

1 **13 Extended OAM for Nx25G-EPON**

2 **13.1 Introduction**

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6 **13.4.1 Extended OAM organizationally-unique identifier (OUI)**

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11 **13.4.6 eOAMPDU types**

12 **13.4.6.1 eOAMPDU codes**

13 eOAMPDUs shall be as defined in Table 13-10. These eOAMPDUs use the Organization Specific
14 Extension mechanisms defined in IEEE Std 802.3, Clause 57. Other values are reserved and ignored on
15 reception.

16 **Table 13-10—eOAMPDUs and assignment of Opcode values**

Opcode	eOAMPDUs	Defined in
0x01	<i>eOAM_Get_Request</i>	13.4.6.2
0x02	<i>eOAM_Get_Response</i>	13.4.6.3
0x03	<i>eOAM_Set_Request</i>	13.4.6.4
0x04	<i>eOAM_Set_Response</i>	13.4.6.5
0x09	<i>eOAM_Software</i>	13.4.6.6
0x0A	<i>eOAM_Certificate_Request</i>	13.4.6.7
0x0B	<i>eOAM_Certificate_Response</i>	13.4.6.7

17 **13.4.6.2 eOAM_Get_Request eOAMPDU**

18 **13.4.6.3 eOAM_Get_Response eOAMPDU**

19 **13.4.6.4 eOAM_Set_Request eOAMPDU**

20 **13.4.6.5 eOAM_Set_Response eOAMPDU**

21 **13.4.6.6 eOAM_Software eOAMPDU**

22 **13.4.6.7 eOAM_Certificate_Request and eOAM_Certificate_Response eOAMPDUs**

23 The *eOAM_Certificate_Request* and *eOAM_Certificate_Response* eOAMPDUs are specific types of the
24 generic eOAMPDU, as defined in Table 13-2. These eOAMPDUs allow the [OLT/NMS to retrieve the](#)

1 Device Authentication Credential (DAC) certificate from the ONU (see 11.2.2.1.3) and to perform remote
 2 management (i.e., installation, removal, and/or retrieval) of the Network Authentication Credential (NAC)
 3 certificates installed in the ONUs.

4 The term “NAC certificate” used in this sub-clause may represent a single end-entity certificate as defined
 5 in 11.2.2.1.3 or a certificate chain consisting of an end-entity certificate and one or more intermediate
 6 certificates, as defined in 11.2.2.1.3.

7 The *eOAM_Certificate_Request* eOAMPDUs are issued by the OLT to request an ONU to perform a
 8 certificate-related management action. The OLT shall not generate any *eOAM_Certificate_Response*
 9 eOAMPDUs.

10 The *eOAM_Certificate_Response* eOAMPDUs are issued by the ONU to report the result of the taken
 11 action. The ONUs shall not generate *eOAM_Certificate_Request* eOAMPDUs.

12 A specific certificate-related management action requested by the *eOAM_Certificate_Request* eOAMPDU
 13 is identified by the *ActionCode* field that follows the *Opcode* field. The *eOAM_Certificate_Response*
 14 eOAMPDU shall carry the same value of *ActionCode* field as was received in the corresponding
 15 *eOAM_Certificate_Request* eOAMPDU. Table 13-21 illustrates the available actions and identifies the
 16 related *eOAM_Certificate_Request* and *eOAM_Certificate_Response* eOAMPDU sub-types.

17 **Table 13-21—Certificate management actions and related eOAM**
 18 **message sub-types**

Action	ActionCode value	Requests (Opcode = 0x0A)	Responses (Opcode = 0x0B)
Install NAC	0x00	<i>eOAM_Install_NAC_Request</i> (see 13.4.6.7.1)	<i>eOAM_Install_NAC_Response</i> (see 13.4.6.7.2)
Retrieve DAC	0x01	<i>eOAM_Retrieve_DAC_Request</i> (see 13.4.6.7.3)	<i>eOAM_Retrieve_DAC_Response</i> (see 13.4.6.7.4)
Retrieve NAC	0x02	<i>eOAM_Retrieve_NAC_Request</i> (see 13.4.6.7.3)	<i>eOAM_Retrieve_NAC_Response</i> (see 13.4.6.7.4)

19 **13.4.6.7.1 eOAM_Install_NAC_Request eOAMPDU NAC certificate installation**

20 **13.4.6.7.1.1 eOAM Install NAC Request eOAMPDU**

21 The *eOAM_Certificate_Request* eOAMPDU with the *ActionCode* field value of 0x00 (Install NAC) is
 22 referred to as *eOAM_Install_NAC_Request* eOAMPDU. The *eOAM_Install_NAC_Request* eOAMPDU is
 23 used by the NMS to remotely install a the NAC certificate into an ONU (see 11.2.2.1.4). If the size of the
 24 NAC certificate exceeds the payload capacity of the eOAM Install NAC Request eOAMPDU, multiple
 25 such OAMPDUs may be used to complete the installation procedure.

26 The structure of the *eOAM_Install_NAC_Request* eOAMPDU shall be as presented in Table 13-22.

27 **Table 13-22—Structure of the eOAM_Install_NAC_Request eOAMPDU**

Size (octets)	Field name	Value and notes
21	eOAMPDU header	See Table 13-2

Size (octets)	Field name	Value and notes
1	Opcode	0x0A (see Table 13-10)
1	ActionCode	0x00 (see Table 13-21)
4	<u>Sequence</u>	<p><u>Bit 31:</u> <u>FirstPdu</u> indicator. When set to 1, identifies the first eOAMPDU in a sequence of one or more OAMPDUs that carry the NAC certificate.</p> <p><u>Bit 30:</u> <u>LastPdu</u> indicator. When set to 1, identifies the last eOAMPDU in a sequence of one or more OAMPDUs that carry the NAC certificate.</p> <p><u>Bits 29-0:</u> <u>OctetCount</u> sub-field. <u>If FirstPdu == 1, then the OctetCount represents the total NAC certificate size in octets.</u> <u>If FirstPdu == 0, then the OctetCount represents the 0-based index of the first octet of the DataBlock field (i.e., the offset position of the DataBlock from the beginning of the certificate).</u></p>
2	<u>CertificateLengthBlockLength</u>	The length of the <u>CertificateDataBlock</u> field. The value of 0x00 indicates that this is a request to remove the existing NAC certificate
\leq <u>14891485</u>	<u>CertificateDataBlock</u>	NAC certificate data (records) as defined in 11.2.2.1.4. This field is not present if the <u>CertificateBlockLength</u> is 0x00-00.
\leq <u>3531</u>	Pad	This field is optional; it is included only when needed to satisfy the minimum OAMPDU size requirements. When included, the Pad value is 0x00-...-00.
4	FCS	See 13.4.2

1 ~~If the ONU that received the eOAM_Install_NAC_Request eOAMPDU already has a NAC installed, the~~
2 ~~existing NAC shall be replaced (overwritten) with the new NAC.~~

3 ~~The action of overwriting of the existing NAC certificate takes place even in the situation when no new~~
4 ~~NAC certificate is supplied by the eOAM_Install_NAC_Request eOAMPDU (i.e., when the value of the~~
5 ~~CertificateLength field is set to 0x00). Essentially, such zero length eOAM_Install_NAC_Request~~
6 ~~eOAMPDU serves as a request to remove the existing NAC certificate.~~

7 **13.4.6.7.1-13.4.6.7.1.2 eOAM_Install_NAC_Response eOAMPDU**

8 The eOAM_Certificate_Response eOAMPDU with the ActionCode field value of 0x00 (Install NAC) is
9 referred to as eOAM_Install_NAC_Response eOAMPDU. The eOAM_Install_NAC_Response eOAMPDU
10 is issued by an ONU to acknowledge the processing of each eOAM_Install_NAC_Request eOAMPDU.

11 The last eOAM_Install_NAC_Response eOAMPDU in the certificate installation sequence also conveys the
12 results of NAC installation or NAC removal actions and the status of the stored certificate(s).

13 The structure of the eOAM_Install_NAC_Response eOAMPDU shall be as presented in Table 13-23.

1

Table 13-23—Structure of the eOAM_Install_NAC_Response eOAMPDU

Size (octets)	Field name	Value and notes
21	eOAMPDU header	See Table 13-2
1	Opcode	0x0B (see Table 13-10)
1	ActionCode	0x00 (see Table 13-21)
<u>4</u>	<u>Sequence</u>	<p><u>Bit 31:</u> FirstPdu indicator. This sub-field value is equal to the value of FirstPdu sub-field in the eOAM_Install_NAC_Request that this response acknowledges.</p> <p><u>Bit 30:</u> LastPdu indicator. This sub-field value is equal to the value of LastPdu sub-field in the eOAM_Install_NAC_Request that this response acknowledges.</p> <p><u>Bits 29-0:</u> OctetCount sub-field confirms the number of installed certificate data octets or signals missing data (see <u>13.3.6.7.1.3</u>).</p>
1	ActionStatus	Value encoding the status of a taken/attempted action, as defined in Table 13-24
1	CertificateStatus	Value encoding the status of the installed certificate, as defined in <u>Table 13-25</u> . This field is only present if LastPdu == 1, i.e., in the last response in a sequence, after the entire NAC certificate has been installed.
<u>351 or 32</u>	Pad	0x00-...-00
4	FCS	See <u>13.4.2</u>

2 The ActionStatus field carries the response code, as defined in Table 13-24. Only the values specified
3 in Table 13-24 are allowed. Other values are reserved and cause the eOAM_Install_NAC_Response
4 eOAMPDU to be ignored by the OLT/NMS.

5

Table 13-24—Values carried in ActionStatus field

Code	Name	Description
<u>0x00</u>	<u>Download in progress</u>	<u>ONU acknowledges that it received the Sequence.OctetCount octets of the NAC certificate without gaps and omissions. This code is reported only while LastPdu == 0.</u>
<u>0x019</u>	Install - success	The received <u>NAC</u> certificate was successfully stored in ONU's non-volatile storage. <u>This code is reported only when LastPdu == 1.</u>
<u>0x024</u>	Replace - success	The existing <u>NAC</u> certificate stored in ONU's non-volatile repository was successfully replaced by a new certificate. <u>This code is reported only when LastPdu == 1.</u>
<u>0x032</u>	Remove - success	The existing <u>NAC</u> certificate was successfully removed, i.e., it was overwritten by an empty (zero-length) certificate. <u>This code is reported only when LastPdu == 1.</u>

Code	Name	Description
0x043	Remove - no action	A request to remove certificate is received, however no certificate is stored in ONU's secure non-volatile storage. <u>This code is reported only when LastPdu == 1.</u>
0x04	Incompatible format	Unable to parse the message and extract certificate. An existing certificate, if any, remains in place.
0x05	Insufficient storage	Storage is insufficient to hold the new <u>NAC</u> certificate. An existing certificate, if any, remains in place.
0x06	Operation timeout Busy, request declined	Cannot perform <u>the</u> requested action due to other activity. <u>The -ONU will not attempt to perform this action again unless it received another request.</u> An existing certificate, if any, remains in place.
0x07	Invalid message format	Unable to parse the eOAM Install NAC Request eOAMPDU and extract the DataBlock field.
0x087	Illegal operation	ONU cannot recognize the request. No action is taken.
0x098	Undefined	Unknown error or one not covered above.

1 The CertificateStatus field conveys the status of the installed certificate after performing the
2 requested action (i.e., after installing a new certificate or after removing an existing certificate). Only the
3 values specified in **Table 13-25** are allowed. Other values are reserved and cause the
4 eOAM_Install_NAC_Response eOAMPDU to be ignored by the OLT/NMS.

5 **Table 13-25—Values carried in CertificateStatus field**

Code	Name	Description
0x00	No certificate	No <u>NAC</u> certificate is present in ONU's secure non-volatile storage.
0x01	Valid certificate	A valid Network Authentication Credential (NAC) certificate is present in ONU's secure non-volatile storage.
0x02	Expired certificate	An expired Network Authentication Credential (NAC) certificate is present in ONU's secure non-volatile storage.
0x03	Invalid format	A <u>NAC</u> certificate is present in ONU's secure non-volatile storage, but its format does not comply with requirements in 11.2.2.1.4
0x04	Corrupted data	Data stored in ONU's secure non-volatile storage is corrupted.

6 **13.4.6.7.1.3 NAC certificate installation protocol**

7 The ONU generates an eOAM Install NAC Response eOAMPDU for every eOAM Install NAC Request
8 it received.

9 When the ONU receives the initial eOAM Install NAC Request (i.e., with Sequence.FirstPdu == 1),
10 it should verify that it has sufficient secure non-volatile storage to store the number of octets equal to
11 Sequence.OctetCount. In case of insufficient storage, the ONU's response shall include the
12 ActionStatus value of 0x05 "Insufficient storage" (see **Table 13-24**).

1 If the ONU successfully parsed and stored ith DataBlock, it generates eOAM Install NAC Response #i
2 with the value of Sequence[i].OctetCount sub-field equal to the Sequence[i].OctetCount
3 + BlockLength[i] as was received in the eOAM Install NAC Request #i being acknowledged.

4 When the OLT receives ONU's response #i with Sequence[i].OctetCount = N, it generates the
5 next request #i+1 with Sequence[i+1].OctetCount = N.

6 The OLT shall transmit the blocks containing parts of the certificate in order. The ONU verifies that all
7 certificate octets are received in order and without gaps using the following criteria:

8 a) For the first received eOAM Install NAC Request eOAMPDU, verify that Sequence.
9 FirstPdu == 1.

10 b) For every subsequent eOAM Install NAC Request message #i (i>0), verify the unbroken chain
11 Sequence[i-1].OctetCount+BlockLength[i-1]==Sequence[i].OctetCount.

12 If ONU missed one or more eOAM Install NAC Request eOAMPDUs that included the initial request (i.e.,
13 the first request that ONU received had Sequence.FirstPdu == 0), it sends a response with
14 Sequence.FirstPdu == 1 and Sequence.OctetCount == 0x3F-FF-FF-FF). This response
15 tells the OLT to restart the sequence from the beginning.

16 If ONU successfully received one or more eOAM Install NAC Request eOAMPDUs that included the
17 initial request, but a subsequent request indicates a gap in the received certificate octets, the ONU response
18 includes the Sequence.OctetCount value that is equal to the Sequence[i-1].OctetCount +
19 BlockLength[i-1] from the last request message for which the condition a) or b) above held true.

20 The ONU may receive a duplicate eOAM Install NAC Request eOAMPDU, for example in a situation
21 when the eOAM Install NAC Response eOAMPDU was lost and the OLT retransmitted its last request.
22 The ONU shall process the duplicate request as if it is not a duplicate (i.e., ONU is to parse and store the
23 new block, overwriting the previously stored block at the same offset).

24 The OLT delays the issuance of eOAM Install NAC Request eOAMPDU until the next DataBlock is
25 available.

26 The ONU generally issues an eOAM Install NAC Response eOAMPDU as soon as the OLT's request is
27 completed, but it may delay such eOAMPDUs to prevent overflow of its receive buffer.

28 The OLT shall maintain a 15-second timer for receiving a response from the ONU. The timer is started
29 every time the OLT issues an eOAM Install NAC Request eOAMPDU and it is stopped every time the
30 OLT receives an eOAM Install NAC Response eOAMPDU. Expiration of this timer may indicate a lost
31 request or a lost response message, or it may be caused by the ONU taking a longer time to complete an
32 operation, such as flash memory erasure or certificate validation.

33 Upon timer expiration, the OLT may retransmit the last eOAM Install NAC Request eOAMPDU.

34 If the ONU has received an eOAM Install NAC Request eOAMPDU while it is still processing the
35 previous request, it shall respond with ActionStatus value of 0x06 "Busy, request declined" (see [Table](#)
36 [13.24](#)).

37 In the last request and the last response in a sequence, Sequence.LastPdu is equal to 1. The ONU shall
38 commit the downloaded NAC certificate (i.e., the entire chain of certificates at once) to the secure non-
39 volatile memory (i.e., the trust store) only after it received the last DataBlock in the sequence. The last
40 response in a sequence contains the CertificateStatus field that conveys the status of the NAC
41 certificate in the trust store.

1 The OLT may initiate a new certificate installation sequence before the current sequence has been
 2 completed. If ONU receives an *eOAM Install NAC Request* eOAMPDU with `Sequence.FirstPdu`
 3 `== 1`, it shall discard any partially-downloaded NAC certificate it may have. Such interruption of the
 4 certificate installation sequence shall not affect the NAC certificate that has been already committed to the
 5 trust store.

6 **13.4.6.7.2 NAC certificate removal**

7 The ONU that successfully received a complete new NAC certificate replaces the existing NAC certificate
 8 in the trust store with the new NAC certificate.

9 The action of overwriting of the existing NAC certificate takes place even in the situation when no new
 10 NAC certificate is supplied by the *eOAM Install NAC Request* eOAMPDU (i.e., when the value of the
 11 `Sequence` field is `0xC0-00-00-00` and the value of the `BlockLength` field is `0x00-00`). Essentially,
 12 such *eOAM Install NAC Request* eOAMPDU with the zero-length certificate serves as a request to
 13 remove the existing NAC certificate.

14 **13.4.6.7.3 NAC or DAC certificate retrieval**

15 **13.4.6.7.1.213.4.6.7.3.1 eOAM_Retrieve_DAC_Request and eOAM_Retrieve_NAC_Request**
 16 **eOAMPDU**

17 The *eOAM_Certificate_Request* eOAMPDU with the `ActionCode` field value of `0x01` (Retrieve DAC) is
 18 referred to as *eOAM_Retrieve_DAC_Request* eOAMPDU. The *eOAM_Retrieve_DAC_Request* eOAMPDU
 19 is used to retrieve the DAC certificate from an ONU (see [11.2.2.1.3](#)).

20 The *eOAM_Certificate_Request* eOAMPDU with the `ActionCode` field value of `0x02` (Retrieve NAC) is
 21 referred to as *eOAM_Retrieve_NAC_Request* eOAMPDU. The *eOAM_Retrieve_NAC_Request* eOAMPDU
 22 retrieves a previously-installed NAC certificate from the ONU (see [11.2.2.1.4](#)).

23 The structure of the *eOAM_Retrieve_DAC_Request* and *eOAM_Retrieve_NAC_Request* eOAMPDU shall
 24 be as presented in [Table 13-26](#).

25 **Table 13-26—Structure of *eOAM_Retrieve_DAC_Request* and**
 26 ***eOAM_Retrieve_NAC_Request* eOAMPDU**

Size (octets)	Field name	Value and notes
21	eOAMPDU header	See Table 13-2
1	Opcode	0x0A (see Table 13-10)
1	ActionCode	Identifies the message type as follows: 0x01 : a request to retrieve the DAC <u>certificate</u> 0x02 : a request to retrieve the NAC <u>certificate</u>

Size (octets)	Field name	Value and notes
4	Sequence	<p><u>Bit 31:</u> FirstPdu indicator. When set to 1, identifies a request for the ONU to send the first block of DAC or NAC certificate.</p> <p><u>Bit 30:</u> LastPdu indicator. When set to 1, this flag indicates to the ONU that the OLT has aborted the certificate retrieval process (see 13.4.6.7.3.3).</p> <p><u>Bits 29-0:</u> OctetCount sub-field represents the number of certificate octets received by the OLT so far and it is also the value of the 0-based index of the first octet of the certificate block that the OLT expects to receive in a response to this request.</p>
3733	Pad	0x00-...-00
4	FCS	See 13.4.2

1 **13.4.6.7.1.3 13.4.6.7.3.2 eOAM_Retrieve_DAC_Response and**
2 **eOAM_Retrieve_NAC_Response eOAMPDUs**

3 The eOAM_Certificate_Response eOAMPDU with the ActionCode field value of 0x01 (Retrieve DAC)
4 is referred to as eOAM_Retrieve_DAC_Response eOAMPDU. The eOAM_Retrieve_DAC_Response
5 eOAMPDU is used by the ONU to convey the contents of the DAC certificate to the OLT/NMS (see
6 11.2.2.1.3).

7 The eOAM_Certificate_Response eOAMPDU with the ActionCode field value of 0x02 (Retrieve NAC)
8 is referred to as eOAM_Retrieve_NAC_Response eOAMPDU. The eOAM_Retrieve_NAC_Response
9 eOAMPDU is used by the ONU to convey the contents of the NAC certificate, if one is present (see
10 11.2.2.1.4).

11 The structure of the eOAM_Retrieve_DAC_Response and eOAM_Retrieve_NAC_Response eOAMPDUs
12 shall be as presented in Table 13-27.

13 **Table 13-27—Structure of eOAM_Retrieve_DAC_Response and**
14 **eOAM_Retrieve_NAC_Response eOAMPDUs**

Size (octets)	Field name	Value and notes
21	eOAMPDU header	See Table 13-2
1	Opcode	0x0B (see Table 13-10)
1	ActionCode	<p>Identifies the message type as follows:</p> <p>0x01 : a response carrying the DAC certificate data</p> <p>0x02 : a response carrying the NAC certificate data</p>

Size (octets)	Field name	Value and notes
4	Sequence	<p><u>Bit 31:</u> FirstPdu indicator. When set to 1, this flag indicates that this eOAMPDU carries the first block of the NAC or DAC certificate.</p> <p><u>Bit 30:</u> LastPdu indicator. When set to 1, this flag indicates that this eOAMPDU carries the last block of the NAC or DAC certificate.</p> <p><u>Bits 29-0:</u> OctetCount sub-field. <u>If FirstPdu == 1, then the OctetCount represents the total size of the DAC or NAC certificate in octets.</u> <u>If FirstPdu == 0, then the OctetCount represents the 0-based index of the first octet of the DataBlock field (i.e., the offset position of the DataBlock from the beginning of the certificate).</u></p>
2	CertificateBlockLength	<p>The length of the CertificateDataBlock field.</p> <p>The value of 0x00 indicates that the requested certificate (NAC or DAC) is not present or cannot be retrieved.</p>
< 14859	CertificateDataBlock	<p>A block of DAC or NAC certificate data (records) as defined in or 11.2.2.1.4 respectively. This field is not present if the CertificateBlockLength is 0x00-00.</p>
< 315	Pad	<p>This field is optional; it is included only when needed to satisfy the minimum OAMPDU size requirement. When included, the Pad value is 0x00-...-00.</p>
4	FCS	See 13.4.2

1

2 **13.4.6.7.3.3 NAC/DAC certificate retrieval protocol**

3 The OLT requests one certificate block at a time. The ONU generates an eOAM Retrieve DAC Response
4 eOAMPDU for every eOAM Retrieve DAC Request, and it generates an eOAM Retrieve NAC Response
5 eOAMPDU for every eOAM Retrieve NAC Request it received.

6 In the initial retrieve request, the value of the Sequence field is equal to 0x80-00-00-00 (i.e.,
7 Sequence.FirstPdu == 1 and Sequence.OctetCount == 0x00-00-00-00).

8 When the ONU receives the OLT's initial retrieve request, it generates the initial retrieve response with
9 Sequence[0].OctetCount = CertificateSize. The initial ONU response with
10 Sequence[0].FirstPdu == 1 and Sequence[0].OctetCount == 0 indicates to the
11 OLT/NMS that the requested certificate (NAC or DAC) is not present or cannot be retrieved.

12 When the OLT receives ONU's response #i with Sequence[i].LastPdu == 0 and after it
13 successfully parsed and stored the DataBlock[i] field of length BlockLength[i], it generates the
14 next request #i+1 with Sequence[i+1].OctetCount = Sequence[i].OctetCount +
15 BlockLength[i].

16 When the ONU receives the OLT's subsequent retrieve request #i (i>0) with Sequence[i].
17 OctetCount == N, it generates the response #i with Sequence[i].OctetCount = N.

1 The OLT controls the frequency of the *eOAM Retrieve DAC Request* and *eOAM Retrieve NAC Request*
2 *eOAMPDU*s to prevent overflow of its receive buffer.

3 If the ONU is unable to retrieve the next certificate block from memory within 1 second OAM timeout
4 interval (see 13.2.3), it generates a response message with `BlockLength == 0` and the `Sequence.`
5 `OctetCount` value the same as in the received request.

6 The OLT treats the ONU response with `Sequence.OctetCount > 0` and `BlockLength == 0` as
7 a “keep alive” message. A keep-alive message indicates to the OLT that the ONU is going to transmit the
8 requested block as soon as it can and without another OLT request. There could be several keep-alive
9 messages before the next block becomes available at the ONU.

10 The OLT may signal to the ONU that it has aborted the certificate retrieval procedure by issuing a retrieve
11 request with `Sequence[i].LastPdu == 1`. The ONU acknowledges such request by issuing a
12 response with `Sequence[i].LastPdu == 1` and `BlockLength[i] == 0`.

13