further OAM until alarm clears. |
| MAC Table Overflow | 83 | ONU MAC Table has seen more addresses than it can hold. |
| PON\_IF\_Switch | 84 | PON interface on the ONU was switched to backup. |

*Insert a new subclause 13.4.1.3.2.8 as shown below*

###### PON\_IF\_Switch (0x84)

1. The PON\_IF\_Switch alarm is raised by the ONU to inform the OLT that the PON interface on the ONU was switched from the active interface to backup interface, according to the tree protection mechanism defined in 9.3.4.

# Management entities

## Management entities for DPoE eOAM profile

### Branch 0xD7 “extended attributes”

1. This subclause lists extended management attributes, which are not part of the definitions in IEEE Std 802.3, Clause 30. The extended attributes shown in Table 14‑132 shall be supported.
2. The extended attributes can be part of *eOAM\_Get\_Request*, *eOAM\_Get\_Response*, *eOAM\_Set\_Request*, and *eOAM\_Set\_Response* eOAMPDUs.

Table 14‑132—Extended attributes defined in branch 0xD7

| 1. Leaf
 | 1. Attribute
 | 1. Defined in
 |
| --- | --- | --- |
| 1. Object group: ONU management
 |
| 1. 0x00-02
 | aOnuId | 1. 14.4.3.1.2
 |
| 1. 0x00-03
 | 1. aOnuFwVersion
 | 1. 14.4.3.1.3
 |
| 1. 0x00-04
 | 1. aOnuInfoChipset
 | 1. 14.4.3.1.4
 |
| 1. 0x00-05
 | 1. aOnuInfoDateManufacture
 | 1. 14.4.3.1.5
 |
| 1. 0x00-06
 | 1. aOnuInfoManufacturer
 | 1. 14.4.3.1.6
 |
| 1. 0x00-07
 | 1. aOnuLlidCount
 | 1. 14.4.3.1.7
 |
| 1. 0x00-08
 | 1. aOnuPonPortCount
 | 1. 14.4.3.1.8
 |
| 1. 0x00-09
 | 1. aOnuUniPortCount
 | 1. 14.4.3.1.9
 |
| 1. 0x00-0A
 | 1. aOnuInfoPacketBuffer
 | 1. 14.4.3.1.10
 |
| 1. 0x00-0B
 | 1. aLlidReportThresholds
 | 1. 14.4.3.1.11
 |
| 1. 0x00-0C
 | 1. aLlidForwardState
 | 1. 14.4.3.1.12
 |
| 1. 0x00-0D
 | 1. aLlidOamFrameRate
 | 1. 14.4.3.1.13
 |
| 1. 0x00-0E
 | 1. aOnuManOrgName
 | 1. 14.4.3.1.14
 |
| 1. 0x00-0F
 | 1. aOnuCvcCvsValidity
 | 1. 14.4.3.1.15
 |
| 1. 0x00-10
 | 1. aOnuUniPortType
 | 1. 14.4.3.1.16
 |
| 1. Object group: Bridging
 |
| 1. 0x01-01
 | 1. aUniDynMacTableSize
 | 1. 14.4.3.2.1
 |
| 1. 0x01-02
 | 1. aUniDynMacAgeLimit
 | 1. 14.4.3.2.2
 |
| 1. 0x01-03
 | 1. aUniDynMacTable
 | 1. 14.4.3.2.3
 |
| 1. 0x01-04
 | 1. aUniStatMacTable
 | 1. 14.4.3.2.4
 |
| 1. 0x01-05
 | aUniPortAutoNeg | 1. 14.4.3.2.5
 |
| 1. 0x01-06
 | aUniAdmissionControl | 1. 14.4.3.2.6
 |
| 1. 0x01-07
 | 1. aUniMinLearnMacCount
 | 1. 14.4.3.2.7
 |
| 1. 0x01-08
 | 1. aUniMaxLearnMacCount
 | 1. 14.4.3.2.8
 |
| 1. 0x01-09
 | 1. aOnuMaxLearnMacCount
 | 1. 14.4.3.2.9
 |
| 1. 0x01-0A
 | 1. aUniLengthDiscard
 | 1. 14.4.3.2.10
 |
| 1. 0x01-0B
 | 1. aUniFloodUnknown
 | 1. 14.4.3.2.11
 |
| 1. 0x01-0C
 | 1. aUniLocalSwitching
 | 1. 14.4.3.2.12
 |
| 1. 0x01-0D
 | 1. aOnuLlidQueueConfig
 | 1. 14.4.3.2.13
 |
| 1. 0x01-0E
 | 1. aOnuFwFileName
 | 1. 14.4.3.2.14
 |
| 1. 0x01-0F
 | 1. aUniMacTableFull
 | 1. 14.4.3.2.15
 |
| 1. Object group: Statistics and counters
 |
| 1. 0x02-01
 | 1. aCountRxFramesGreen
 | 1. 14.4.3.3.1
 |
| 1. 0x02-02
 | 1. aCountTxFramesGreen
 | 1. 14.4.3.3.2
 |
| 1. 0x02-03
 | 1. aCountRxFrames2Short
 | 1. 14.4.3.3.3
 |
| 1. 0x02-04
 | 1. aCountRxFrames64
 | 1. 14.4.3.3.4
 |
| 1. 0x02-05
 | 1. aCountRxFrames65to127
 | 1. 14.4.3.3.5
 |
| 1. 0x02-06
 | 1. aCountRxFrames128to255
 | 1. 14.4.3.3.6
 |
| 1. 0x02-07
 | 1. aCountRxFrames256to511
 | 1. 14.4.3.3.7
 |
| 1. 0x02-08
 | 1. aCountRxFrames512to1023
 | 1. 14.4.3.3.8
 |
| 1. 0x02-09
 | 1. aCountRxFrames1024to1518
 | 1. 14.4.3.3.9
 |
| 1. 0x02-0A
 | 1. aCountRxFrames1519
 | 1. 14.4.3.3.10
 |
| 1. 0x02-0B
 | 1. aCountTxFrames64
 | 1. 14.4.3.3.11
 |
| 1. 0x02-0C
 | 1. aCountTxFrames65to127
 | 1. 14.4.3.3.12
 |
| 1. 0x02-0D
 | 1. aCountTxFrames128to255
 | 1. 14.4.3.3.13
 |
| 1. 0x02-0E
 | 1. aCountTxFrames256to511
 | 1. 14.4.3.3.14
 |
| 1. 0x02-0F
 | 1. aCountTxFrames512to1023
 | 1. 14.4.3.3.15
 |
| 1. 0x02-10
 | 1. aCountTxFrames1024to1518
 | 1. 14.4.3.3.16
 |
| 1. 0x02-11
 | 1. aCountTxFrames1519
 | 1. 14.4.3.3.17
 |
| 1. 0x02-12
 | 1. aQueueDelayThr
 | 1. 14.4.3.3.18
 |
| 1. 0x02-13
 | 1. aQueueDelayValue
 | 1. 14.4.3.3.19
 |
| 1. 0x02-14
 | 1. aCountFramesDropped
 | 1. 14.4.3.3.20
 |
| 1. 0x02-15
 | 1. aCountOctetsDropped
 | 1. 14.4.3.3.21
 |
| 1. 0x02-16
 | 1. aCountOctetsDelayed
 | 1. 14.4.3.3.22
 |
| 1. 0x02-17
 | 1. aCountUsOctetsUnused
 | 1. 14.4.3.3.23
 |
| 1. 0x02-1D
 | 1. aPonOptMonitTemp
 | 1. 14.4.3.3.24
 |
| 1. 0x02-1E
 | 1. aPonOptMonitVcc
 | 1. 14.4.3.3.25
 |
| 1. 0x02-1F
 | 1. aPonOptMonitBias
 | 1. 14.4.3.3.26
 |
| 1. 0x02-20
 | 1. aPonOptMonitTxPower
 | 1. 14.4.3.3.27
 |
| 1. 0x02-21
 | 1. aPonOptMonitRxPower
 | 1. 14.4.3.3.28
 |
| 1. 0x02-22
 | 1. aCounterRxFramesY
 | 1. 14.4.3.3.29
 |
| 1. 0x02-23
 | 1. aCounterTxFramesY
 | 1. 14.4.3.3.30
 |
| 1. 0x02-24
 | 1. aCounterTxOctetsG
 | 1. 14.4.3.3.31
 |
| 1. 0x02-25
 | 1. aCounterRxOctetsY
 | 1. 14.4.3.3.32
 |
| 1. 0x02-26
 | 1. aCounterRxOctetsG
 | 1. 14.4.3.3.33
 |
| 1. 0x02-27
 | 1. aCounterTxOctetsY
 | 1. 14.4.3.3.34
 |
| 1. 0x02-28
 | 1. aCounterTxFramesL2Unicast
 | 1. 14.4.3.3.35
 |
| 1. 0x02-29
 | 1. aCounterTxFramesL2Multicast
 | 1. 14.4.3.3.36
 |
| 1. 0x02-2A
 | 1. aCounterTxFramesL2Broadcast
 | 1. 14.4.3.3.37
 |
| 1. 0x02-2B
 | 1. aCounterRxFramesL2Unicast
 | 1. 14.4.3.3.38
 |
| 1. 0x02-2C
 | 1. aCounterRxFramesL2Multicast
 | 1. 14.4.3.3.39
 |
| 1. 0x02-2D
 | 1. aCounterRxFramesL2Broadcast
 | 1. 14.4.3.3.40
 |
| 1. 0x02-2E
 | 1. aOnuCounterNumber
 | 1. 14.4.3.3.41
 |
| 1. 0x02-2F
 | 1. aCounterRxFramesL2CP
 | 1. 14.4.3.3.42
 |
| 1. 0x02-30
 | 1. aCounterRxOctetsL2CP
 | 1. 14.4.3.3.43
 |
| 1. 0x02-31
 | 1. aCounterTxFramesL2CP
 | 1. 14.4.3.3.44
 |
| 1. 0x02-32
 | 1. aCounterTxOctetsL2CP
 | 1. 14.4.3.3.45
 |
| 1. 0x02-33
 | 1. aCounterDiscardFramesL2CP
 | 1. 14.4.3.3.46
 |
| 1. 0x02-34
 | 1. aCounterDiscardOctetsL2CP
 | 1. 14.4.3.3.47
 |
| 1. 0x02-35
 | 1. aCounterL2TxErrors
 | 1. 14.4.3.3.48
 |
| 1. 0x02-36
 | 1. aCounterL2RxErrors
 | 1. 14.4.3.3.49
 |
| 1. Object group: Alarms
 |
| 1. 0x03-01
 | 1. aAlarmPortStatThr
 | 1. 14.4.3.4.1
 |
| 1. 0x03-02
 | 1. aAlarmLlidStatThr
 | 1. 14.4.3.4.2
 |
| 1. 0x03-03
 | 1. aAlarmStatusControl
 | 1. 14.4.3.4.3
 |
| 1. Object group: Encryption
 |  |
| 1. 0x04-01
 | 1. aEncryptionKeyExpiration
 | 1. 14.4.3.5.1
 |
| 1. 0x04-02
 | 1. aEncryptionMode
 | 1. 14.4.3.5.2
 |
| 1. Object group: Frame processing
 |
| 1. 0x05-01
 | 1. aRuleSetConfig
 | 1. 14.4.3.6.1
 |
| 1. 0x05-02
 | 1. aRuleCustomField
 | 1. 14.4.3.6.2
 |
| 1. 0x05-03
 | 1. aRuleTpidCAlter
 | 1. 14.4.3.6.3
 |
| 1. 0x05-04
 | 1. aRuleTpidSAlter
 | 1. 14.4.3.6.4
 |
| 1. 0x05-05
 | 1. aRuleIpmcFwrConfig
 | 1. 14.4.3.6.5
 |
| 1. 0x05-06
 | 1. aRuleTpidIAlter
 | 1. 14.4.3.6.6
 |
| 1. 0x05-07
 | 1. aRuleTpidBAlter
 | 1. 14.4.3.6.7
 |
| 1. Object group: Service-level agreements
 |
| 1. 0x06-01
 | 1. aRateLimitBroadcast
 | 1. 14.4.3.7.1
 |
| 1. 0x06-04
 | 1. aQueueCIR
 | 1. 14.4.3.7.2
 |
| 1. 0x06-05
 | 1. aFecMode
 | 1. 14.4.3.7.3
 |
| 1. 0x06-06
 | 1. aQueueEIR
 | 1. 14.4.3.7.4
 |
| 1. 0x06-07
 | 1. aQueueColorMarking
 | 1. 14.4.3.7.5
 |
| 1. 0x06-08
 | 1. aQueueRateLimiterCap
 | 1. 14.4.3.7.6
 |
| 1. 0x06-09
 | 1. aCouplingFlag
 | 1. 14.4.3.7.7
 |
| 1. Object group: Clock transport
 |
| 1. 0x07-01
 | 1. aClockTranspCapab
 | 1. 14.4.3.9.1
 |
| 1. 0x07-02
 | 1. aClockTranspStatus
 | 1. 14.4.3.9.2
 |
| 1. 0x07-03
 | 1. aClockTranspTransfer
 | 1. 14.4.3.9.3
 |
| 1. 0x07-04
 | 1. aClockTranspPropagParam
 | 1. 14.4.3.9.4
 |
| 1. 0x07-05
 | 1. aClockTranspRtt
 | 1. 14.4.3.9.5
 |
| 1. Object group: Demarc auto-configuration
 |
| 1. 0x08-00
 | 1. aDacConfig
 | 1. 14.4.3.10.1
 |
| 1. 0x08-01
 | 1. aDacConfigFlags
 | 1. 14.4.3.10.2
 |
| 1. 0x08-02
 | 1. aDacPassChallenge
 | 1. 14.4.3.10.3
 |
| 1. 0x08-03
 | 1. aDacStatus
 | 1. 14.4.3.10.4
 |
| 1. Object group: Optical Line Protection
 |
| 1. 0x09-00
 | 1. aOnuProtectionCapability
 | 1. 14.4.1.9.1
 |
| 1. 0x09-01
 | 1. aOnuConfigProtection
 | 1. 14.4.1.9.2
 |
| 1. 0x09-02
 | 1. aOnuConfigPonActive
 | 1. 14.4.1.9.3
 |
| 1. 0x09-03
 | 1. aONUConfigHoldoverPeriod
 | 1. 14.4.1.9.4
 |
| 1. Object group: Power saving
 |
| 1. 0xFF-FF
 | 1. aOnuPwrSavingCap
 | 1. 14.4.3.8.1
 |

1. All other Leaf values are reserved and ignored on reception.

#### ONU management

#### Bridging

#### Statistics and counters

#### Alarms

Individual alarms are exchanged between the ONU and the OLT using DPoE *Event Notification* TLVs, carried in the *Event Notification* OAMPDU, as defined in IEEE Std 802.3, Clause 57.

#### Encryption

#### Frame processing

#### Service-level agreements (SLAs)

#### Power saving

#### Optical Link Protection

##### Attribute *aOnuProtectionCapability* (0xD7/0x09-00)

1. This attribute represents the ONU’s optical link protection capabilities, including support for trunk and tree protection modes. This attribute consists of the following sub-attributes: *sSupportTrunk*, *sSupportTreeLine*, and *sSupportTreeClient*.
2. Sub-attribute *aOnuProtectionCapability.sSupportTrunk*:
3. **Syntax:** Boolean
4. **Remote access:** Read-Only
5. **Description:** This sub-attribute indicates whether the ONU supports the trunk protection scheme (9.3.3). The following values are defined:
6. supported: Trunk protection scheme is supported.
7. not\_supported: Trunk protection scheme is not supported.
8. Sub-attribute *aOnuProtectionCapability.sSupportTreeLine*:
9. **Syntax:** Boolean
10. **Remote access:** Read-Only
11. **Description:** This sub-attribute indicates whether the ONU supports the tree protection scheme (9.3.4) utilizing L-ONU protection switching (9.3.2.1.1). The following values are defined:
12. supported: Tree protection scheme with L-ONU protection switching is supported.
13. not\_supported: Tree protection scheme with L-ONU protection switching is not supported.
14. Sub-attribute *aOnuProtectionCapability.sSupportTreeClient*:
15. **Syntax:** Boolean
16. **Remote access:** Read-Only
17. **Description:** This sub-attribute indicates whether the ONU supports the tree protection scheme (9.3.4) utilizing C-ONU protection switching (9.3.2.1.2). The following values are defined:
18. supported: Tree protection scheme with C-ONU protection switching is supported.
19. not\_supported: Tree protection scheme with C-ONU protection switching is not supported.
20. The *aOnuProtectionCapability* attribute is associated with the ONU object (see 14.4.1.1). The Variable Container TLV for the *aProtectionCapability* attribute shall be as specified in Table 14-xx1.

Table 14‑xx1—*ONU Protection Capability* TLV (0xD7/0x09-00)

| 1. **Size(octets)**
 | 1. **Field(name)**
 | 1. **Value**
 | 1. **Notes**
 |
| --- | --- | --- | --- |
| 1. 1
 | 1. Branch
 | 1. 0xD7
 | 1. Branch identifier
 |
| 1. 2
 | 1. Leaf
 | 1. 0x09-00
 | 1. Leaf identifier
 |
| 1. 1
 | 1. Length
 | 1. 0x03
 | 1. The size of TLV fields following the Length field
 |
| 1. 1
 | 1. SupportTrunk
 | 1. Varies
 | 1. Value of *sSupportTrunk* sub-attribute, defined as follows:
2. supported: 0x01 not\_supported: 0x00
 |
| 1. 1
 | 1. SupportTreeLine
 | 1. Varies
 | 1. Value of *sSupportTreeLine* sub-attribute, defined as follows:
2. supported: 0x01 not\_supported: 0x00
 |
| 1. 1
 | 1. SupportTreeClient
 | 1. Varies
 | 1. Value of *sSupportTreeClient* sub-attribute, defined as follows:
2. supported: 0x01 not\_supported: 0x00
 |

##### Attribute *aOnuConfigProtection* (0xD7/0x09-01)

1. This attribute represents the protection function configuration of the ONU, including the duration of the optical and MAC loss-of-signal detection thresholds. This attribute consists of the following sub-attributes: *sLosOptical* and *sLosMac.*
2. Sub-attribute *aOnuConfigProtection.sLosOptical*:
3. **Syntax:** Unsigned integer
4. **Range:** 0x00-00 to 0x03-E8 (1 second)
5. **Default value:** 0x00-02
6. **Unit:** 1 ms
7. **Remote access:** Read/Write
8. **Description:** This sub-attribute indicates the period of time that has to elapse before the ONU moves to the HOLD\_OVER\_START state (see 9.3.3.3) if no optical signal is detected.
9. Sub-attribute *aOnuConfigProtection.sLosMac*:
10. **Syntax:** Unsigned integer
11. **Range:** 0x00-00 to 0x03-E8 (1 second)
12. **Default value:** 0x00-32 (50 ms)
13. **Unit:** 1 ms
14. **Remote access:** Read/Write
15. **Description:** This sub-attribute indicates the period of time that has to elapse before the ONU moves to the HOLD\_OVER\_START state if no *GATE* MPCPDU is received. This attribute corresponds to the gate\_timeout as specified in IEEE Std 802.3, 64.3.5.1 and 77.3.5.1.
16. The *aOnuConfigProtection* attribute is associated with the ONU object (see 14.4.1.1). The Variable Container TLV for the *aOnuConfigProtection* attribute shall be as specified in Table14-xx2.

Table 14‑xx2—*ONU Protection Configuration* TLV (0xD7/0x09-01)

| 1. **Size(octets)**
 | 1. **Field(name)**
 | 1. **Value**
 | 1. **Notes**
 |
| --- | --- | --- | --- |
| 1. 1
 | 1. Branch
 | 1. 0xD7
 | 1. Branch identifier
 |
| 1. 2
 | 1. Leaf
 | 1. 0x09-01
 | 1. Leaf identifier
 |
| 1. 1
 | 1. Length
 | 1. 0x04
 | 1. The size of TLV fields following the Length field
 |
| 1. 2
 | 1. LosOptical
 | 1. Varies
 | 1. Value of *sLosOptical* sub-attribute
 |
| 1. 2
 | 1. LosMac
 | 1. Varies
 | 1. Value of *sLosMac* sub-attribute
 |

##### Attribute *aOnuConfigPonActive* (0xD7/0x09-02)

1. This attribute represents the active PON port on the ONU.
2. Attribute *aOnuConfigPonActive*
3. **Syntax:** Unsigned integer
4. **Size (octets):** 1
5. **Default value:** 0x00
6. **Remote access:** Read/Write
7. **Description:** This attribute represents the index of the active PON port on the ONU. Individual PON ports are numbered sequentially starting with 0x00. For ONU supporting the tree protection mode, the PON port 0x00 is designated as the primary port, and the PON port 0x01 is designated as the backup port. Either the primary or the backup port can be in active (i.e., working) state. A port that is not in the working state is in the standby state.
8. The *aOnuConfigPonActive* attribute is associated with the ONU object (see 14.4.1.1). The Variable Container TLV for the *aOnuConfigPonActive* attribute shall be as specified in Table14-xx3.

Table 14‑xx3—*PON Interface Administrate* TLV (0xD7/0x09-02)

| 1. **Size(octets)**
 | 1. **Field(name)**
 | 1. **Value**
 | 1. **Notes**
 |
| --- | --- | --- | --- |
| 1. 1
 | 1. Branch
 | 1. 0xD7
 | 1. Branch identifier
 |
| 1. 2
 | 1. Leaf
 | 1. 0x09-02
 | 1. Leaf identifier
 |
| 1. 1
 | 1. Length
 | 1. 0x01
 | 1. The size of TLV fields following the Length field
 |
| 1. 1
 | 1. PonPortActive
 | 1. Varies
 | 1. Value of *aOnuConfigPonActive* attribute
 |

##### Attribute *aOnuConfigHoldoverPeriod* (0xD7/0x09-03)

1. This attribute represents the support for the timestamp drift prevention mechanism on the ONU, including its administrative status and duration of the holdover status, loaded to timerHoldOver, as defined in 9.3.3. This attribute consists of the following sub-attributes: *sAdminStatus* and *sHoldOverPeriod.*
2. Sub-attribute *aOnuConfigHoldoverPeriod.sAdminStatus*:
3. **Syntax:** Boolean
4. **Remote access:** Read/Write
5. **Default value:** enabled
6. **Description:** This sub-attribute represents the administrative status of the timestamp drift prevention mechanism on the given ONU. Individual values have the following meanings:
7. disabled: timestamp drift prevention mechanism is disabled.
8. enabled: timestamp drift prevention mechanism is enabled.
9. Sub-attribute *aOnuConfigHoldoverPeriod.sHoldOverPeriod*:
10. **Syntax:** Unsigned integer
11. **Range:** 0x00-00 to 0x03-E8 (1 second)
12. **Remote access:** Read/Write
13. **Unit:** 1 ms
14. **Default value:** 0x00-C8
15. **Description:** This sub-attribute represents the value loaded into the timerHoldOver timer, as defined in 9.3.3.
16. The *aOnuConfigHoldoverPeriod* attribute is associated with the ONU object (see 14.2.3.1). The Variable Container TLV for the *aOnuConfigHoldoverPeriod* attribute shall be as specified in Table 14‑xx4.

Table 14‑xx4— *ONU Config HoldOver Period* TLV (0xD7/0x09-03)

| 1. **Size(octets)**
 | 1. **Field(name)**
 | 1. **Value**
 | 1. **Notes**
 |
| --- | --- | --- | --- |
| 1. 1
 | 1. Branch
 | 1. 0xD7
 | 1. Branch identifier
 |
| 1. 2
 | 1. Leaf
 | 1. 0x09-03
 | 1. Leaf identifier
 |
| 1. 1
 | 1. Length
 | 1. 0x08
 | 1. The size of TLV fields following the Length field
 |
| 1. 4
 | 1. AdminStatus
 | 1. Varies
 | 1. Value of *sAdminStatus* sub-attribute, defined as follows:
2. disabled: 0x00-00-00-01 enabled: 0x00-00-00-02
 |
| 1. 4
 | 1. HoldOverPeriod
 | 1. Varies
 | 1. Value of *sHoldOverPeriod* sub-attribute, mapped into the 4-octet-wide value, right justified.
 |

# (normative)Protocol implementation conformance statement (PICS) for Package A

## Introduction

This subclause specifies the PICS proforma for Package A, as specified in Table 4‑1, separated into ONU and OLT specific requirements.

The supplier of an EPON ONU or OLT implementation that is claimed to conform to SIEPON Package A shall complete the following PICS proforma.11[[1]](#footnote-1)

A detailed description of the symbols used in the PICS proforma, along with instructions for completing the PICS proforma, can be found in 3.6.

## ONU-specific PICS

### Management entities

*Insert the following entries at the end of table in 4A.2.13*

| **Item** | **Description** | **Subclause** | **Value/Comment** | **Status** | **Support** |
| --- | --- | --- | --- | --- | --- |
| AU-ME145 | *ONU Protection Capability* TLV (0xD7/0x09-00) | 14.4.1.9.1 | Meets the requirements of Table 14‑xx1. | M | [   ] Yes |
| AU-ME146 | *ONU Protection Configuration* TLV(0xD7/0x09-01) | 14.4.1.9.2 | Meets the requirements of Table 14‑xx2. | AU-LPTE0+ AU-LPTK0:M | [   ] Yes |
| AU-ME147 | *PON Interface Administrate* TLV(0xD7/0x09-02) | 14.4.1.9.3 | Meets the requirements of Table 14‑xx3. | AU-LPTE0:M | [   ] Yes |
| AU-ME148 | *ONU Configuration Holdover Period* TLV(0xD7/0x09-03) | 14.4.1.9.4 | Meets the requirements of Table 14‑xx4. | AU-LPTK0:M | [   ] Yes |

*Insert new subclauses 4A.2.19 and 4A.2.20, as shown below*

### Trunk protection

| **Item** | **Description** | **Subclause** | **Value/Comment** | **Status** | **Support** |
| --- | --- | --- | --- | --- | --- |
| AU-LPTK0 | Implement trunk optical link protection | Table 4‑1 | ONU implements trunk optical link protection per 9.3.3 and 9.3.5.2 | O | [   ] Yes[   ] No  |
| AU-LPTK1 | Fault condition detection | 9.3.2.2.2 | Detect the fault condition on the optical line using Optical LoS or MAC LoS mechanism. | AU-LPTK0:M | [   ] Yes |
| AU-LPTK2 | Switching time | 9.3.3.1 | Be lower than or equal to150 ms.  | AU-LPTK0:M | [   ] Yes |
| AU-LPTK3 | TLoS\_Optical and TLoS\_MAC Configuration | 9.3.3.4 | The values for TLoS\_Optical and TLoS\_MAC parameters are configured via eOAM, as specified in using the *ONU Protection Configuration* TLV (0xD7/0x09-01) per 14.4.1.9.2. | AU-LPTK0:M | [   ] Yes[   ] No |
| AU-LPTK4 | ONU operation | 9.3.3.4.5 | Meet the requirements of Figure 9‑11. | AU-LPTK0:M | [   ] Yes |

### Tree protection

| **Item** | **Description** | **Subclause** | **Value/Comment** | **Status** | **Support** |
| --- | --- | --- | --- | --- | --- |
| AU-LPTE0 | Implement tree optical link protection | Table 4‑1 | ONU implements tree optical link protection per 9.3.4 and 9.3.5.2 | O | [   ] Yes[   ] No  |
| AU-LPTE1 | Line monitoring mechanisms (ONU) | 9.3.2.2.2 | Detect the fault condition on the working optical line using Optical LoS or MAC LoS mechanisms. | AU-LPTE0:M | [   ] Yes |
| AU-LPTE2a | Switching time | 9.3.4.1 | Be lower than or equal to 50 ms. | AU-LPTE0:M | [   ] Yes |
| AU-LPTE2b | Working L-ONU registration status | 9.3.4.1 | The working L-ONU is registered at the working L-OLT and remain fully active (including MPCP, OAM and subscriber data flows) as long as the link between the working L-ONU and working L-OLT remains functional. | AU-LPTE0:M | [   ] Yes |
| AU-LPTE2c | Standby L-ONU registration status | 9.3.4.1 | The standby L-ONU is registered at the standby L-OLT and remain fully active (including MPCP and OAM flows) as long as the link between the standby L-ONU and the standby L-OLT remains functional. | AU-LPTE0:M | [   ] Yes |
| AU-LPTE2d | Data flows on backup path | 9.3.4.1 | The link between the standby L-ONU and the standby L-OLT does not carry any subscriber traffic. | AU-LPTE0:M | [   ] Yes |
| AU-LPTE2e | Device discovery and registration | 9.3.4.1 | MPCP discovery and registration processes, IEEE 802.3 (Clause 57) OAM discovery, eOAM discovery, and ONU authentication process if configured to do so by the operator exeAUted independently for the primary and backup links. | AU-LPTE0:M | [   ] Yes |
| AU-LPTE3 | TLoS\_Optical and TLoS\_MAC Configuration | 9.3.4.5 | The values for TLoS\_Optical and TLoS\_MAC parameters are configured via eOAM, as specified in using the *ONU Protection Configuration* TLV (0xD7/0x09-01) per 14.4.1.9.2. | AU-LPTE0:M | [   ] Yes[   ] No |
| AU-LPTE4a | ONU operation | 9.3.4.5.5 | Meet the requirements of Figure 9‑19. | AU-LPTE0:M | [   ] Yes |
| AU-LPTE4b | ONU state diagram count  | 9.3.4.5.5 | State diagram per Figure 9‑19 is instantiated per each registered C-ONU. | AU-LPTE0:M | [   ] Yes |

## OLT-specific PICS

### 4A.3.11 Management Entities

*Insert the following entries at the end of table in 4A.3.11*

| **Item** | **Description** | **Subclause** | **Value/Comment** | **Status** | **Support** |
| --- | --- | --- | --- | --- | --- |
| AT-ME144 | *ONU Protection Capability* TLV (0xD7/0x09-00) | 14.4.1.9.1 | Meets the requirements of Table 14‑xx1. | M | [   ] Yes |
| AT-ME145 | *ONU Protection Configuration* TLV(0xD7/0x09-01) | 14.4.1.9.2 | Meets the requirements of Table 14‑xx2. | AT-LPTE0+ AT-LPTK0:M | [   ] Yes |
| AT-ME146 | *PON Interface Administrate* TLV(0xD7/0x09-02) | 14.4.1.9.3 | Meets the requirements of Table 14‑xx3. | AT-LPTE0:M | [   ] Yes |
| AT-ME147 | *ONU Configuration Holdover Period* TLV(0xD7/0x09-03) | 14.4.1.9.4 | Meets the requirements of Table 14‑xx4. | AT-LPTK0:M | [   ] Yes |

*Insert new subclauses 4A.3.18 and 4A.3.19, as shown below*

### 4A.3.18 Trunk protection

| **Item** | **Description** | **Subclause** | **Value/Comment** | **Status** | **Support** |
| --- | --- | --- | --- | --- | --- |
| AT-LPTK0 | Implement trunk optical link protection | Table 4‑1 | OLT implements trunk optical link protection per 9.3.3 and 9.3.5.2 | O | [   ] Yes[   ] No |
| AT-LPTK1 | Fault condition detection | 9.3.2.2.1 | The working OLT detects the fault condition on the working optical line using Optical LoS or MAC LoS mechanism. | AT-LPTK0:M | [   ] Yes |
| AT-LPTK2 | Switching time | 9.3.3.1 | Be lower than or equal to150 ms.  | AT-LPTK0:M | [   ] Yes |
| AT-LPTK3 | *GATE* MPCPDU transmission | 9.3.3.2 | The backup OLT, once the switchover process is complete, sends one or more *GATE* MPCPDUs to force each registered ONU to resynchronize to the MPCP clock. | AT-LPTK0:M | [   ] Yes |
| AT-LPTK4a | OLT state diagram count (Trunk\_1) | 9.3.3.4.5 | State diagram per Figure 9‑10 is instantiated per C-OLT. | AT-LPTK0:M | [   ] Yes |
| AT-LPTK4b | OLT state diagram count (Trunk\_2) | 9.3.3.4.5 | State diagram per Figure 9‑10 is instantiated per L-OLT. | AT-LPTK0:M | [   ] Yes |

### 4A.3.19 Tree protection

| **Item** | **Description** | **Subclause** | **Value/Comment** | **Status** | **Support** |
| --- | --- | --- | --- | --- | --- |
| AT-LPTE0 | Implement tree optical link protection | Table 4‑1 | OLT implements tree optical link protection per 9.3.4 and 9.3.5.2 | O | [   ] Yes[   ] No |
| AT-LPTE1 | Line monitoring mechanisms (OLT) | 9.3.2.2.1 | The working OLT deteATs the fault condition on the working optical line using Optical LoS or MAC LoSi mechanisms. | AT-LPTE0:M | [   ] Yes |
| AT-LPTE2a | Switching time | 9.3.4.1 | Be lower than or equal to 50 ms. | AT-LPTE0:M | [   ] Yes |
| AT-LPTE2b | Data flows on backup path | 9.3.4.1 | MPCP and OAM data flows only | AT-LPTE0:M | [   ] Yes |
| AT-LPTE2c | Device discovery and registration | 9.3.4.1 | MPCP discovery and registration processes, IEEE  802.3 (Clause 57) OAM discovery, eOAM discovery and ONU authentication process if configured to do so by the operator executed independently for the primary and backup links. | AT-LPTE0:M | [   ] Yes |
| AT-LPTE3a | Configuration of backup ONUs | 9.3.4.2 | Backup OLT supports configuration of backup ONUs connected to backup path. | AT-LPTE0:M | [   ] Yes |
| AT-LPTE3b | Maintain data link connectivity with backup ONU | 9.3.4.2 | The standby OLT enables all necessary MPCP and OAM/eOAM mechanisms defined in this standard as well as in IEEE Std 802.3 in order to maintain data link connectivity with individual standby ONUs. | AT-LPTE0:M | [   ] Yes |
| AT-LPTE3c | Upstream grants to backup ONUs | 9.3.4.2 | The standby OLT issues grants to the standby ONUs to ensure normal operation of the MPCP.  | AT-LPTE0:M | [   ] Yes |
| 1. AT-LPTE3d
 | Suppress alarms and warnings | 9.3.4.2 | The standby OLT suppresses generation of any alarms and warnings associated with the arrival of empty/underutilized upstream transmission slots. | AT-LPTE0:M | [   ] Yes |
| 1. AT-LPTE3e
 | Downstream traffic for standby ONUs | 9.3.4.2 | The standby OLT disallows any downstream user traffic prior to the switchover event. | AT-LPTE0:M | [   ] Yes |
| AT-LPTE4a | OLT operation | 9.3.4.5.5 | Meet the requirements of Figure 9‑18. | AT-LPTE0:M | [   ] Yes |
| AT-LPTE4b | OLT state diagram count  | 9.3.4.5.5 | State diagram per Figure 9‑18 is instantiated per each registered C-ONU. | AT-LPTE0:M | [   ] Yes |

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