Technical Specification

MEF 16

Ethernet Local Management Interface (E-LMI)

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1. Abstract

This technical specification addresses the E-LMI protocol. The E-LMI protocol is based on ITU-T Q.933, X.36 and other relevant recommendations as well as Frame Relay Local Management Interface (FR-LMI) Implementation Agreement document defined by the Frame Relay Forum and related ITU-T recommendations.

The E-LMI procedures and protocol are used for enabling auto configuration of the CE to support Metro Ethernet services. The E-LMI protocol also provides UNI and EVC status information to the CE. The UNI and EVC information enables automatic configuration of CE operation based upon the Metro Ethernet Network configuration.

2. Acronyms

CE	Customer Edge
DI	Data Instance
EVC	Ethernet Virtual Connection
IETF	Internet Engineering Task Force
ITU	International Telecommunication Union
MAC	Media Access Control
MEF	Metro Ethernet Forum
MEN	Metro Ethernet Network
OAM	Operations, Administration and Maintenance
Subscriber	The organization purchasing and/or using Ethernet Services. Alternate term: Customer
UNI	User Network Interface
UNI-C	User Network Interface C
UNI-N	User Network Interface N
TLV	Type, Length and Value

3. Scope

The E-LMI protocol is based on the relevant IEEE Ethernet standards, ITU-T frame relay standards, Frame Relay Forum implementation agreements, and Metro Ethernet Forum technical specifications (see the list of references in Section 6).

The E-LMI protocol is used for enabling the CE to request and receive status and service attributes information from the MEN so that it can configure itself to access Metro Ethernet ser-

vices. The Metro Ethernet Forum has defined an extensive set of service attributes and associated parameters of Ethernet services observable from User Network Interface to User Network Interface [2]. This technical specification specifies the E-LMI to contain EVC and UNI status information and UNI and EVC information sufficient to allow the CE to auto-configure itself. Although E-LMI is based to a large extent on the Frame Relay LMI, unlike the Frame Relay LMI, E-LMI does not manage the link between the CE and the MEN. E-LMI assumes that this is accomplished by other means such as the link management function in IEEE 802.3[6].

The means by which the E-LMI capability is activated on the CE and/or the MEN is beyond the scope of this technical specification. The E-LMI technical specification is not intended to deal with operation, administration and maintenance procedures on the UNI.

4. Compliance Levels

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in [3]. All key words must be in upper case, bold text.

5. E-LMI Messages, Protocol and Procedures

5.1 E-LMI Scope

The E-LMI protocol has a local significance at the UNI between the MEN and the CE. The scope of the E-LMI protocol is shown in Figure 1**.**

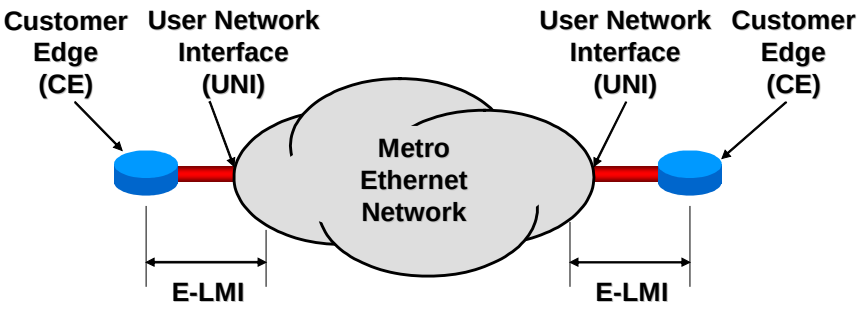


Figure 1 – E-LMI Scope

In the terms of the model of [7], E-LMI is a protocol that is terminated by the UNI-C on the CE side of the UNI and by the UNI-N on the MEN side of the UNI. This is illustrated in Figure 2 which is adapted from Figure 5 of [7].

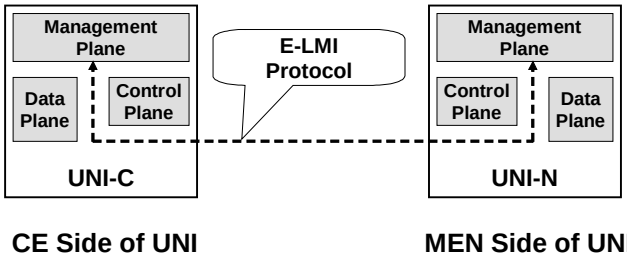


Figure 2 – E-LMI Termination in Functional Components

The E-LMI defines the protocol and procedures that convey the information that allows auto configuration of the CE. The E-LMI protocol also provides the means for notification of the status of an Ethernet Virtual Connection. In particular, the E-LMI protocol includes the following procedures:

1. Notification to the CE of the addition of an EVC;
2. Notification to the CE of the deletion of an EVC;
3. Notification to the CE of the availability state of a configured EVC (Active, Not Active, or Partially Active);
4. Communication of UNI and EVC attributes to the CE.

The mechanisms internal to the MEN for determining the information that is carried by E-LMI is beyond the scope of this Technical Specification.

5.2 E-LMI Framing Mechanism

In order to transfer E-LMI messages between the UNI-C and the UNI-N, a framing or encapsulation mechanism is needed. This section describes the framing mechanism defined for transferring E-LMI messages across the Ethernet UNI interface between the UNI-C and UNI-N. The E-LMI frame structure is based on the IEEE 802.3 untagged MAC-frame format.[1]

The E-LMI messages are encapsulated inside Ethernet frames and the E-LMI framing structure is presented in Figure 3. When the E-LMI message is less than 46 octets, pad octets with value 0x00 are added such that the E-LMI PDU is 46 octets long.

Destination Address	Source Address	E-LMI Ethertype	E-LMI PDU (message)	CRC
6 Octets	6 Octets	2 Octets	46 – 1500 Octets (Data + Pad)	4 Octets

Figure 3 – E-LMI Framing structure

[1] The E-LMI technical specification is intended to be compatible with all IEEE 802.3 MACs.

The destination address **SHALL** be 01-80-C2-00-00-07. The E-LMI Ethertype **SHALL** be 88-EE. The source address **SHALL** be the MAC address of the sending station or port.

Note:

Use of the address (01-80-C2-00-00-07) requires that there is no 802.1Q complaint component between UNI-C and UNI-N.

5.3 EVC Status (New, Active, Not Active, Partially Active)

When an EVC is "New," it has just been added to the CE-VLAN ID/EVC Map. When an EVC is "Active," it is in the CE-VLAN ID/EVC Map and fully operational between the UNIs in the EVC. When an EVC is "Not Active," it is in the CE-VLAN ID/EVC Map but not capable of transferring traffic among any of the UNIs in the EVC. The status "Partially Active" is applicable for Multipoint-to-Multipoint EVCs. When a Multipoint-to-Multipoint EVC is "Partially Active", it is in the CE-VLAN ID/EVC Map, it is capable of transferring traffic among some but not all of the UNIs in the EVC. Table 1 details the possible combinations of "New", "Active", and "Not Active" for a "Point-to-Point EVC. Table 2 details the possible combinations of "New", "Active", "Not Active" and "Partially Active" for a "Multipoint-to-Multipoint EVC. A Point-to-Point EVC can be in either the "Active" or "Not Active" state. A Multipoint-to-Multipoint EVC can be in the "Active", "Not Active" or "Partially Active" state.

New	Active	Not Active
ü	ü	
ü		ü
	ü	
		ü

Table 1 – Possible Status Combinations for a Point-to-Point EVC

New	Active	Not Active	Partially Active
ü	ü		
ü		ü	
ü			ü
	ü		
		ü	
			ü

Table 2 – Possible Status Combinations for a Multipoint-to-Multipoint EVC

5.4 E-LMI Service Attributes and Parameters

In order to enable the auto configuration of the Customer Edge (CE) equipment, a certain set of service attributes (and parameters) have to be provided by the MEN. This section identifies the

service attributes that will be provided to the CE for the auto configuration based upon the MEN network configuration. The service attributes supported in this specification include a subset of the service attributes defined by Metro Ethernet Forum. The Metro Ethernet Forum has defined a set of service attributes and associated parameters of Ethernet services observable from User Network Interface to User Network Interface [2]. This technical specification specifies the E-LMI to contain EVC and UNI status information and UNI and EVC information sufficient to allow the CE to auto-configure itself. However, the use of TLV coding will allow this protocol to be easily extended to additional service attributes.

5.5 E-LMI Messages

The following are the two messages defined for the E-LMI protocol:

- STATUS and
- STATUS ENQUIRY

This section describes the E-LMI message format, information elements, and sub-information elements which are included in the E-LMI messages (STATUS and STATUS ENQUIRY).

5.5.1 General Message Format and Information Element Coding

Every message of the E-LMI protocol **SHALL** consist of the following parts:

a) Protocol Version

b) Message Type

c) Report Type

d) Other information elements and sub-information elements.

The E-LMI message parts a), b), and c) are common to all the E-LMI messages and **SHALL** always be present. Each message **MAY** have additional information and sub-information elements. The E-LMI message organization is shown in Figure 4.

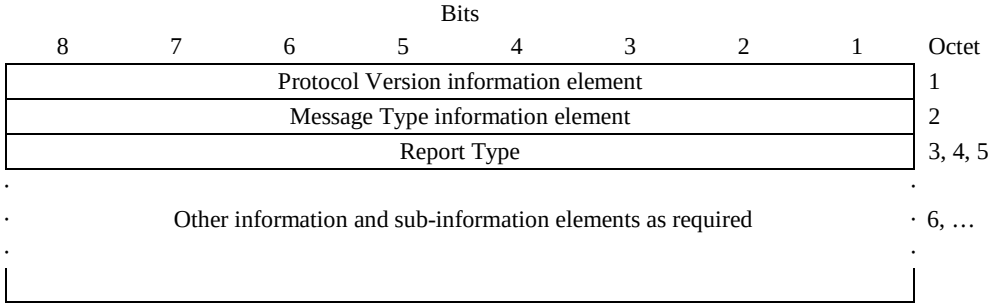


Figure 4 – General E-LMI message organization example

Relative to Figure 4, the octets of an E-LMI message are transmitted from top to bottom, and the bits of each octet are transmitted from left to right.

Unless specified otherwise, a particular information element **MUST** be present only once in a given message.

The information elements used for the E-LMI protocol are shown in Table 3.

Information element	Identifier	Section Reference
	bits 8 7 6 5 4 3 2 1	
Protocol version	Not applicable	5.5.3.1
Message type	Not applicable	5.5.3.2
Report Type	0 0 0 0 0 0 0 1	5.5.3.3
Sequence Numbers	0 0 0 0 0 0 1 0	5.5.3.4
Data Instance (DI)	0 0 0 0 0 0 1 1	5.5.3.8
UNI Status	0 0 0 1 0 0 0 1	5.5.3.6
EVC Status	0 0 1 0 0 0 0 1	5.5.3.7
CE-VLAN ID/EVC Map	0 0 1 0 0 0 1 0	5.5.3.5

Table 3 – Information Element Identifiers

NOTE: As per [4] and [8], Report Type is treated as a TLV and this will give us future capability of supporting messages without Report Type.

The values of the sub-information elements used for the E-LMI protocol are shown in Table 4.

Sub-information element	Identifier	Section Reference
	bits 8 7 6 5 4 3 2 1	
UNI Identifier	0 1 0 1 0 0 0 1	5.5.3.11
EVC Parameters	0 1 1 0 0 0 0 1	5.5.3.13
EVC Identifier	0 1 1 0 0 0 1 0	5.5.3.12
EVC Map Entry	0 1 1 0 0 0 1 1	5.5.3.10
Bandwidth Profile	0 1 1 1 0 0 0 1	5.5.3.8

Table 4 – Sub-information Element Identifiers

The coding of the information elements other than Protocol Version and Message Type is as follows:

- The information elements, other than Protocol Version and Message Type, which are used with the E-LMI protocol, are of variable length. There **SHALL** be particular order of appearance for each information element in a message. The code values of the variable length information element identifiers are assigned in numerical order according to the actual order of appearance of each information element in a message with information elements with lower value identifiers appearing before those with higher value identifiers. This allows a receiver to detect the presence or absence of a particular information element without scanning through the entire message.

- Some information elements contain more than one sub-information element. When there is more than one sub-information element in an information element, the order of appearance of the sub-information elements **SHALL** be based on the numerical value of the sub-information identifiers with sub-information elements with lower value identifiers appearing before those with higher value identifiers.

- When the description of the information elements contains reserve bits, these spare bits **SHALL** be set to "0".

- The second octet of a variable length information element indicates the total length of the contents starting with octet 3. It is the binary coding of the number of octets of the contents, with bit 1 as the least significant bit.

- Each octet of a variable length information element is numbered in the figures.

- An octet group is a self-contained entity; it contains one or more octets. For E-LMI information elements, the internal structure of an octet group is described as follows: The first octet of an octet group is identified by a number (N) in the figures. The subsequent octets are identified as N.1, N.2, N.3, ... in the figures.

- When a field extends over more than one octet, the order of bit values progressively decreases as the octet number increases. The least significant bit of the field is represented by the lowest numbered bit of the highest-numbered octet of the field.

5.5.2 E-LMI STATUS and STATUS ENQUIRY Messages

5.5.2.1 STATUS Message

The STATUS message **MUST** be sent by the UNI-N to the UNI-C in response to a STATUS ENQUIRY message to indicate the status of EVCs or for the exchange of sequence numbers. It **MAY** be sent without a STATUS ENQUIRY to indicate the status of a single EVC. See Section 5.6.6.

The STATUS message can include EVC Service Attributes and Parameters. (See Section 5.5.3.7.) This additional information enables automatic configuration of CE devices based upon the network configuration. This information is not included in the asynchronous status message (Report Type equal to Single EVC Asynchronous Status).

The structure of the STATUS message is presented in Figure 5.

Message Type: STATUS **Direction: UNI-N to UNI-C**		
Information element	**Reference**	**Type**
Protocol Version	5.5.3.1	Mandatory
Message Type	5.5.3.2	Mandatory
Report Type	5.5.3.3	Mandatory
Sequence Numbers	5.5.3.4	Optional (Note 1)
Data Instance (DI)	5.5.3.8	Optional (Note 1)
UNI Status	5.5.3.6	Optional (Note 2)
EVC Status (Note 3,7)	5.5.3.7	Optional (Note 4)
CE-VLAN ID/EVC Map (Note 6, 7)	5.5.3.5	Optional (Note 5)

NOTE 1 – Mandatory if the **Report Type** is *Full Status* or *E-LMI Check(5.5.3.3)* or *Full Status Continued*. Not included in the asynchronous status message (**Report Type** equal to *Single EVC Asynchronous Status*).

NOTE 2 – Included in the case of a *Full Status* and *Full Status Continued* to indicate the status and parameters of UNI.

NOTE 3 –The EVC Status information elements **SHALL** be arranged in the message in ascending order of EVC Reference IDs; the EVC with the lowest EVC Reference ID is first, the second lowest EVC Reference ID is second, and so on. (See Section 5.5.3.5 for a description of the EVC Reference ID.) If all information elements cannot be sent in a single Ethernet frame, more STATUS messages **MUST** be sent with Report Type *Full Status Continued*. The asynchronous STATUS message **MUST** contain a Single EVC Status information element.

NOTE 4 – Mandatory if the report type information element indicated *Full Status* or *Single EVC Asynchronous Status* and the UNI has EVCs configured.

NOTE 5 – Included in the case of a *Full Status* message to report parameters and mappings to UNI-C. The conditions when they are included are specified in the procedures.

NOTE 6 – This information element can be repeated in the STATUS message for each EVC on the UNI.

NOTE 7 – The EVC Status information element **MUST** precede the CE-VLAN ID/EVC information element.

Figure 5 – STATUS message

Figure 6 displays the information elements that are carried in the STATUS message for each Report Type information element value.

Information Element	Report Type Information Element Value			
	Full Status	E-LMI Check	Single EVC Asynchronous Status	Full Status Continued
Sequence Numbers	**X**	**X**		**X**
Data Instance	**X**	**X**		**X**
UNI Status	**X**			
EVC Status	**X**		**X**	**X**
CE-VLAN ID/EVC Map	**X**			**X**

Figure 6 – Relationship between the Report Type and Information Elements in the STATUS message

5.5.2.2 STATUS ENQUIRY

This message is sent by the UNI-C to request status or to verify sequence numbers. The UNI-C **MUST** send a STATUS message in response to a STATUS ENQUIRY message. The structure of the STATUS ENQUIRY message is presented in Figure 7.

Message type: STATUS ENQUIRY **Direction: UNI-C to UNI-N**		
Information element	**Reference**	**Type**
Protocol Version	5.5.3.1	Mandatory
Message type	5.5.3.2	Mandatory
Report Type	5.5.3.3	Mandatory
Sequence Numbers	5.5.3.4	Mandatory
Data Instance	5.5.3.8	Mandatory

Figure 7 – STATUS ENQUIRY message

5.5.3 E-LMI Message Elements

5.5.3.1 Protocol Version

This one-octet field indicates the version supported by the sending entity (UNI-C or UNI-N). This field **SHALL** contain the value shown in Figure 8 to claim compliance with Version 1 of this protocol.

Bits
8 7 6 5 4 3 2 1
0 0 0 0 0 0 0 1

Figure 8 – Coding of Protocol Version

5.5.3.2 Message Type

The purpose of the Message Type information element is to identify the function of the E-LMI message being sent. The message type is the second part of every message. The message type is coded as shown in Figure 9 and Figure 10. Bit 8 is reserved for possible future use as an extension bit.

8	7	6	5	4	3	2	1	Octet
Message type								1

Figure 9 – Message Type Information Element

Bits								Message Type
8	7	6	5	4	3	2	1	
0	1	1	1	1	1	0	1	STATUS
0	1	1	1	0	1	0	1	STATUS ENQUIRY

Figure 10 – Message Type Coding[2]

The following sub-sections define the structure and values of all information elements that are used for E-LMI STATUS and STATUS ENQUIRY messages.

5.5.3.3 Report Type Information Element

The purpose of the Report Type information element is to indicate the type of enquiry requested when included in a STATUS ENQUIRY message or the contents of the STATUS message. The length of this information element is 3 octets. See Figure 11 and Figure 12**.**

8	7	6	5	4	3	2	1	Octet
Report Type information element identifier per Table 3								1
Length of **Report Type** contents (always 00000001)								2
Report Type								3

Figure 11 – Report Type Information Element

Bits								Report Type
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Full Status
0	0	0	0	0	0	0	1	E-LMI Check
0	0	0	0	0	0	1	0	Single EVC Asynchronous Status[3]
0	0	0	0	0	0	1	1	Full Status Continued

Figure 12 – Report Type Coding[2]

[2] All other values are reserved.
[3] Not allowed in the STATUS ENQUIRY message.

5.5.3.4 Sequence Numbers Information Element

The purpose of the Sequence Numbers information element is to exchange sequence numbers between the UNI-N and the UNI-C on a periodic basis. This allows each protocol entity to detect if it has not received messages and to acknowledge receipt of messages to the other entity. The length of this information element is 4 octets. See Figure 13. The values of the Send sequence number and the Receive sequence number are set according to Section 5.6.4.

8	7	6	5	4	3	2	1	Octet
Sequence Numbers information element identifier per Table 3								1
Length of **Sequence Numbers** contents (= 00000010)								2
Send sequence number								3
Receive sequence number								4

Figure 13 –Sequence Numbers Information Element

5.5.3.5 CE-VLAN ID/EVC Map Information Element

The purpose of the CE-VLAN ID/EVC Map information element is to convey how CE VLAN IDs are mapped to specific EVCs. The maximum number of bytes needed to carry this information element depends on the number of VLAN IDs mapped to an EVC. When the number of octets needed exceeds the maximum length that can be specified in the TLV length octet (255), this information element can be repeated for the same EVC.

See Figure 14 for detailed structure of the CE-VLAN ID/EVC Map information element. The EVC Reference ID in Figure 14 is a shorthand method of referring to an EVC. It allows the UNI-C to correlate information received in the CE-VLAN ID/EVC Map IE and the EVC Status Information Element (Section 5.5.3.7) to the same EVC. It is a binary encoded number in the range 0 – 65,535. The EVC Reference ID is locally significant which means that a given EVC can have a different value of EVC Reference ID at each of the UNIs in the EVC.

8	7	6	5	4	3	2	1	Octet
CE-VLAN ID/EVC Map information element identifier per Table 3								1 (Note 1)
Length of **CE-VLAN ID/EVC Map** information element								2
EVC Reference ID								3
EVC Reference ID – continue								4
Reserve 0	Last IE (Note 2)	CE-VLAN ID/EVC Map Sequence # (Note 5)						5
Reserve 0						Un-tagged/Priority Tagged (Note 4)	Default EVC (Note 3)	6
EVC Map Entry Sub-Information element per Section 5.5.3.10								7 – 10

NOTE 1 – If the **CE-VLAN ID/EVC Map** information content is greater than 255 octets, the information will be sent in multiple **CE-VLAN ID/EVC Map** information elements.

EVC Reference ID (octet 3 and 4)
Contains the Value of EVC Reference ID which is binary encoded. The EVC Reference ID is only significant at the local UNI. The EVC Reference ID is not same as the EVC Identifier which is globally significant an described in Section 5.5.3.12

Sequence # (Octet 5, bits 1 to 6)
Sequence number of the IE segment. It starts with one for the first segment IE in the message and increments by 1 for subsequent IE segments in the message. It is used to check the order of multiple IE segments in a status message.

NOTE 2 - If the "Last IE Bit" *(Octet 5, bit 7)* is set to 1, it indicates that this is the last (or only one) **CE-VLAN ID/EVC Map** information element segment.

If the "Last IE Bit" is set to 0, it indicates that **CE-VLAN ID/EVC Map** is carried in more than one information element and this segment is not the last **CE-VLAN ID/EVC Map** information element segment.

NOTE 3 – If "*Default EVC*" bit is set to 1, it indicates that all CE-VLAN IDs that are not specified in this or other CE-VLAN ID/EVC Map IEs are mapped to this EVC. At most one EVC can be identified as a Default EVC on the UNI. The "*Default EVC*" bit has significance only if *CE-VLAN ID/EVC Map Type* is equal to "Bundling" (see UNI Status information element octet 3). It **MUST** be set to 0 when it is not significant.

NOTE 4 – If "*Untagged/Priority Tagged*" bit is set to 1, it indicates that this **EVC Map Entry** identifies the CE VLAN ID for Untagged/Priority Service Frames. The "*Untagged/Priority Tagged*" bit has significance only if *CE-VLAN ID/EVC Map Type* is not equal to "All to one Bundling" (see UNI Status information element octet 3). It **MUST** be set to 0 when it is not significant.

NOTE 5 – If the sequence number exceeds 6 bits counter, it **MUST** roll over to zero.

Figure 14 – CE-VLAN ID/EVC Map Information Element

5.5.3.6 UNI Status Information Element

The purpose of the UNI Status information element is to convey the status and other relevant UNI service attributes of the UNI as defined in [2]. This information element cannot be repeated in a STATUS message. The length of this information element depends on the number and size of UNI Identifier sub-information element..

8	7	6	5	4	3	2	1	Octet
UNI Status information element identifier per Table 3								1
Length of **UNI Status** information element contents								2
CE-VLAN ID/EVC Map Type								3
Bandwidth Profile Sub-Information element per Section 5.5.3.8								
UNI Identifier Sub-information element per Section 5.5.3.11								

Figure 15 – UNI Status Information Element

Bits								CE-VLAN ID/EVC Map Type
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	1	All to one bundling
0	0	0	0	0	0	1	0	Service Multiplexing with no bundling
0	0	0	0	0	0	1	1	Bundling

Figure 16 – CE-VLAN ID/EVC Map Type Coding[2]

5.5.3.7 EVC Status Information Element

The purpose of the EVC Status information element is to convey the status and attributes of a specific EVC on the UNI. This information element can be repeated, as necessary to indicate the status of all configured EVCs on the UNI.

The format and coding of this information element are shown in Figure 17 and Figure 18**.**

8	7	6	5	4	3	2	1	Octet
EVC Status information element identifier per Table 3								1
Length of **EVC Status** information element								2
EVC Reference ID								3
EVC Reference ID (Continue)								4
EVC Status Type								
Reserve 0				Reserve 0		Partially Active	Active	New	5
EVC Parameters Sub-information Element per Section 5.5.3.13								6
EVC ID Sub-information element per Section 5.5.3.12								7
Bandwidth Profile Sub-information element per Section 5.5.3.8								8

Figure 17 – EVC Status Information Element

Bits			EVC Status
3	2	1	
0	0	0	Not Active
0	0	1	New and Not Active
0	1	1	New and Active
0	1	0	Active
1	0	0	Partially Active
1	0	1	New and Partially Active

Figure 18 – EVC Status Coding[2]

Which sub-information elements are carried in the EVC Status information element is dependent upon the report type of the message. The EVC Status information element **MUST** contain the sub-information elements for each report type as shown in Table 5.

Sub-information Element	Report Type[4]		
	Full Status	Single EVC Asynchronous Status	Full Status Continued
EVC Parameters	ü		ü
EVC Identifier	ü		ü
Bandwidth Profile	ü		ü

Table 5 – Presence of Sub-information Elements in the EVC Status Information Element

5.5.3.8 Data Instance (DI) Information Element

DI reflects the current state of UNI and EVC information that is active on the UNI-N and UNI-C. Whenever there is mismatch in DI, it is time to exchange UNI and EVC information between UNI-N and UNI-C as per Section 5.6.7. The format is shown in Figure 19.

8	7	6	5	4	3	2	1	Octet
Data Instance information element identifier per Table 1								1
Length of **Data Instance** information element contents (00000101)								2
Reserved 0								3
Data Instance								4 (Note1)
Data Instance – continue								5
Data Instance – continue								6
Data Instance – continue								7

Note 1 - Data Instance: Any integer value packed in 4 bytes. Value "0x00000000" is unique and will be used by UNI-C to send its first message to UNI-N. Value "0x00000000" **MUST** never be sent by the UNI-N.

Figure 19 – Data Instance Information Element

5.5.3.9 Bandwidth Profile Sub-information Element

The purpose of the Bandwidth Profile sub-information element is to convey the characterization of the length and arrival for a sequence of the Service Frames at a reference point, e.g., the UNI. This sub-information element is included in the UNI Status and EVC Status information elements. It can be repeated, up to eight times in an EVC Status Information element, when there are eight per CoS Identifier Bandwidth Profiles.

The format and coding of this information element are shown in Figure 20.

[4] The E-LMI Check report type is not included in the table since the EVC Status information element is not contained in this report.

8	7	6	5	4	3	2	1	Octet
Bandwidth Profile sub-information element per Table 4								1 (Note 1)
Length of **Bandwidth Profile** sub-information element contents (= 00001100)								2
Reserve 0					CM	CF	Per CoS bit (Note 2)	3
CIR Magnitude								4
CIR Multiplier (Note 4)								4.1 4.2
CBS Magnitude								5
CBS Multiplier (Note 5)								5.1
EIR Magnitude								6
EIR Multiplier (Note 6)								6.1 6.2
EBS Magnitude								7
EBS Multiplier (Note 7)								7.1
user_priority bits 111	user_priority bits 110	user_priority bits 101	user_priority bits 100	user_priority bits 011	user_priority bits 010	user_priority bits 001	user_priority bits 000	8

NOTE 1 – The bandwidth Profile information elements can be repeated up to 8 times in the EVC Status IE and appear one time in the UNI IE.

NOTE 2 – When this sub-information element appears in the UNI IE, this bit is set to 0. When this sub-information appears in the EVC Status IE, if this bit is set to zero, then the Bandwidth Profile is a per-EVC Bandwidth Profile.

Committed Information Rate (CIR) (Octet group 4)

NOTE 4 – Octets 4.1 and 4.2 represent CIR multiplier value in binary. CIR = (CIR multiplier) * $10^{(\text{CIR magnitude})}$ [Kbps].

Committed Burst Size (CBS) (Octet group 5)

NOTE 5 – Octet 5.1 represent the CBS multiplier value. CBS = (CBS multiplier) * $10^{(\text{CBS magnitude})}$ [Kbytes].

Excess Information Rate (EIR) (Octet group 6)

NOTE 6– Octet 6.1 and 6.2 represent EIR multiplier value in binary. EIR = (EIR multiplier) * $10^{(\text{EIR magnitude})}$ [Kbps].

Excess Information Rate (EBS) (Octet group 7)

NOTE 7 - Octet 7.1 represent the EBS multiplier. EBS = (EBS multiplier) * $10^{(\text{EBS magnitude})}$ [Kbytes]

Figure 20 – Bandwidth Profile Sub-information Element

The coding of the various fields in the Bandwidth Profile sub-information element are shown in Figure 21.

Field Name	Value	Meaning
Per CoS bit (octet 3, bit 1)	0	user_priority bit values are ignored and not processed
	1	user_priority bit values are significant
Coupling Flag (CF) (octet 3, bit 2)	0	Coupling Flag not set
	1	Coupling Flag set
Color Mode Flag (CM) (octet 3, bit 3)	0	Color Mode Flag is not set
	1	Color Mode Flag is set
user_priority bits 000 (octet 8, bit 1)	0	Bandwidth Profile does not apply to frames with user_priority = 000
	1	Bandwidth Profile applies to frames with user_priority = 000
user_priority bits 001 (octet 8, bit 2)	0	Bandwidth Profile does not apply to frames with user_priority = 001
	1	Bandwidth Profile applies to frames with user_priority = 001
user_priority bits 010 (octet 8, bit 3)	0	Bandwidth Profile does not apply to frames with user_priority = 010
	1	Bandwidth Profile applies to frames with user_priority = 010
user_priority bits 011 (octet 8, bit 4)	0	Bandwidth Profile does not apply to frames with user_priority = 011
	1	Bandwidth Profile applies to frames with user_priority = 011
user_priority bits 100 (octet 8, bit 5)	0	Bandwidth Profile does not apply to frames with user_priority = 100
	1	Bandwidth Profile applies to frames with user_priority = 100
user_priority bits 101 (octet 8, bit 6)	0	Bandwidth Profile does not apply to frames with user_priority = 101
	1	Bandwidth Profile applies to frames with user_priority = 101
user_priority bits 110 (octet 8, bit 7)	0	Bandwidth Profile does not apply to frames with user_priority = 110
	1	Bandwidth Profile applies to frames with user_priority = 110
user_priority bits 111 (octet 8, bit 8)	0	Bandwidth Profile does not apply to frames with user_priority = 111
	1	Bandwidth Profile applies to frames with user_priority = 111

Figure 21 – Coding in Bandwidth Profile Sub-information Element

5.5.3.10 EVC Map Entry Sub-information Element

The purpose of the EVC Map Entry sub-information element is to specify one or more CE-VLAN IDs. The coding is shown in Figure 22. At least one CE-VLAN ID **MUST** be present from the values 1,2,…..,4095. More than one CE-VLAN ID **MAY** be present. Each CE-VLAN ID is binary encoded into two octets.

8	7	6	5	4	3	2	1	Octet
EVC Map Entry sub-information element identifier per Table 4								1
Length of **EVC Map Entry** contents								2
CE-VLAN ID								3 4
CE-VLAN ID								5 6
…								…

Figure 22 – EVC Map Entry Sub-information Element

5.5.3.11 UNI Identifier Sub-information Element

The purpose of the UNI Identifier sub-information element is to convey the value of UNI identifier. The coding is shown in Figure 23. When no UNI Identifier is defined, the UNI-N SHALL set the contents of the IE to 0x00 (ASCII null). When the actual value of the UNI Identifier is greater than 64 ASCII octets, the UNI Identifier sub-information element **SHALL** contain the first 64 ASCII octets of the actual value.

8	7	6	5	4	3	2	1	Octet
UNI Identifier sub-information element identifier per Table 4								1
Length of **UNI Identifier** contents								2
ASCII Octet								3
ASCII Octet								4
…								…

Figure 23 – UNI Identifier Sub-information Element

5.5.3.12 EVC Identifier Sub-information Element

The purpose of the EVC Identifier sub-information element is to convey the value of EVC identifier. The coding is shown in Figure 24. When no EVC Identifier is defined, the UNI-N SHALL set the contents of the IE to 0x00 (ASCII null). When the actual value of the EVC Identifier is greater than 100 ASCII octets, the EVC Identifier sub-information element **SHALL** contain the first 100 ASCII octets of the actual value.

8	7	6	5	4	3	2	1	Octet
EVC Identifier sub-information element identifier per Table 4								1
Length of **EVC Identifier** contents								2
ASCII Octet								3
ASCII Octet								4
…								…

Figure 24 – EVC Identifier Sub-information Element

5.5.3.13 EVC Parameters Sub-information Element

The purpose of the EVC Parameters sub-information element is to convey the service attributes of an existing EVC on the UNI. This sub-information element can be repeated, as necessary, in a STATUS message to indicate the service attributes of all configured EVCs on the UNI.

The format and coding of this information element are shown in Figure 25 and Figure 26.

8	7	6	5	4	3	2	1	Octet
EVC Parameters sub-information element identifier per Table 4								1
Length of **EVC Parameters** sub-information element contents								2
Reserve 0					EVC Type			3

Figure 25 – EVC Parameters Sub-Information Element

Bits 3	2	1	EVC Type
0	0	0	Point-to-Point EVC
0	0	1	Multipoint-to-Multipoint EVC

Figure 26 – EVC Type Coding[2]

5.6 E-LMI Procedures

The behavior of the E-LMI protocol is defined by set of procedures that need to be carried out based on the following:

- The events at the CE and the MEN
- The received E-LMI messages or PDUs (Protocol Data Units) by the UNI-C and the UNI-N

The E-LMI procedures are characterized by a set of E-LMI messages that will be exchanged at the UNI. This technical specification describes a set of E-LMI procedures that are modeled on the existing FR-LMI (Frame Relay Local Management Interface) procedures ([5]).

5.6.1 System parameters

Table 6 and Table 7 summarize the acceptable values for the configurable parameters described in these procedures.

Count	Corresponding Counter Name	Description	Range	Default	Usage	UNI-C or UNI-N
N391	Polling Counter	Full status (status of UNI and all EVCs) polling count	1-65k	360	Polling cycles between Full Status exchanges.	UNI-C
N393	Status Counter	Count of consecutive errors	2 - 10	4	Used to determine if E-LMI is operational or not	UNI-C and UNI-N

Table 6 – System parameters – Counters

Time Interval	Corresponding Timer Name	Range (seconds)	Default (seconds)	Started	Stopped	Actions taken when expired
T391 (Note 2)	Polling Timer (PT)	5-30	10	Transmit STATUS ENQUIRY	–	Transmit STATUS ENQUIRY. Record error if STATUS message not received
T392 (Note 3)	Polling Verification Timer (PVT)	5-30 (Note 1)	15	Transmit STATUS	Receive STATUS ENQUIRY	Record error
NOTE 1 – T392 should be greater than T391. **NOTE 2** – T391 applies to the UNI-C only. **NOTE 3** – T392 applies to the UNI-N only.						

Table 7 – System parameters – Timers

The Polling Verification Timer (PVT) **MAY** be disabled. If it is disabled, the PVT never expires.

5.6.2 Periodic Polling

The UNI-C initiates periodic polling and the procedures are described below. The STATUS ENQUIRY **SHALL** only be sent by the UNI-C.

1) At least, every **T391** seconds, the UNI-C **SHALL** send a STATUS ENQUIRY message to the UNI-N.
2) At least every **N391** polling cycles, as measured by the Polling Counter, the UNI-C **SHALL** send a *Full Status* STATUS ENQUIRY (report type equal *Full Status* as per Figure 12). All other polls **SHALL** be report type equal *E-LMI Check* as per Figure 12. Reception by the UNI-C of the *Full Status Continued* (as per Figure 12) STATUS has no effect on the Polling Counter.
3) The UNI-N responds to each STATUS ENQUIRY message with a STATUS message and resets the Polling Verification Timer, which is used by the UNI-N to detect errors. (The reset of PVT happens only if the PVT timer is enabled, see Section 5.6.1.) If the UNI-C sends a STATUS ENQUIRY requesting full status, the UNI-N **MUST** respond with a STATUS message with the Report Type specifying *Full Status* (as per Figure 12). The STATUS message sent in response to a STATUS ENQUIRY contains the Sequence Numbers and Report Type information elements. If the content of the Report Type information element specifies *Full Status*, then the STATUS message **MUST** contain one EVC Status information element for each EVC configured on the UNI.

   If the UNI-N cannot fit EVC status information elements and service attributes and parameters for all EVCs into a single *Full Status* STATUS message, the UNI-N **MUST** respond with a *Full Status Continued* STATUS message, containing as many EVC Status information elements as allowed by the Ethernet frame size.

The UNI-N **MUST** respond to a *Full Status Continued* STATUS ENQUIRY with a *Full Status* STATUS or *Full Status Continued* STATUS message starting at the next EVC Reference ID that follows the last EVC Status information element reported by the UNI-N in the previous STATUS message. The *Full Status* STATUS response **MUST** be sent when the UNI-N can fit all remaining EVC Status information elements in the STATUS message.

4) The UNI-C **SHALL** parse the STATUS message depending on the Report Type. If it is a *Full Status*, or *Full Status Continued* STATUS message, the UNI-C **SHOULD** update its configuration according to the status of the UNI and the status and service attributes of each configured EVC.

   Upon receipt of a *Full Status Continued* STATUS message, the UNI-C **SHALL** continue to request EVC status by sending a *Full Status Continued* STATUS ENQUIRY message (without waiting for the Polling Timer to expire). The UNI-C **SHALL** restart Polling Timer with value **T391** each time it transmits a *Full Status Continued* STATUS ENQUIRY message. When the UNI-N responds with a *Full Status* STATUS message, it is an indication that all information has been sent.

5) The UNI-C **SHALL** compare the EVC reference ID sent in the full status with the previously reported EVC reference ID and omission of any EVC reference ID will result in deletion of that EVC.

Note that the single EVC asynchronous STATUS message is not part of the periodic polling process.

5.6.3 Sequence Numbers

The purpose of the Sequence Numbers information element is to allow the UNI-N and the UNI-C to determine the status of the E-LMI process including correlating STATUS ENQUIRY messages with STATUS messages.

The UNI-C and the UNI-N maintain the following internal counters:

- The send sequence counter **SHALL** maintain the value of the send sequence number field of the last Sequence Numbers information element sent;

- The receive sequence counter **SHALL** maintain the value of the last received send sequence number field in the Sequence Numbers information element and **SHALL** maintain the value to be placed in the next transmitted received sequence number field.

The following procedure is used:

1. Before any messages are exchanged, the UNI-N and the UNI-C set the send sequence counter and receive sequence counters to zero.
2. Each time the UNI-C sends a STATUS ENQUIRY message, it **SHALL** increment the send sequence counter and place its value into the send sequence number field. It also **SHALL** place the current value of the receive sequence counter into the receive sequence

number field of the Sequence Numbers information element. The UNI-C increments the send sequence counter using modulo 256. The value zero **SHALL** be skipped.

3. When the UNI-N receives a STATUS ENQUIRY from the UNI-C, the UNI-N **SHALL** check the receive sequence number received from the UNI-C against its send sequence counter. If the values do not match, an error condition **SHALL** exist.

   The received send sequence number **SHALL** be stored in the receive sequence counter. The UNI-N then **SHALL** increment its send sequence counter and places its current value in the send sequence number field and the value of the receive sequence counter (the last received send sequence number) into the receive sequence number field of the outgoing Sequence Numbers information element. The UNI-N then **SHALL** transmit the completed STATUS message back to the UNI-C. The UNI-N **SHALL** increment the send sequence counter using modulo 256. The value zero **SHALL** be skipped.

4. When the UNI-C receives a STATUS message from the UNI-N in response to a STATUS ENQUIRY, the UNI-C **SHALL** check the receive sequence number received from the UNI-N against its send sequence counter. If the values do not match, an error condition **SHALL** exist. The received send sequence number **SHALL** be stored in the receive sequence counter.

NOTE – The value zero in the receive sequence number indicates that the receive sequence number field contents are undefined; this value is normally used after initialization. The value zero **SHALL** not be sent in the send sequence number field so that the receive sequence number **SHALL** never contain the value zero to differentiate the undefined condition from the normal modulo round off.

Figure 27 shows an example of the use of the send and receive sequence numbers.

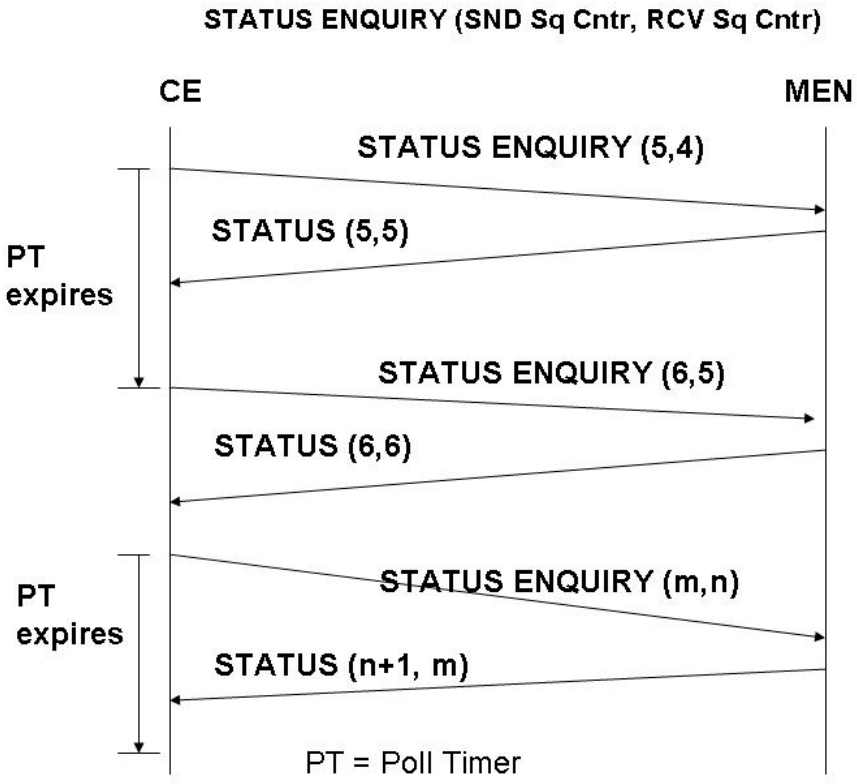


Figure 27 – E-LMI Status Check Example

5.6.4 Full Status

The UNI-C uses the EVC Status information element to detect a change in status of configured EVCs. When the UNI-C sends a STATUS ENQUIRY message with a Report Type of *Full Status*. the UNI-N responds with a STATUS message containing an EVC Status information element for each EVC configured at that UNI. Each EVC Status information element contains an active bit and a partially active bit indicating the availability or unavailability of that EVC. For a Point-to-Point EVC, the EVC status is "Active" if and only if the active bit is set to 1. For a Multipoint-to-Multipoint EVC, the status of the EVC is defined by Table 8.

Active Bit	Partially Active Bit	Status
1	0	Active
0	0	Not Active
0	1	Partially Active
1	1	Not Defined

Table 8 – Status for a Multipoint-to-Multipoint EVC

The action of the UNI-C based on the EVC status **SHALL** be independent of the action based on the "New" bit. The UNI-N **MAY** send an EVC information element with the "New" bit set to 1 and the EVC status equal to Active, Not Active, or Partially Active.

If the UNI-C receives an EVC Status information element indicating that the EVC is Not Active, the CE **SHALL** stop transmitting frames on the EVC until the UNI-C receives an EVC Status Information Element for that EVC indicating a status of Active or Partially Active. Other actions taken by the CE are implementation dependent.

Since there is a delay between the time the MEN makes an EVC available and the time the UNI-N transmits an EVC Status information element notifying the UNI-C, there is a possibility of the CE receiving frames on an EVC marked as Not Active. The action the CE takes on receipt of frames on a Not Active EVC is implementation dependent

Since there is a delay between the time the MEN detects that an EVC has become Not Active or Partially Active and the time UNI-N transmits an EVC Status information element notifying the UNI-C, there is a possibility of the MEN receiving frames on a Not Active or Partially Active EVC. The action the MEN takes on receipt of frames for a Not Active or Partially Active EVC is network dependent and may include the dropping of frames on a Not Active EVC.

5.6.5 Full Status Continued

When the information for all of the EVCs cannot be supported by the maximum Ethernet frame size, the procedures defined in this section are to be supported by both the UNI-C and the UNI-N. The procedures use the *Full Status Continued* report type in the Report Type information element in order to segment the Full STATUS message. When the UNI-C receives a STATUS message with *Full Status Continued* report type, the UNI-C **MUST** transmit a STATUS Enquiry with a report type *Full Status Continued* to obtain status and service attributes on additional EVCs. The sequence of messages is shown in Figure 28.

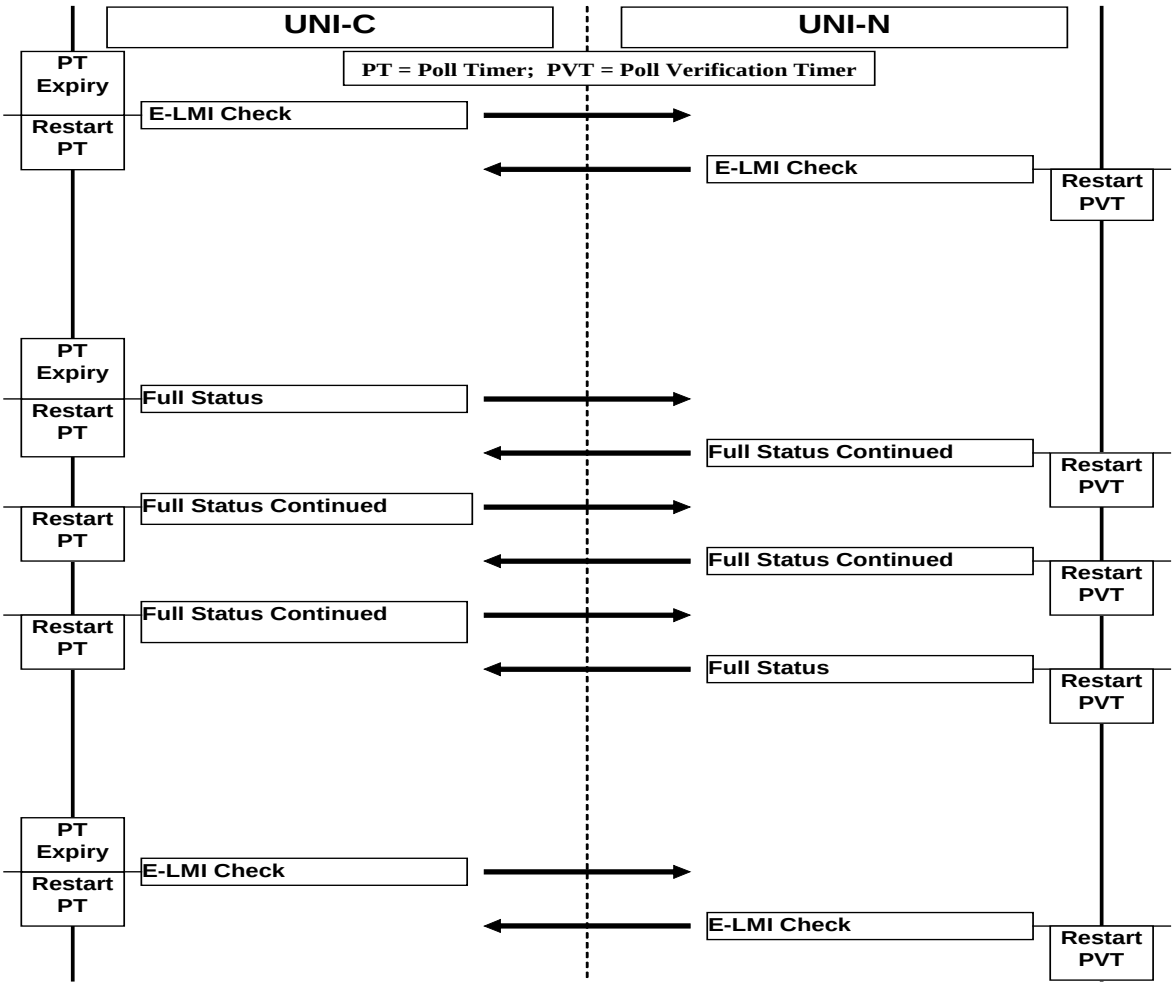


Figure 28 – Full Status Continued Enquiry Operation

5.6.6 Asynchronous Status

The function of this procedure is to notify the UNI-C that the EVC has changed status without waiting for a request from UNI-C. The UNI-N uses the EVC Status information element to inform the UNI-C about a change in status of a configured EVC. This STATUS message **SHOULD** be sent when the UNI-N detects the EVC status change, and the report type **SHALL** be set to *Single EVC Asynchronous Status*.

If the UNI-C receives an EVC Status information element indicating that the EVC is Not Active, the CE **SHALL** stop transmitting Service Frames on the EVC until it receives the STATUS message indicating that the EVC is Active or Partially Active.

Since there is a delay between the time that the MEN detects that a EVC has become Not Active or Partially Active and the time the UNI-N transmits an EVC Status information element notifying the UNI-C, there is a possibility of the network receiving Service Frames on a Not Active or Partially Active EVC. The action the MEN takes on receipt of service frames for a Not Active or

Partially Active EVC is network dependent and may include the dropping of frames on a Not Active EVC.

This asynchronous STATUS message **MUST** only contain the following information elements as shown in Figure 6.

This procedure is always initiated by the UNI-N.

The interval between Asynchronous messages **SHOULD** be greater than or equal to 1/10th of T391.

5.6.7 Data Instance Triggered Update

In addition to triggering *Full Status* and *Full Status Continued* reports every N391 polling cycles, the Data Instance is used to trigger such reports each time there is a change in EVC or UNI information. This eliminates the delay in receiving this new information that the UNI-C would experience if the information was only sent every N391 polling cycles.

5.6.7.1 UNI-C Procedures

When the UNI-C comes up for first time or is restarted, the UNI-C **MUST** set its DI to 0. Also the UNI-C **MUST** send the ELMI STATUS ENQUIRY with report type *Full Status*.

The UNI-C will then receive *Full Status* or *Full Status Continued* reports, including the latest UNI and EVC information and update its local database. At this stage, the UNI-C's local DI **MUST** be set to the UNI-N DI that is received in the *Full Status* report.

For ELMI *Full Status Continued*, the DI value sent by the UNI-N MUST not change until the Status procedure is complete. Any Full Status procedure, with errors **SHALL** result in the UNI-C not updating the local DI to the UNI-N DI value and a Full Status Enquiry **SHALL** be triggered.

On PT expiry with the polling counter not equal to 0, the UNI-C **SHALL** decrement the polling counter and send ELMI Check with local DI included. On receipt of the STATUS message, the UNI-C **SHALL** compare the received UNI-N DI with its local DI and take the following actions:

- A mismatch indicates that the UNI-N has new data to send and UNI-C **MUST** immediately send a FULL STATUS message with its local DI value.
- If they are equal, No action **SHALL** be taken.

5.6.7.2 UNI-N Procedures

When the UNI-N first comes up, it **SHALL** set its DI value to a non-zero value that is different from the DI value received in the first message received from the UNI-C. Any change in infor-

mation related to UNI or EVC including status change **SHALL** result in incrementing DI value to reflect the change in data.

When the UNI-N increments the DI, the value zero **SHALL** be skipped.

For *Full Status and Full Status Continued* reports, the DI value sent by the UNI-N **MUST NOT** change from that sent in the first *Full Status Continued* report until the Status procedure is complete.

For ELMI Check, on receipt of ELMI STATUS ENQUIRY, with ELMI Check, UNI-N **SHALL** respond with ELMI STATUS and include the current value of DI.

Figure 29 illustrates the use of the Data Instance.

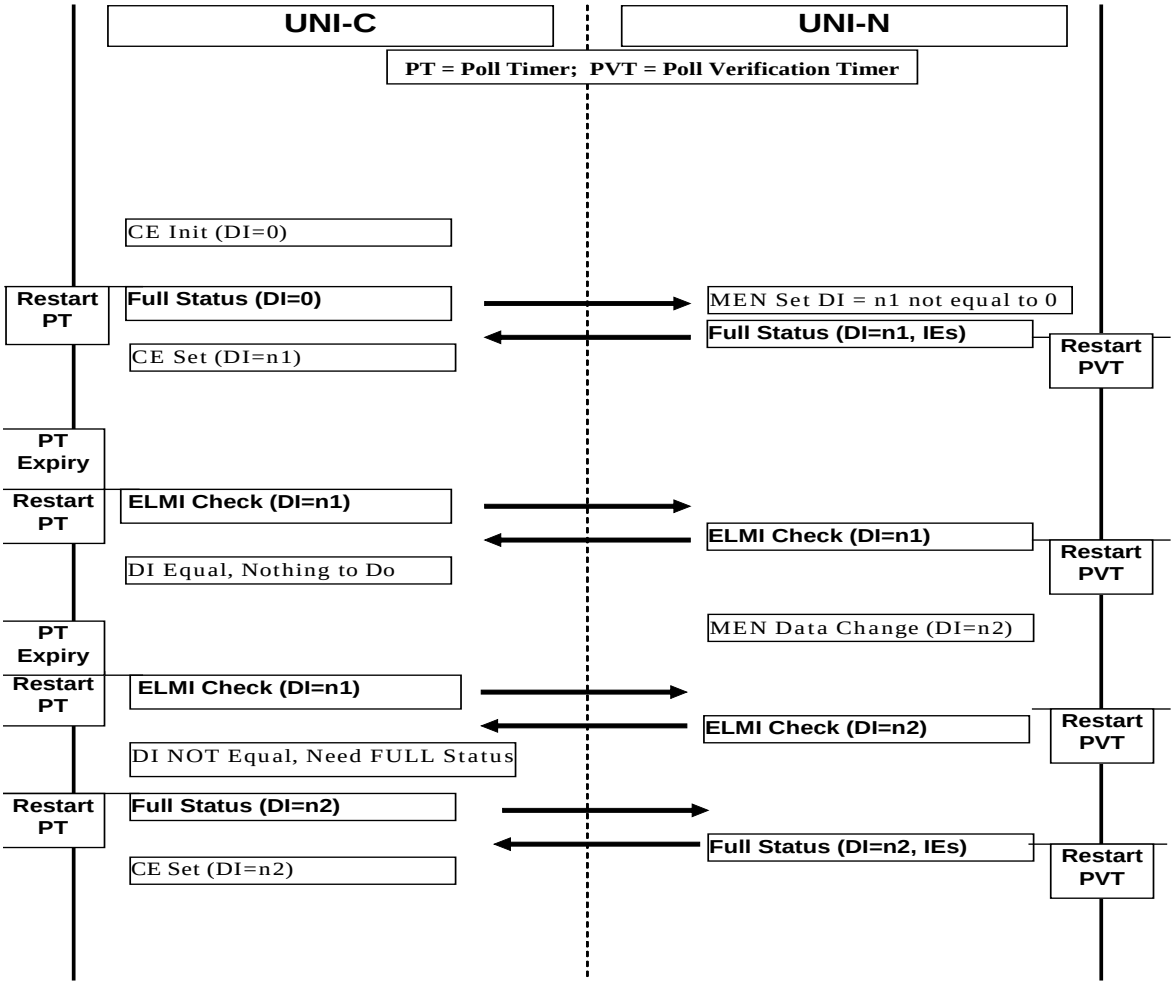


Figure 29 – Data Instance Exchange and Update in UNI-C and UNI-N

5.6.8 Reporting a New EVC

One of the functions of the E-LMI is to notify the UNI-C of newly added EVC using a *Full Status* STATUS message. The EVC reporting procedures are defined as follows:

1. When a new Ethernet Virtual Connection has been added, the UNI-N **SHALL** increment its DI and set the "New" bit to 1 in the EVC Status information element for that EVC in the next *Full Status* or *Full Status Continued* STATUS message sent after the addition of the EVC.
2. The "New" bit in the EVC Status information element **SHALL** be set to 1 until the DI in the STATUS ENQUIRY received by the UNI-N is equal to the DI sent by the UNI-N in the messages in which the New bit was set to 1.
3. When the UNI-C receives a *Full Status* or *Full Status Continued* STATUS message containing an EVC information element with the "New" bit of the EVC Status information element set to 1, the UNI-C **SHALL** do the following:
    a) If the UNI-C has an EVC with the same EVC Reference ID in its list of configured EVCs, the UNI-C **SHALL** delete the EVC from its list.
    b) The UNI-C **SHALL** add this new EVC to its list of configured EVCs.
    c) If the UNI-C is not able to update the new EVC information in its database for any reason, it **SHALL** not update its local DI value.

NOTE – When an existing EVC attribute (e.g., Bandwidth profile) is changed, UNI-N **SHALL** set the "New" bit of the EVC Status information element to 0.

5.6.9 Error Procedures

The UNI-N and the UNI-C use the information provided by periodic polling for error monitoring. The UNI-N and UNI-C **SHALL** detect the following error conditions:

- Reliability errors (i.e., non-receipt of STATUS/STATUS ENQUIRY messages or invalid sequence numbers in a Sequence Numbers information element).

- Protocol errors. See Section 5.6.10. The UNI-N and the UNI-C **SHALL** ignore messages (including their sequence numbers) containing these errors.

Unrecognized information and sub-information elements **SHALL** be ignored by both the UNI-C and UNI-N. No errors **SHALL** be counted in the UNI-C and in the UNI-N.

When an error is detected, the appropriate management entity **SHOULD** be notified. The details of this management entity are beyond the scope of this Technical Specification.

5.6.9.1 UNI-N Operation

The UNI-N **SHALL** consider any of the following as reliability errors:

- When the Polling Verification Timer is enabled, failure to receive a STATUS ENQUIRY is within the Polling Verification Timer interval (**T392**) is an error and the UNI-N **SHALL** restart the Polling Verification Timer (**T392**

- Invalid receive sequence number in a Sequence Numbers information element. The received receive sequence number is not valid when it is not equal to the last transmitted send sequence number. The UNI-N **SHALL** reply with the requested Report Type and restart the Polling Verification Timer.

When a protocol error occurs, the UNI-N **SHALL** ignore the entire message. As a result, the Polling Timer expires and the UNI-C observes an error.

5.6.9.2 UNI-C Operation

The UNI-C **SHALL** operate as follows:

- The expiration of the Polling Timer without having received a response to STATUS ENQUIRY sent when the Polling Timer was started **SHALL** be considered an error. If the last message sent before the expiry was either a *Full Status* STATUS ENQUIRY or a *Full Status Continued* STATUS ENQUIRY, the *Full Status* STATUS ENQUIRY procedure **SHALL** be reinitiated.

- On receipt of a STATUS message with Report Type set to E-LMI Check in response to a STATUS ENQUIRY message with Report Type set to *Full Status*, the message **SHALL** be ignored.

- Receipt of an E-LMI Check STATUS message in response to a *Full Status Continued* STATUS ENQUIRY **SHALL** be considered an error. In addition, no *Full Status Continued* STATUS ENQUIRY message **SHALL** be issued. At the next Polling Timer expiry, the *Full Status* STATUS ENQUIRY procedure **SHALL** be reinitiated (rather than E-LMI Check STATUS ENQUIRY).

- Receipt of an unsolicited STATUS message with Report Type set to *Full Status, Full Status Continued* or *E-LMI Check* **SHALL** be considered an error and the message **SHALL** be ignored.

- If the received receive sequence number is not equal to the last transmitted send sequence number. The UNI-C **SHALL** ignore the message.

- If the *Full Status* or *Full Status Continued* STATUS response to a *Full Status Continued* STATUS ENQUIRY message indicates a lower-valued EVC Reference ID than the highest reported in the previous *Full Status Continued* STATUS message, the UNI-C **SHALL** consider this an error and the message **SHALL** be ignored.

- If the UNI-C receives an EVC Status information element for an EVC not currently defined and the “Active” bit is set to 1, the UNI-C **SHALL** record this as an error and add the EVC to the active EVCs. Other actions taken by the UNI-C are implementation dependent.

NOTE 1 – Using the send sequence number of a STATUS message containing an invalid receive sequence number may cause the UNI-C to acknowledge a STATUS message containing a

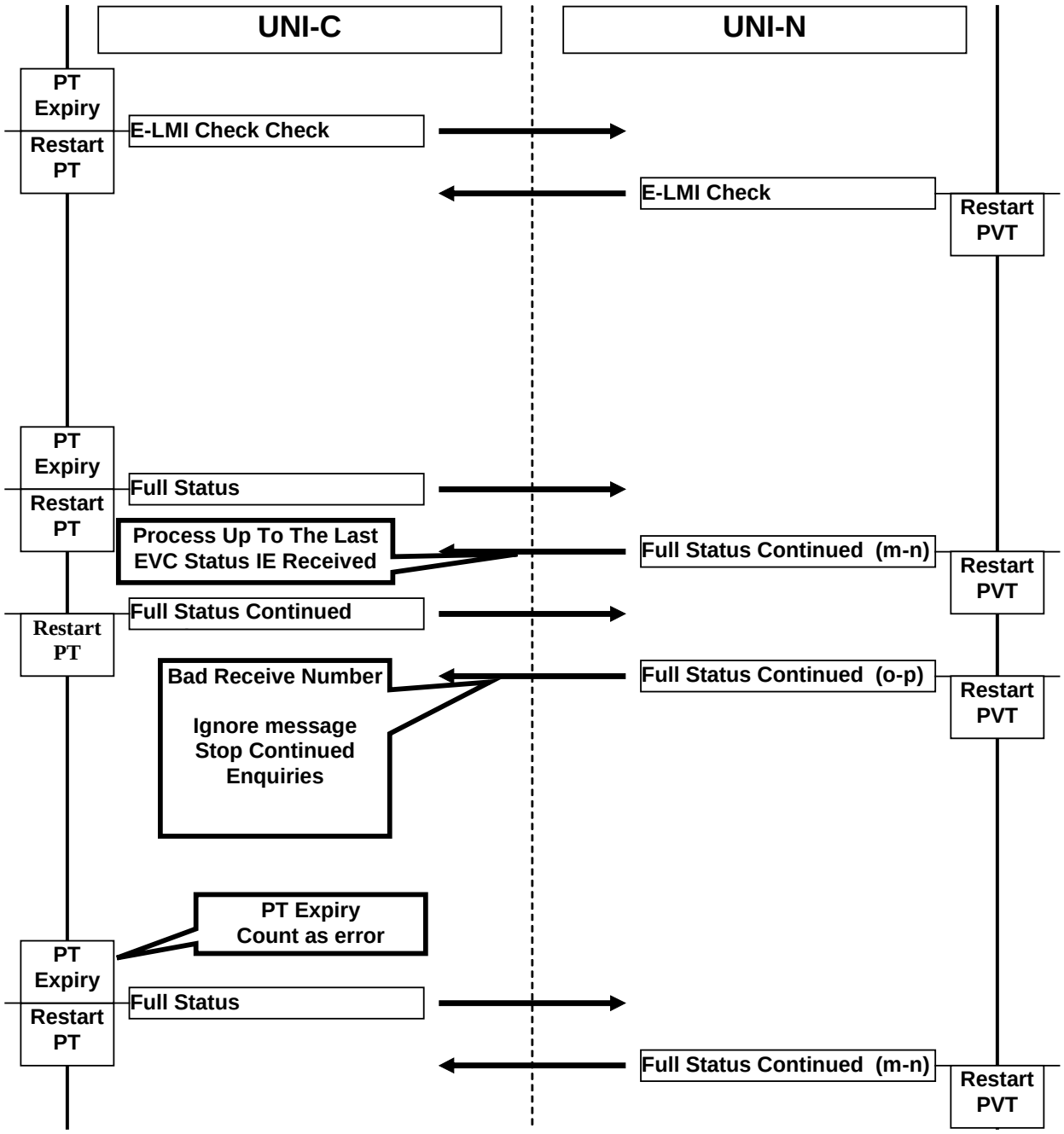
Full Status or *Full Status Continued* report that has been ignored (i.e., acknowledgment of the "New" bit and deletion status).

NOTE 2 – Asynchronous STATUS messages do not satisfy the requirement for a STATUS message in a given polling interval (Polling Interval).

In addition to the above error conditions, when an E-LMI protocol error occurs, the UNI-C SHALL ignore the entire message.

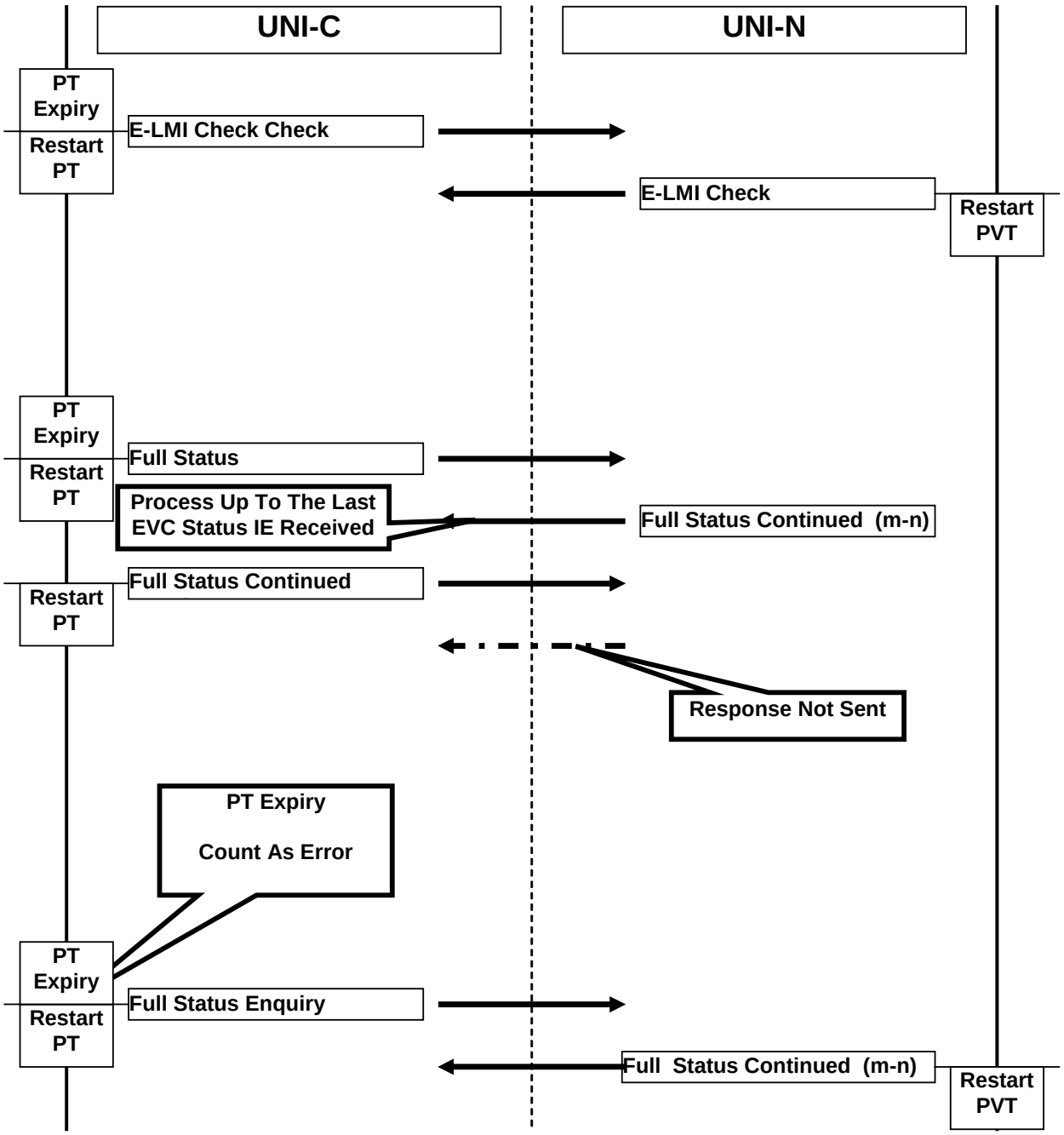
5.6.9.3 Examples of Error Procedures

The following figures are provided to illustrate operation under error conditions.



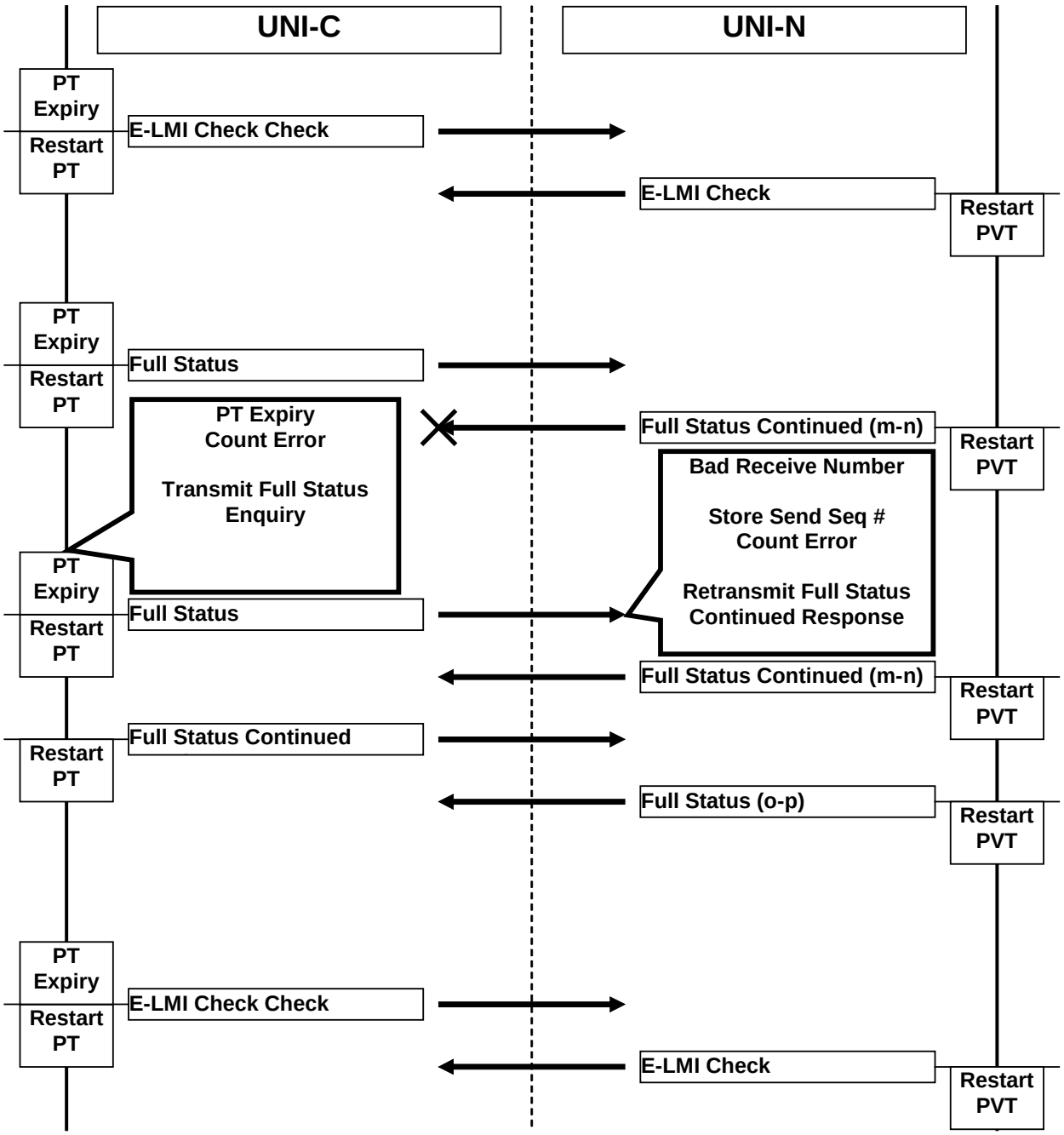
(m-n) : EVC Status IEs for EVC Ids *m* thru *n*

Figure 30 – UNI-C Receives Errored Full Status *Continued* Response



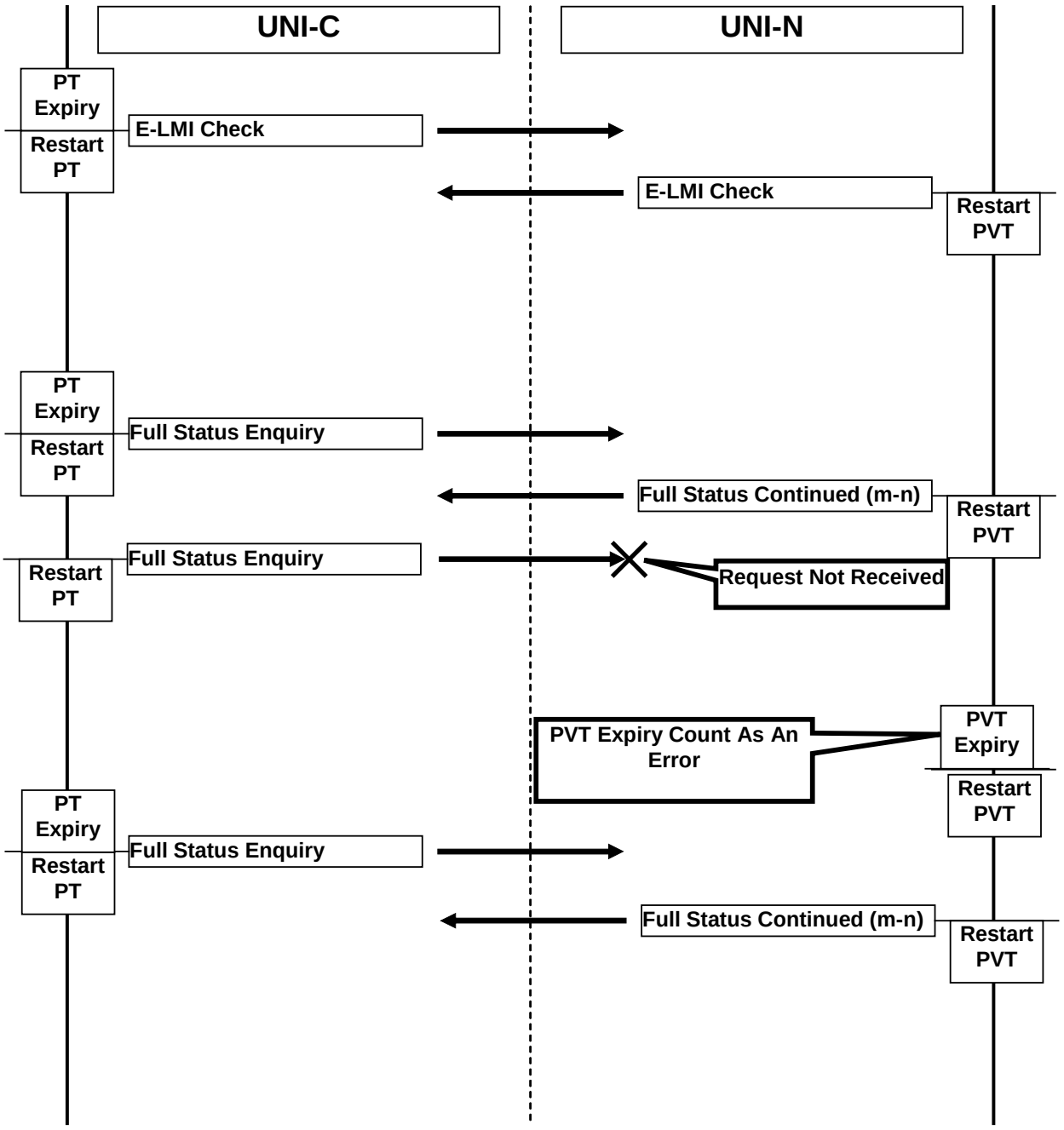
(m-n) : EVC Status IEs for EVC IDs *m* thru *n*

Figure 31 – UNI-C PT Expiry on Full Status *Continued* Response



(m-n) : EVC Status IEs for EVC IDs *m* thru *n*

Figure 32 – UNI-N Receives Errored Full Status *Continued* Enquiry



(m-n) : EVC Status IEs for EVC IDs *m* thru *n*

Figure 33 – UNI-N PVT Expiry

5.6.10 Handling of Error Conditions

Detailed error handling procedures are implementation dependent. This section provides general rules required by each implementation to facilitate the orderly treatment of error conditions. The general rules do not take precedence over applicable procedures as specified in other sections of

this technical specification. Order of precedence among the rules is defined by the order of description of this section.

5.6.10.1 Protocol Version Error

When a message is received with a protocol version coded other than (0000 0001), the message **SHALL** be ignored.

5.6.10.2 Message too short

When a message is received that is too short to contain a complete message type information element, that message **SHALL** be ignored.

5.6.10.3 Message type errors

When an E-LMI message is received that specifies a message type which is not recognized, the E-LMI message **SHALL** be ignored.

5.6.10.4 General information element errors

5.6.10.4.1 Information element out of sequence

A variable length information element which has a code value lower than the code value of the variable length information element preceding it **SHALL** be considered as out of sequence information element.

If the UNI-N or the UNI-C receives a message containing an out of sequence information element, it **SHALL** ignore this information element. When UNI-N or the UNI-C ignores this out of sequence information element, then the error handling procedure for missing mandatory information elements as described below **SHALL** apply.

5.6.10.4.2 Duplicated information and sub-information elements

If an information element is duplicated in a message or sub-information element is duplicated in an information element, in which repetition is not permitted, only the contents of the first instance of the information element or sub-information element **SHALL** be considered and all subsequent instances **SHALL** be ignored.

5.6.10.4.3 Mandatory information element missing

When a message (STATUS or STATUS ENQUIRY) is received which has one or more mandatory information elements missing, t the procedure shall be restarted. There SHALL not be change in the DI.

5.6.10.4.4 Mandatory information element error

When a message (STATUS or STATUS ENQUIRY) is received which has one or more mandatory information elements error, the procedure shall be restarted. There SHALL not be change in the DI. An example is a conflict arising in the EVC reference IDs received in the EVC status IE and the CE-VLAN ID/EVC map, this SHALL be treated as a Mandatory IE error and the procedure shall be restarted.

5.6.10.4.5 Unexpected recognized information element

When a message is received with a recognized information element not defined to be contained in that message, the receiving entity **SHALL** treat the information element as an unrecognized information element and ignore it**.**

5.6.11 E-LMI Operational Status Determination

Both the UNI-C and the UNI-N determine if the E-LMI is operating properly (operational) or not (not operational). The actions taken when the E-LMI is deemed to be not operational are implementation dependent. For example, the CE could fall back to a preconfigured state and attempt to use the services.

5.6.11.1 UNI-C Procedures

When the Polling Timer expires, it is said to be a *normal expiration* if a STATUS message was received in response to the STATUS EQUIRY sent when the Polling Timer was restarted. Otherwise it said to be an *abnormal expiration*. Note that an error in the STATUS message that causes the UNI-C to ignore the message is the same as not receiving the STATUS message.

The UNI-C **SHALL** make a determination about the operational status of the E-LMI at each expiration of the Polling Timer as follows:

- When the UNI-C first comes up, it considers E-LMI operational at each of the first N393 – 1 expirations of the Polling Timer.
- If the E-LMI was operational at the previous Polling Timer expiration and the N393 most recent Polling Timer expirations were *abnormal expirations,* then the E-LMI is deemed to be not operational, otherwise the E-LMI is deemed to be operational.
- If the E-LMI was not operational at the previous Polling Timer expiration and the N393 most recent Polling Timer expirations were *normal expirations*, then the E-LMI is deemed to be operational, otherwise the E-LMI is deemed to be not operational.

5.6.11.2 UNI-N Procedures

If the PVT is enabled, then the UNI-N SHALL make a determination about the operational status of the E-LMI as follows:

- When the UNI-N first comes up, it considers the E-LMI to be operational.
- If the E-LMI is deemed operational, it continues to be deemed operational until the Polling Verification Timer expires N393 consecutive times at which time the E-LMI is deemed to be not operational. Note that the Polling Verification Timer will expire when either a STATUS ENQUIRY message is not received or is received but ignored due to an error.
- If the E-LMI is deemed to be not operational, it continues to be deemed not operational until N393 consecutive STATUS ENQUIRY messages are received without the Polling Verification Timer expiring at which point the E-LMI is deemed to be operational.

6. References

[1] Metro Ethernet Forum, *Metro Ethernet Network Architecture Framework, Part 2: Ethernet Services Layer*, July 22, 2003.

[2] Metro Ethernet Forum, *Ethernet Services Attributes, Phase 1*, Technical Specification MEF 10, 24 November 2004.

[3] Bradner, S., IETF, S. Bradner, *Key words for use in RFC to Indicate Requirement Levels*, RFC 2119, March 1997.

[4] Frame Relay Forum, FRF1.2, *PVC User-to-Network Interface (UNI) Implementation Agreement*, July, 2000.

[5] ITU-T, Recommendation X.36, *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for public data networks providing frame relay data transmission service by dedicated circuit*, February, 2003.

[6] IEEE Std 802.3 – 2005, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*, Clause 57.

[7] Metro Ethernet Forum, *User Network Interface (UNI) Requirements and Framework*, MEF Technical Specification MEF 11, November 2004.

[8] ITU Q.933, *Digital Subscriber Signalling System No. 1 (DSS 1) - Signalling specifications for frame mode switched and permanent virtual connection control and status monitoring*, February 2003.