7 Connectivity configurations

7.1 Introduction

Clause 7 describes features that affect EPON connectivity. These features include VLAN configurations, tunneling configurations, and multicast configurations that determine forwarding behavior of OLTs and ONUs. As illustrated in IEEE Std 1904.1, Figure 6-1, the connectivity configurations affect the provisioning of Classifier, Modifier, and CrossConnect functional blocks. This Clause does not specify configurations for the Policing/Shaping, Queuing, or Scheduling functional blocks, which affect performance characteristics of flows.

7.2 VLAN configurations

This subclause defines VLAN modes that are used to establish VLAN-dependent connectivity for various types of services in EPON. A VLAN mode defines VLAN-dependent transformation and forwarding of a frame within either the ONU or the OLT. In the case of the OLT, a VLAN mode covers transformation and forwarding of a frame between the NNI and OLT_MDI in the downstream and upstream directions. In the case of the ONU, a VLAN mode covers transformation and forwarding of a frame between the UNI and ONU_MDI in the downstream and upstream directions.

7.2.1 Device-based VLAN modes

In the device-based VLAN modes, each EPON device is assigned a specific VLAN mode as defined in the following subclauses.

A C-OLT shall support all of the following VLAN modes:

— Transparent VLAN mode (see IEEE 1904.1, 7.2.2.1.1)

— Tagging VLAN mode (see IEEE 1904.1, 7.2.2.1.3)

— Translation VLAN mode (see IEEE 1904.1, 7.2.2.1.5)

A C-OLT shall be able to operate in at least one VLAN mode, as provisioned by the NMS.

A C-ONU shall support all of the following VLAN modes:

— Transparent VLAN mode (see IEEE 1904.1, 7.2.2.1.2)

— Tagging VLAN mode (see IEEE 1904.1, 7.2.2.1.4)

— ToS/CoS Conversion VLAN mode (see IEEE 1904.1, 7.2.2.1.6)

A C-ONU shall be able to operate in at least one VLAN mode, as provisioned and configured using the Type/Length/Values (TLVs) defined in 14.3.1.5.

Note that all of the defined device-based VLAN modes may operate on single-tagged or double-tagged (IEEE Std 802.1Q compliant) frames.

7.2.1.1.1 Default configuration

The OLT preserves the last provisioned configuration for VLAN mode and VLAN IDs in the nonvolatile memory. Upon the power-up, reset, or restart caused by local or remote signaling, the OLT shall use the last provisioned VLAN mode and VLAN IDs for all LLIDs.

The ONU preserves the last provisioned configuration for VLAN mode, VLAN IDs, and the ToS/CoS conversion table in the nonvolatile memory. Upon the power-up, reset, or deregistration, the ONU shall use the last provisioned VLAN mode, VLAN IDs, and the ToS/CoS conversion table.

7.2.1.1.2 Device-based VLAN management

The management of the VLAN modes specified for the ONU-based VLAN modes in IEEE 1904.1, 7.2.2.1 uses the standard set of eOAMPDUs to perform attribute read/set operations using the *eOAM_Get_Request*/*eOAM_Get_Response* for reading and *eOAM_Set_Request*/*eOAM_Set_Response* for setting the specific attribute.

The managed objects associated with VLAN management are defined in 14.3.1.5, 14.3.1.13, and 14.3.1.33. These TLVs shall be used for management and configuration of unicast VLANs only.

The existing VLAN mode configuration for the given ONU shall be overwritten every time a new TLV is received.

7.2.1.2 Port-based VLAN modes

In the port-based VLAN modes, each of the ONU UNI ports is assigned one and only one specific mode defined in the following subclauses, as configured using the TLVs defined in 14.2.2.21. A single C-OLT shall be able to support all VLAN modes specified below and shall be able to operate in at least one VLAN mode, as configured by the NMS. A single C-ONU shall be able to support all VLAN modes specified below and shall be able to operate in at least one VLAN mode, as configured by the OLT. A new mode provisioned by the OLT for a given C-ONU port overrides the previously configured VLAN mode.

Five port-based VLAN modes are defined in this profile:

- Transparent VLAN mode (see IEEE 1904.1, 7.2.2.2.1)
- Tagging VLAN mode (see IEEE 1904.1, 7.2.2.2.2)
- Translation VLAN mode (see IEEE 1904.1, 7.2.2.2.3)
- Filtering VLAN mode (see IEEE 1904.1, 7.2.2.2.4)
- N:1 Aggregation VLAN mode (see IEEE 1904.1, 7.2.2.2.5)

7.2.1.2.1 Default configuration

Upon power-up, reboot, or restart caused by local or remote signaling, the OLT shall be configured to use the Transparent VLAN mode for all ESPs associated with the active ONUs.

Upon power-up, reboot, or deregistration, the ONU shall be configured to use the Transparent VLAN mode for all ESPs associated with the configured UNI ports.

7.2.1.2.2 Port-based VLAN management

The management of the VLAN modes relies on *eOAM_Get_Request*/*eOAM_Get_Response* eOAMPDUs for reading and *eOAM_Set_Request*/*eOAM_Set_Response* eOAMPDUs for setting the specific VLAN-related attributes. The VLAN-related attributes for this profile use the *Port VLAN* TLV (0xC7/0x00-21) (see 14.2.2.21) to manage the VLAN modes for specific UNI ports.

All VLAN operation modes are UNI port-based. Each instance of the *Port VLAN* TLV (0xC7/0x00-21) shall contain VLAN configuration for only one UNI port, as indicated by the *Object_ID* TLV (0x37/varies), as defined in 14.2.3.1, preceding the *Port VLAN* TLV (0xC7/0x00-21). The *Port VLAN* TLV (0xC7/0x00-21) shall be used for management and configuration of unicast VLANs only.

Each UNI port shall be associated with only one VLAN mode (i.e., it is not permitted for a single port to be associated with more than one VLAN mode).

The existing VLAN mode configuration for the given UNI port shall be overwritten every time the *Port VLAN* TLV (0xC7/0x00-21) is received. As a result, the VLAN configuration mode for the given UNI port cannot be extended by adding new entries to the existing configuration tables. Every time a change in the VLAN configuration mode for the given UNI port is needed, a complete VLAN mode configuration needs to be sent to the ONU in question, replacing the previously existing configuration.

7.2.1.2.3 MAC aging function

ONUs and OLTs complying with this profile support a limited number of MAC address entries, learned through the MAC learning function provided by the Classifier block or provisioned by the operator using other mechanisms. The limitation in question is typically hardware related, due to constraints in the size of available memory rather than constraints in the MAC learning function or the provisioning model defined in this standard.

To avoid a lockdown of the MAC address table, its overflow and loss of MAC address information, and rejection of new MAC addresses because of the lack of available storage space and to prevent certain types of network attacks, individual MAC addresses are aged and consequently removed from the MAC address table if they are not refreshed for a predefined period of time. A typical implementation maintains a timer associated with each MAC address, counting from a certain provisioned default value toward zero. When this timer reaches zero, the MAC address associated with this timer is considered to be aged and consequently is removed from the MAC address table. This timer is reset to its default value every time this MAC address is observed by the MAC learning function, extending the validity of the given MAC address.

ONUs and OLTs complying with this profile shall support the MAC aging function, as described above. The configuration of this function on the OLT is the responsibility of the NMS and remains outside the scope of this standard. The OLT should configure this function on the ONU using the *MAC Aging Time Configuration* TLV (0xC7/0x00-A4), as defined in 14.2.2.33, including the administrative status of this function (enabled/disabled) and the MAC aging period, when MAC aging is enabled. The duration of the MAC address validity period may be configured by the operator to an arbitrary value. Unless otherwise configured by the operator, the ONU and OLT shall enable the MAC aging functions. When the MAC aging function is enabled, the ONU and OLT shall use the default duration of the MAC aging timeout of 300 seconds unless configured otherwise by the operator.

7.2.1.3 Provider Bridging (PB) VLAN modes

In the PB VLAN modes, each of the ONU UNI ports is assigned one and only one specific mode defined in the following subclauses, as configured using a combination of the *Port Ingress Rule* TLV (0xDB/0x05-01), the *Custom Field* TLV (0xDB/0x05-02), the *Alternative C-TPID* TLV (0xDB/0x05-03), and the *Alternative S-TPID* TLV (0xDB/0x05-04), as defined in 14.4.3.6.4 and its subclauses.

A single C-OLT shall support all of the following PB VLAN modes and shall be able to operate in at least one of those PB VLAN mode, as configured by the NMS:

— Transport PB VLAN mode (see IEEE 1904.1, 7.2.1.3.1)

— Encapsulation PB VLAN mode (see IEEE 1904.1, 7.2.1.3.2)

A single C-ONU shall be able to configure any of the following PB VLAN modes on any of UNIs.

— Transport PB VLAN mode (see IEEE 1904.1, 7.2.1.3.1)

— Encapsulation PB VLAN mode (see IEEE 1904.1, 7.2.1.3.2)

Each C-ONU UNI shall operate in one and only one PB VLAN mode at a time, as configured by the OLT.

When an ONU is provisioned with a specific PB VLAN mode for a specific UNI, the previously existing configuration for this UNI is overwritten.

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7.2.1.3.1 MAC-Source-Address-based admission control function

The MAC-Source-Address-based admission control function operating on the selected ONU UNI port in the upstream direction controls which frames received from ONU UNI ports are admitted for upstream transmission.

When the MAC-Source-Address-based admission control function for the given UNI port is disabled, all frames received from the ONU UNI port are admitted for upstream transmission.

When the MAC-Source-Address-based admission control function for the given UNI port is enabled, the ONU shall drop any frame received from the ONU UNI port if the MAC Source Address for such a frame is not present in the MAC address admission control table on the ONU. This table is configured through provisioning.

7.3 Tunneling modes

This subclause defines tunneling modes, which are used to define Backbone-Service-Instance-dependent connectivity for various types of services in EPON. A tunneling mode defines transformation and forwarding of a frame within either the ONU or the OLT.

In the case of the OLT, a tunneling mode covers transformation and forwarding of a frame between the NNI and OLT_MDI in either the downstream or upstream direction. In the case of the ONU, a tunneling mode covers transformation and forwarding of a frame between the UNI and ONU_MDI in either the downstream or upstream direction.

All tunneling modes are defined in terms of Classifier rules and their associated Modifier actions (tunneling operations). Field codes used as arguments in the Classifier rules and Modifier actions are described in IEEE Std 1904.1, 6.5.2.1.1. Individual tunneling operations are specified in 7.3.1. The rules that comprise a tunneling mode are shown in order of their priority and are executed sequentially until the first matched rule is found.

A frame is considered to have an I-Tag if its I-TPID matches one of the I-TPID values provisioned by the operator. A frame is considered to have a B-Tag if its B-TPID matches one of the B-TPID values provisioned by the operator.

In the tunneling modes, each of the ONU UNI ports is assigned one and only one specific mode defined in the following subclauses, as configured using a combination of the *Port Ingress Rule* TLV (0xDB/0x05-01), the *Custom Field* TLV (0xDB/0x05-02), the *Alternative C-TPID* TLV (0xDB/0x05-03), and the *Alternative S-TPID* TLV (0xDB/0x05-04), as defined in 14.4.3.6 and its subclauses. A single C-OLT shall be able to support all tunneling modes specified below and shall be able to operate in at least one tunneling mode, as configured by the NMS. A single C-ONU shall be able to configure any of the tunneling modes on any of the UNIs. Each UNI shall operate in one and only one tunneling mode at a time, as configured by the OLT. In essence, every time an ONU is provisioned with a specific tunneling mode for the specific UNI, the previously existing configuration for this UNI is overwritten.

A C-OLT shall support all of the following VLAN modes:

— Transport mode (see IEEE 1904.1, xxxx)

— Encapsulation mode (see IEEE 1904.1, xxxx)

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7.4 Multicast configurations

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