# Recommendation

# ITU-T G.9962 (04/2023)

SERIES G: Transmission systems and media, digital systems and networks

Access networks – In premises networks

# Unified high-speed wire-line based home networking transceivers – Management specification

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# Recommendation ITU-T G.9962

## Unified high-speed wire-line based home networking transceivers – Management specification

**Summary**

Recommendation ITU-T G.9962 specifies the physical and data link layer management for the ITU T G.996x series home networking transceiver specifications. It defines common management parameters and protocols for all ITU-T G.996x-series Recommendations for the purpose of device configuration, status and performance management, fault monitoring and diagnostics. It also provides management functionalities to coordinate multiple domains. It includes support for LCMP communication and the LCMP data model for using Centralized NDIM to coordinate multiple lines.

**History** *

| Edition | Recommendation | Approval | Study Group | Unique ID |
|---------|----------------|----------|-------------|-----------|
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| 1.1 | ITU-T G.9962 (2013) Amd. 1 | 2013-08-29 | 15 | 11.1002/1000/12005 |
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| 2.1 | ITU-T G.9962 (2014) Amd. 1 | 2016-04-13 | 15 | 11.1002/1000/12821 |
| 2.2 | ITU-T G.9962 (2014) Cor. 1 | 2016-11-13 | 15 | 11.1002/1000/13114 |
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**Keywords**

Data model, G.hn, LCMP, management.

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FOREWORD

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The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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## Unified high-speed wire-line based home networking transceivers – Management specification

## 1 Scope

This Recommendation specifies the physical and data link layer management for the ITU-T G.996x-series home networking transceiver specifications. It defines the management architecture, protocols and common management parameters, for all ITU-T G.996x-series Recommendations. More specifically, this Recommendation includes the following:

−  Architecture and reference model for management layer;

−  Management protocols defined in [ITU-T G.9980], [BBF TR-069], necessary for device configuration, status and performance management, fault monitoring, and diagnostics and security;

−  Management parameters defined in [BBF TR-181 I2A8] for transparent integration with remote management functionality;

−  Global master (GM) functionality that facilitates coordination of multiple ITU-T G.996x domains;

−  Support for Layer 2 Configuration and Management Protocol (LCMP);

−  Support for centralized NDIM data model.

## 2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.9960]   Recommendation ITU-T G.9960 (2023), *Unified high-speed wire-line based home networking transceivers – System architecture and physical layer specification.*

[ITU-T G.9961]   Recommendation ITU-T G.9961 (2018), *Unified high-speed wire-line based home networking transceivers – Data link layer specification.*

[ITU-T G.9963]   Recommendation ITU-T G.9963 (2023), *Unified high-speed wire-line based home networking transceivers – Multiple input/multiple output specification.*

[ITU-T G.9964]   Recommendation ITU-T G.9964 (2011), *Unified high-speed wire-line based home networking transceivers – Power spectral density specification.*

[ITU-T G.9980]   Recommendation ITU-T G.9980 (2012), *Remote management of customer premises equipment over broadband networks – Customer premises equipment WAN management protocol.*

[BBF TR-069]   Broadband Forum TR-069 (2013), *CPE WAN Management Protocol.*

[BBF TR-181 I2A8]   Broadband Forum TR-181 Issue 2, Amendment 12 (2018), *Device data model for TR-069*[2].

# 3        Definitions

## 3.1      Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

Unless otherwise noted, the definitions in [ITU-T G.9960] and [ITU-T G.9961] shall apply.

## 3.2      Terms defined in this Recommendation

This Recommendation defines the following terms:

**3.2.1      client**: An application entity distinguished in the network by its unique address (e.g., MAC address).

**3.2.2      global master (GM)**: A function that provides coordination between different domains (such as communication resources, priority setting, policies of domain masters and crosstalk mitigation). A global master may also convey management functions initiated by the remote management system (e.g., the Broadband Forum CPE WAN management protocol) to support broadband access.

# 4        Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AE            Application Entity

AGC          Automatic Gain Control

BGN          Background Noise

CFR          Channel Frequency Response

C-NDIM     Centralized NDIM

DLL          Data Link Layer

DM            Domain Master

DME          DLL Management Entity

DMME        Domain Master Management Entity

EP            End Point

FW            Firmware

GM            Global Master

GME          Global Master Entity

LCMP         Layer 2 Configuration and Management Protocol

MCS          Management, Control and Security

MIMO         Multiple Input; Multiple Output

MSB          Most Significant Bit

NME          Node Management Entity

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[2]   See also http://www.broadband-forum.org/cwmp/tr-181-2-8-0.html for the root object definitions.

| PHY | Physical |
|-----|----------|
| PME | PHY Management Entity |
| PSD | Power Spectral Density |
| SC | Security Controller |
| SCE | Security Controller Entity |
| VB | Vector Boost |

## 5 Conventions

### 5.1 Format of the primitive parameters

Table 5-1 provides the possible format to be applied to the parameters used in the primitives described in this Recommendation.

**Table 5-1 – MNGMT_TYPE.IND parameters**

| Format | Possible values |
|--------|-----------------|
| Binary(N) | N-bit concatenation |
| Boolean | True or False |
| EtherType | 4 hexadecimal digits (digits 0-9, letters A-F or a-f). ([0-9A-Fa-f][0-9A-Fa-f]){4} |
| MAC Address | 12 hexadecimal digits (digits 0-9, letters A-F or a-f) displayed as six pairs of digits separated by colons. ([0-9A-Fa-f][0-9A-Fa-f]:){5}([0-9A-Fa-f][0-9A-Fa-f]) |

## 6 Architecture and reference model

### 6.1 Architecture

A model of the [ITU-T G.9960] management, control, and security (MCS) architecture is depicted in Figure 6-1. The model consists of various entities located either within nodes, within a domain, or external to the domain. MCS entities provide management, control, and security of the layer they reside in as well as services and interfaces to enable MCS communications.

The structure of MCS begins with the layers of the node; the physical (PHY) layer and the data link layer (DLL). Each of these has a specific MCS entity. Above these in the MCS hierarchy, but still within Layer 2, is the node management entity (NME), which is responsible for managing the node's overall functions. Outside of the node are two entities that reside in the same domain as the node. These are the security controller entity (SCE) and the domain master management entity (DMME). These manage and control their specific areas of responsibility (e.g., security for the SCE) within the domain. These two entities are still within Layer 2 as they are solely functioning to facilitate Layer 2 activities. These two entities are considered to operate at the domain level, unlike the node located ones that operate at the node or device level. The next entity is the global master entity (GME). This entity is defined as external to the domain, performing management and control functions for all domains within a specific home network. Global master (GM) functions are logical and able to be distributed among its managed domain masters (DMs). As GM functions concern actions that span multiple domains within a common network, it is referenced as operating at the network level for logical representation of its place in the MCS hierarchy. This is an arbitrary assignment given the logical nature of the GM. Entities that perform functions above the security controller (SC) and the GM or, in its absence the DM, are considered to be non-ITU-T G.9960 entities and out of scope. They are described in summary here as they may exist and effect the operation of the entities lower than them in the hierarchy.

The SC and DM are depicted as separate entities as they might or might not be located within the same device and might or might not be associated with the same node.

NOTE – The SC itself may be a proxy function versus a standalone entity, as it may be only a local presence of a remote authenticating system/entity that is out of scope of [ITU-T G.9960]. The internal operation and structure of the SC is as well out of scope, only its operations facing into the domain are within scope of [ITU-T G.9960], such operations as represented by its messaging and functions as described in clauses 8 and 9 of [ITU-T G.9961].
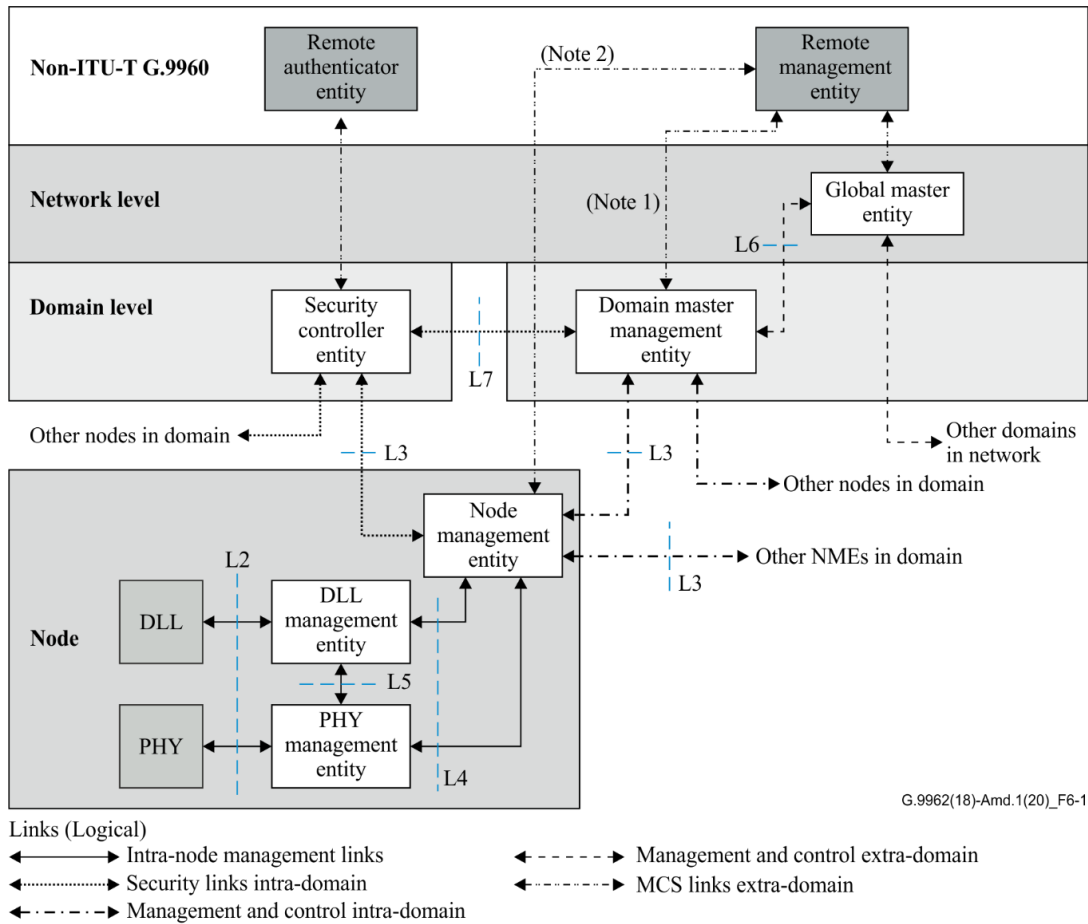


**Figure 6-1 – Architecture of management, control and security**

At the device level within the same domain, management and control messages are exchanged between node NMEs and between node NMEs and application entities (AEs).

An AE may exchange management and control messages with the NME in its device or with another node's NME in the same domain (L1 interface) using the Layer 2 configuration and management protocol (LCMP) (see clause 8.22 of [ITU-T G.9961]). Nodes exchange management and control messages between NMEs to facilitate communications between nodes (L3 interface). These interactions are illustrated in Figure 6-2 and discussed at length in clause 7 of [ITU-T G.9960] and clause 8 of [ITU-T G.9961].

Specific AE to AE communications are outside of scope of [ITU-T G.9960].
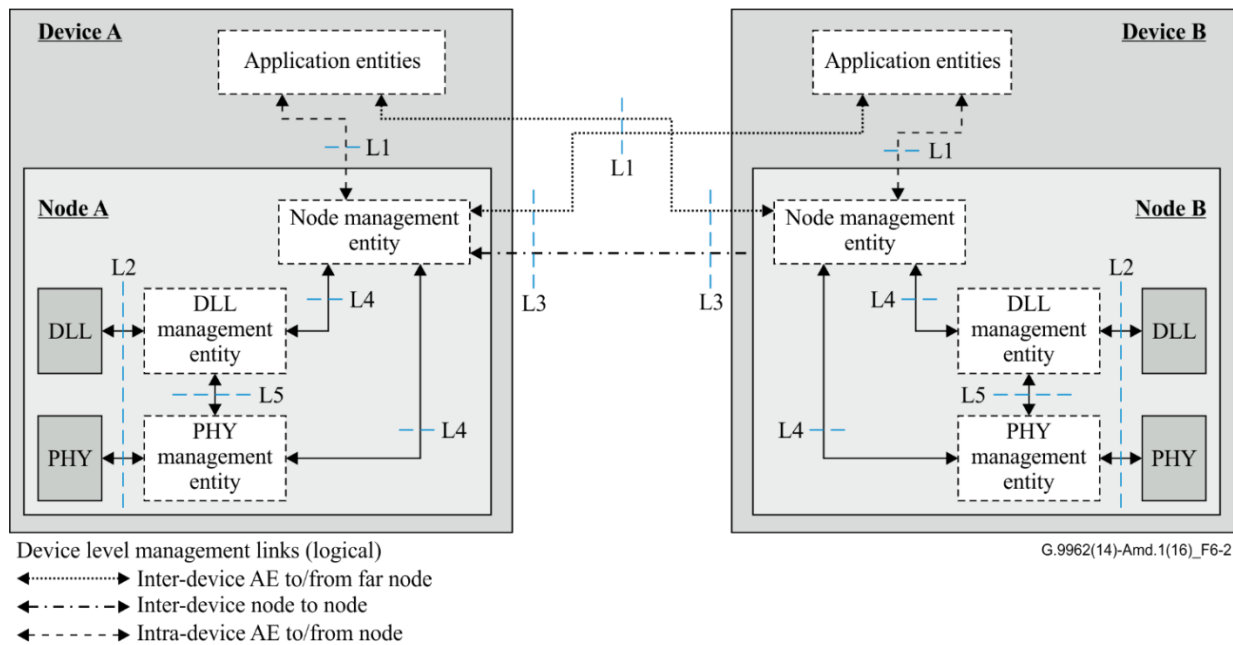
**Figure 6-2 – Device level management links**

### 6.1.1 Overall MCS structure

The MCS entities are associated with physical and network components of the [ITU-T G.9960] architecture. Each node has a PHY layer and a DLL, with each of these having its own management entity, the PHY management entity (PME) and the DLL management entity (DME), respectively. These entities are under control of the node management entity (NME). The NME is under control of the domain master management entity (DMME) as well it may receive commands from application entities above the node's A interface. Further, the node must be authenticated, and its security status controlled by the security controller entity (SCE). The SCE and the DMME communicate between themselves for management of security in the network (e.g., node authentication failure notification to the DMME from SCE). The domain may be part of a larger [ITU-T G.9960] network consisting of itself and possibly several other [ITU-T G.9960] domains under control of a global master entity (GME). The GME may be under the control of a remote management entity while the SCE may be under the control of, or depend on functions located in, a remote authenticator entity. Neither the remote management entity nor the remote authenticator are defined within [ITU-T G.9960] other than as references to MCS services provided by entities that control entities defined within [ITU-T G.9960].

### 6.1.2 Management and control entities

The management and control functions and their interactions are as follows.

#### 6.1.2.1 PHY management entity (PME)

The PME manages the node's PHY layer. The PME provides the PHY services to the DME and NME.

#### 6.1.2.2 DLL management entity (DME)

The DME manages the node's DLL. The DME provides the DLL's services to the PME and NME.

#### 6.1.2.3 Node management entity (NME)

The NME manages the node through the PME and DME while also providing domain-interfacing functions as needed for registration, authentication, and bandwidth control. The NME provides a node management service to the DME and PME while also providing a node service interface and client functions to the SCE and DMME.

### 6.1.2.3.1  L1 interface primitives

The following primitives describe the L1 interface.

**Table 6-1 – Authentication primitives summary**

| Primitive type | Direction | Description |
|---|---|---|
| EA_AUTH.IND(MAC,Status) | AE → NME | External Authentication authentication status (see Table 6-2) |
| EA_SET_KEYS.IND(MAC, TK Seed, GTK Seed) | AE → NME | Key seeds to be used by the node to generate encryption keys when using external authentication (see Table 6-3) |
| MNGMT_TYPE.IND(EtherType, MAC) | AE → NME | Classify incoming APDUs with this EtherType and MAC as APDUs carrying management data (see Table 6-4) |

**Table 6-2 – AUTH.IND parameters**

| Parameter | Format (See clause 5.1) | Description |
|---|---|---|
| MAC | MAC Address | MAC address of the supplicant for which this authentication status indication is provided |
| Status | Boolean | Indicates the status of the authentication. True: Authentication granted False: Authentication not granted |

**Table 6-3 – EA_SET_KEYS.IND parameters**

| Parameter | Format (See clause 5.1) | Description |
|---|---|---|
| MAC | MAC Address | MAC address of the supplicant for which this authentication status indication is provided |
| TK Seed | Binary(128) | TK seed be used to generate encryption keys (see Annex D of [ITU-T G.9961]) |
| GTK Seed | Binary(128) | GTK seed to be used to generate encryption keys (see Annex D of [ITU-T G.9961]) |

**Table 6-4 – MNGMT_TYPE.IND parameters**

| Parameter | Format (See clause 5.1) | Description |
|---|---|---|
| EtherType | EtherType | Ethertype of the frames to be classified as carrying management information |
| MAC | MAC Address | Source MAC address of the frames that need to be classified |

### 6.1.2.3.2  L7 interface primitives

The following primitives describe the L7 interface.

**Table 6-4 – Authentication primitives summary**

| Primitive type | Direction | Description |
|---|---|---|
| EA_AUTH.IND(MAC,Status) | NME → SC | External Authentication authentication status (see Table 6-2) |
| REG_NEWNODE.IND(Device ID) | NME → SC | Convey the identity of a new registered node |

#### 6.1.2.3.3 Application entities and NME communication (L1 interface)

For the case when the application entity and the NME are physically separated, the messages passed between them shall use the LCMP protocol specified in clause 8.22 of [ITU-T G.9961] along with the LCMPValue field specified in Annex C.

NOTE – While it may occur with certain implementations that the application entity may reside in the same physical device as the NME, there remains the need to pass messages between these entities. In this case, the formats of these intra-device messages are vendor specific.

#### 6.1.2.4 Domain master management entity (DMME)

The domain master management entity manages and controls the nodes in its domain through each node's NME by way of management messages and the MAP. The DMME also manages communications with neighbouring domains to address interference mitigation. The DMME provides the domain management services to each node within its domain as well as the SCE while providing domain-level service interface and client functions to the GME or a remote management entity if there is no GME.

#### 6.1.2.5 Global master entity (GME)

The Global master manages all domains it is responsible for through the domains' individual DMME. The GME provides the network management services to each [ITU-T G.9960] domain within its network while providing network-level service interface and client functions to the remote management entity and the WAN its network is a part of.

#### 6.1.2.5.1 DMME and GME communications (L6 interface)

For the case when the DMME and GME are physically separated, the messages passed between them may use the G.hn LCMP protocol as described in Annex B.

NOTE – While it may occur with certain implementations that the DMME and GME are located within the same physical device, there remains the need to pass messages between these entities. In this case, the formats of these intra-device messages are vendor specific.

#### 6.1.2.6 Security controller entity (SCE)

The security controller (SC) manages security for the domain as specified in clause 9 (Security) of [ITU-T G.9961]. The SC may be under control of a remote authenticator entity. The SCE provides security services for the nodes in the domain as well as for the domain master.

#### 6.1.2.6.1 DMME and SCE communications (L7 interface)

For the case when the DMME and SCE are physically separated (i.e., not in the same node), the messages passed between them are specified within clause 9 of [ITU-T G.9961].

NOTE – While it may occur with certain implementations that the DMME and SCE are located within the same physical device, there remains the need to pass messages between these entities. The formats of these intra-device messages are vendor specific.

## 6.2 Reference model

Figure 6-3 illustrates data-plane, control-plane and management-plane reference models for an [ITU-T G.9960/G.9961] transceiver. Data-plane and control-plane reference models are described in clause 5.3 of [ITU-T G.9960].
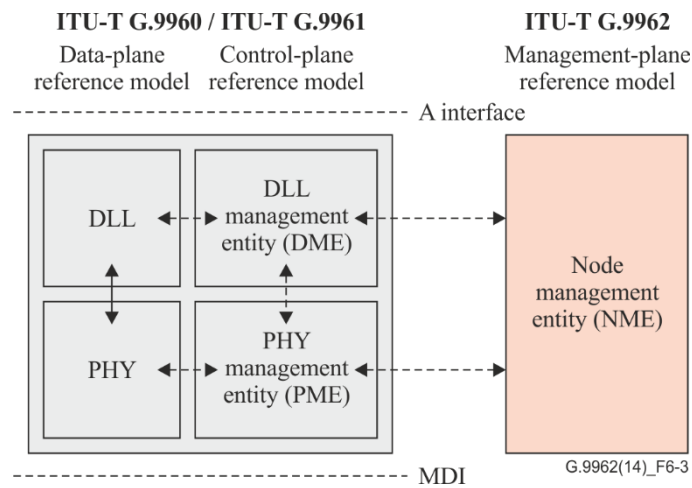


**Figure 6-3 – ITU-T G.9962 reference model**

## 7 ITU-T G.996x interface data model

ITU-T G.996x interface data model shall comply with [BBF TR-181 I2A5].

# Annex A

## LCMP communication through L1 interface

(This annex forms an integral part of this Recommendation.)

### A.1  LCMP_CONTROL in L1 interface

LCMP frames conveying information via the L1 interface shall use $0_{16}$ as LCMP_CONTROL.

### A.2  Data model for L1 interface

For further study.

# Annex B

## LCMP communication through L6 interface

(This annex forms an integral part of this Recommendation.)

### B.1 LCMP_CONTROL in L6 interface

LCMP frames conveying information via the L6 interface shall use as value of the field LCMP_CONTROL:

- $5_{16}$ when the communication through the L6 interface is related to C-NDIM protocol (Annex E).

### B.2 Data model for L6 interface

The data model for L6 interface related to the C-NDIM protocol is defined in Annex E.

The use of L6 interface for other protocols is for further study.

# Annex C

# G.hn LCMPValue field

(This annex forms an integral part of this Recommendation.)

## C.1 LCMPValue field behaviour

The LCMP protocol defines a way for G.hn devices to communicate with external entities (see clause 8.22 of [ITU-T G.9961]).

This protocol is based on an exchange of LCMP messages that contain an LCMPValue field that shall be filled differently depending on the type of communication.

In particular, four actions can be performed using LCMP protocol. Table C.1 shows these actions and relates them to LCMP messages.

**Table C.1 – List of defined actions**

| LCMP action | Description | Involved LCMP messages | Clause |
|---|---|---|---|
| WRITE | Write a parameter into the device | LCMP_WRITE.req; LCMP_WRITE.cnf | C.1.1 |
| READ | Read a parameter from the device | LCMP_READ.req; LCMP_READ.cnf | C.1.1 |
| CONTROL | Control the device | LCMP_CTRL.req; LCMP_CTRL.cnf | C.1.1 |
| NOTIFY | Notify information | LCMP_NOTIFY.ind LCMP_NOTIFY.rsp | C.1.1 |

## C.1.1 Embedding LCMP actions into LCMP

Figure C.1 shows the encapsulation of LCMPValue field within ITU-T LCMP protocol (see Table 8-129 of [ITU-T G.9961]).
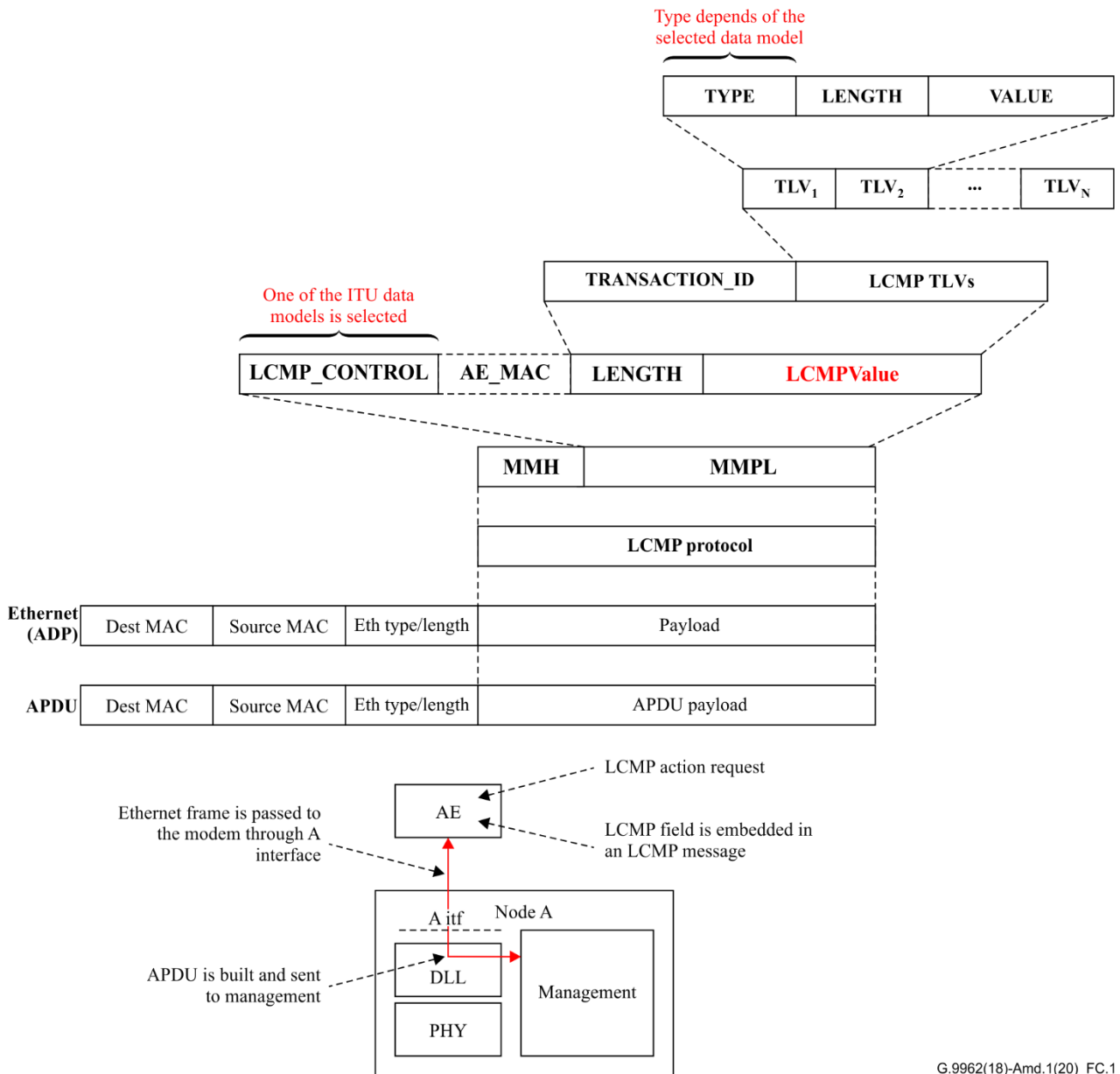
**Figure C.1 – Encapsulation of LCMPValue field**

The LCMP protocol uses the LCMP control codes reserved for ITU in LCMP protocol. The meaning of each of the control codes is specified in Table 8-129 of [ITU-T G.9961].

## C.2 LCMP actions

LCMP actions are mapped to the corresponding [ITU-T G.9961] messages as shown in the following clauses.

The LCMP_CONTROL field the messages shall be set to the value corresponding to the data model being addressed (see clause C.3).

LCMP actions shall not be mixed in a single action (e.g., READ and WRITE actions shall not be conveyed in the same LCMP request).

Each action is marked with a specific transaction identification tag through the TRANSACTION_ID field of the payload (see clause C.4). The TRANSACTION_ID field contents of a confirmation shall be the same than the one received during the request.

The source of an action may decide to merge several petitions in a single action. However, the recipient of the action shall not merge different requests in a single answer.

### C.2.1    LCMP WRITE action

An LCMP WRITE action allows writing a parameter into a device. The following diagram describes the sequence of elements.
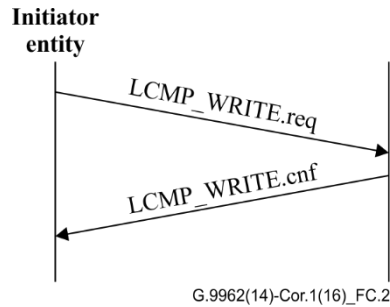


**Figure C.2 – LCMP WRITE action**

The LCMP Value of the LCMP_WRITE.req message shall contain:

–    Zero or one INFO TLV

–    One or more PARAMETER TLV

The LCMP Value field of the LCMP_WRITE.cnf message shall contain:

–    Zero or one INFO TLV

–    One WRITE_PARAMETER_CONFIRM TLV

### C.2.2    LCMP READ action
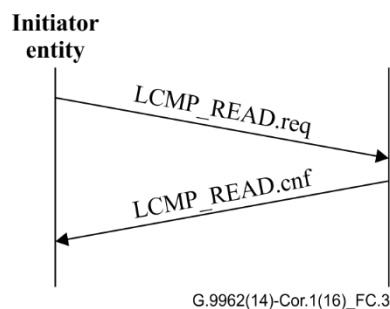


**Figure C.3 – READ action**

The LCMP Value field of the LCMP_READ.req message shall contain:

–    Zero or one INFO TLV

–    One or more READ_PARAMETER TLV

The LCMP Value field of the LCMP_READ.cnf message shall contain:

–    Zero or one INFO TLV

–    One or more PARAMETER TLV

### C.2.3 CONTROL action
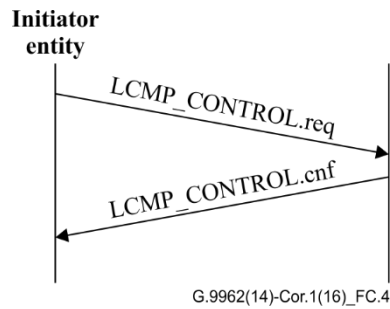


**Figure C.4 – CONTROL action**

The LCMP Value field of the LCMP_CONTROL.req message shall contain:

– Zero or one INFO TLV

– One or more CONTROL TLV

The LCMP Value field of the LCMP_CONTROL.cnf message shall contain:

– Zero or one INFO TLV

– One or more CONTROL_CONFIRM TLV

### C.2.4 NOTIFY action
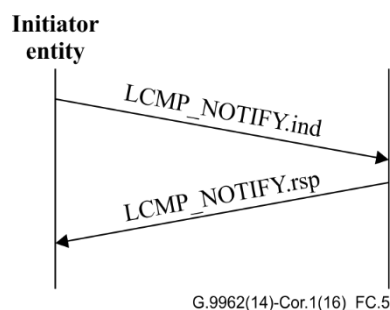


**Figure C.5 – NOTIFY action**

The LCMP Value field of the LCMP_NOTIFY.ind message shall contain:

– Zero or one INFO TLV

– One or more NOTIFY TLV

The LCMP_NOTIFY.rsp message shall only be sent when the NotificationAck bit of the received LCMP_NOTIFY.ind is set to one. In this case, the LCMP TLV Field of the LCMP_NOTIFY.rsp message shall contain:

– Zero or one INFO TLV

– One or more NOTIFY_CONFIRM TLV

### C.3 Supported Data Models

Nodes shall support at least the following data models:

– **L1 interface data model**, including information exchanged through L1 interface (see clause 6.1 and Annex A).

– **L6 interface data model**, including information exchanged through L6 interface (see clause 6.1 and Annex B).

## C.3.1 LCMP control codes

Field Data Model of LCMP_CONTROL field of LCMP messages shall be set to one of the values described in Table 8-129 of [ITU-T G.9961].

## C.4 TRANSACTION_ID field

TRANSACTION_ID field is a 16-bit field that helps upper layer entities to track the transactions over LCMP.

The recipient of the action shall use the value of this field in the received message to fill the TRANSACTION_ID of the response message.

The source of the action should ensure that the TRANSACTION_IDs for different processes are distinct from each other (e.g., using the most significant bit (MSB) of the TRANSACTION_ID).

NOTE – Using sequential numbers for TRANSACTION_IDs for a given process may help determining the order of messages on the receive side.

## C.5 LCMP fields

### C.5.1 TLV structure

TLVs follow the structure described in Table C.2.

**Table C.2 – TLV structure**

| Field | Octet | Bits | Description |
|---|---|---|---|
| Type | 0 | [7:0] | Type of TLV. See Table C.3 |
| Length | 1-2 | [15:0] | Length in octets of the value field |
| Value | Variable | Variable | Value corresponding to the TLV type. See Table C.3 |

### C.5.2 TLVs

#### C.5.2.1 TLV types and values

**Table C.3 – TLV type**

| TLV type | TLV type name | TLV type length (octets) | TLV type value |
|---|---|---|---|
| $00_{16}$ | INFO or PARAMETER | 1 | If RequestType in the LCMP Control field is different than $5_{16}$, the Value field of this TLV shall be filled following clause C.5.2.1.8. This TLV, if it exists, shall be the first TLV to be transmitted. <br><br> If RequestType in the LCMP Control field is $5_{16}$, Write/Read a parameter into/from the device through the C-NDIM protocol following Annex E |
| $01_{16}$ | WRITE_PARAMETER_ CONFIRM | Variable | If RequestType in the LCMP Control field is $5_{16}$, Confirmation of parameter writing. The value field of this TLV shall be filled as described in Annex E |
| $02_{16}$ | READ_PARAMETER | Variable | If RequestType in the LCMP Control field is $5_{16}$, the value field of this TLV shall be filled following Annex E |

**Table C.3 – TLV type**

| TLV type | TLV type name | TLV type length (octets) | TLV type value |
|---|---|---|---|
| $03_{16}$ | CONTROL | Variable | If RequestType in the LCMP Control field is $5_{16}$, control operation. The value field of the TLV shall be filled following Annex E |
| $04_{16}$ | Reserved by ITU-T | N/A | Reserved by ITU-T |
| $05_{16}$ | CONTROL_CONFIRM | Variable | If RequestType in the LCMP Control field is $5_{16}$, confirmation of writing of control information in the device. It shall be filled as described in clause C.5.2.1.5 |
| $06_{16}$ | NOTIFY | Variable | If RequestType in the LCMP Control field is $5_{16}$, notification. It shall be filled as described in clause C.5.2.1.6 |
| $07_{16}$ | NOTIFY_CONFIRM | Variable | If RequestType in the LCMP Control field is $5_{16}$, confirmation of a notification. It shall be filled as described in clause C.5.2.1.7 |
| $08_{16}$-$0F_{16}$ | Reserved by ITU-T | N/A | Reserved by ITU-T |
| $10_{16}$ | PARAMETER | Variable | Write/Read a parameter into/from the device. The value field of the TLV shall be filled following clause C.5.2.1.1 |
| $11_{16}$ | WRITE_PARAMETER_ CONFIRM | Variable | Confirmation of parameter writing. The value field of this TLV shall be filled as described in clause C.5.2.1.2 |
| $12_{16}$ | READ_PARAMETER | Variable | The value field of this TLV shall be filled following clause C.5.2.1.3 |
| $13_{16}$ | CONTROL | Variable | Control operation. The value field of the TLV shall be filled following clause C.5.2.1.4 |
| $14_{16}$ | CONTROL_CONFIRM | Variable | Confirmation of writing of control information in the device. It shall be filled as described in clause C.5.2.1.5 |
| $15_{16}$ | NOTIFY | Variable | Notification. It shall be filled as described in clause C.5.2.1.6 |
| $16_{16}$ | NOTIFY_CONFIRM | Variable | Confirmation of a notification. It shall be filled as described in clause C.5.2.1.7 |
| $17_{16}$ to $FF_{16}$ | Reserved by ITU-T | N/A | Reserved by ITU-T |

### C.5.2.1.1 PARAMETER TLV value field

The following table specifies the value field of PARAMETER TLV.

**Table C.4 – PARAMETER TLV value field**

| Field | Octet | Bits | Description |
|-------|-------|------|-------------|
| ParameterType | 0 | [7:0] | ParameterId of the parameter to be written. It shall be filled according to:<br>• Annex A in the case of accessing the L1 interface data model<br>• Annex B in the case of accessing the L6 interface data model |
| ParameterValue | 1 | Variable | This field is parameter-dependent and shall be filled according to:<br>• Annex A in the case of accessing L1 interface data model<br>• Annex B in the case of accessing L6 interface data |

### C.5.2.1.2 WRITE_PARAMETER_CONFIRM TLV value field

The following table specifies the value field of WRITE_PARAMETER_CONFIRM TLV.

**Table C.5 – WRITE_PARAMETER_CONFIRM TLV value field**

| Field | Octet | Bits | Description |
|-------|-------|------|-------------|
| NumberOfParameters | 0 | [7:0] | Number of parameters (N) for which the correct writing is confirmed |
| Parameter[0] | 1 | [7:0] | ParameterId of the first parameter to be confirmed for the accessed data model |
| … | … | … | … |
| Parameter[N-1] | N | [7:0] | ParameterId of the last parameter to be confirmed for the accessed data model |

### C.5.2.1.3 READ_PARAMETER TLV value field

The following table specifies the value field of READ_PARAMETER TLV.

**Table C.6 – READ_PARAMETER TLV value field**

| Field | Octet | Bits | Description |
|-------|-------|------|-------------|
| ParameterId | 0 | [7:0] | ParameterId of the first parameter to be read. It shall be filled according to:<br>• Annex A in the case of accessing L1 interface data model<br>• Annex B in the case of accessing L6 interface data |

### C.5.2.1.4 CONTROL TLV value field

The following table specifies the value field of CONTROL TLV.

**Table C.7 – CONTROL TLV value field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| ControlType | 0 | [7:0] | ControlId of the control operation. It shall be filled according to:<br>• Annex A in the case of accessing L1 interface data model<br>• Annex B in the case of accessing L6 interface data |
| ControlValue | 1 | Variable | This field is parameter-dependent and shall be filled according to:<br>• Annex A in the case of accessing L1 interface data model<br>• Annex B in the case of accessing L6 interface data |

### C.5.2.1.5 CONTROL_CONFIRM TLV value field

The following table specifies the value field of CONTROL_CONFIRM TLV.

**Table C.8 – CONTROL_CONFIRM TLV value field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| NumberOfControlOps | 0 | [7:0] | Number of control operations (N) for which the correct writing is confirmed |
| ControlOp[0] | 1 | [7:0] | ControlId of the first control operation to be confirmed for the accessed data model |
| … | … | … | … |
| ControlOp[N-1] | N | [7:0] | ControlId of the last control operation to be confirmed for the accessed data model |

### C.5.2.1.6 NOTIFY TLV value field

The following table specifies the value field of NOTIFY TLV.

**Table C.9 – NOTIFY TLV value field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| NotifyType | 0 | [7:0] | NotifyID of the control operation. It shall be filled according to:<br>• Annex A in the case of accessing L1 interface data model<br>• Annex B in the case of accessing L6 interface data |
| NotifyValue | 1 | Variable | This field is parameter-dependent and shall be filled according to:<br>• Annex A in the case of accessing L1 interface data model<br>• Annex B in the case of accessing L6 interface data |

### C.5.2.1.7 NOTIFY_CONFIRM TLV Value field

The following table specifies the value field of NOTIFY_CONFIRM TLV.

**Table C.10 – NOTIFY_CONFIRM TLV value field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| NumberOfNotifies | 0 | [7:0] | Number of notification operations (N) for which the correct writing is confirmed |
| Notify[0] | 1 | [7:0] | NotifyId of the first control operation to be confirmed for the accessed data model |
| … | … | … | … |

**Table C.10 – NOTIFY_CONFIRM TLV value field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| Notify[N-1] | N | [7:0] | NotifyId of the last control operation to be confirmed for the accessed data model |

### C.5.2.1.8 INFO TLV Value field

The following table specifies the value field of INFO TLV.

**Table C.11 – INFO TLV value field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| Reserved by ITU-T | 0-4 | [39:0] | Reserved by ITU-T (Note) |
| NOTE – Bits that are reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver. | | | |

# Annex D

*(This annex has been intentionally left blank.)*

# Annex E

# L6 interface for the coordination of G.hn domains for mitigation of interferences between lines – Centralized neighboring domain interference mitigation (C-NDIM)

(This annex forms an integral part of this Recommendation.)

## E.1 Introduction

This annex describes how to apply coordination techniques that facilitate the operation of different G.hn domains over cables that are physically close with a high level of interference between them (crosstalk).

## E.2 C-NDIM protocol

## E.2.1 General principles

When several domains operate over different cables that are physically close over a non-shielded medium, the crosstalk between the lines may create interferences between the different domains.

In order to minimize such interferences, a central entity that coordinates the transmissions in the domains (central coordinator) may be used, as shown in Figure E.1.
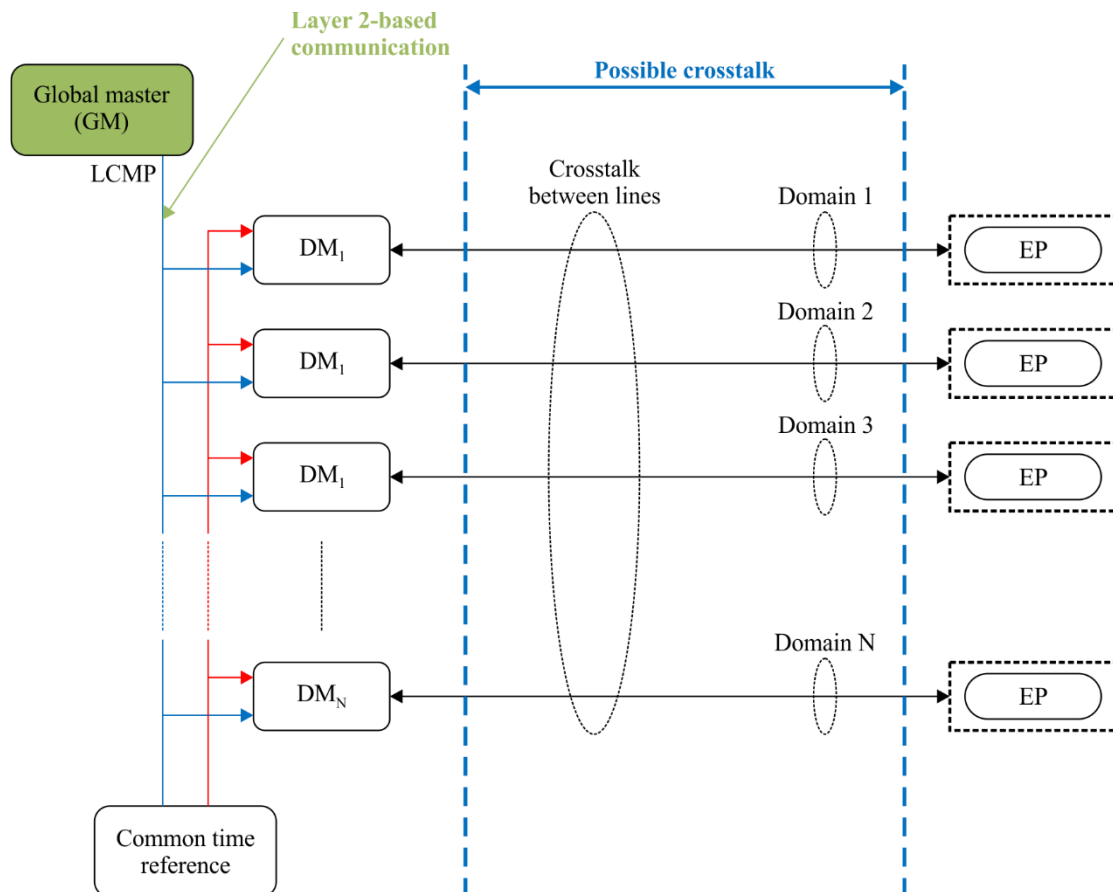


**Figure E.1 – Management of interference between domains using centralized coordination**

The domains shown in Figure E.1 operate independently, and define their own scheduling to access the medium. If the MAC cycles of the different domains are aligned, a GM may however impose

additional constraints to the generation of the scheduling in each of the domains by using LCMP exchanges with the DMs that may suffer/create interference.

NOTE – The procedure for the alignment of the MAC cycles is out of scope of this Recommendation. However, providing the same physical clock source for each of the DMs may be enough in the majority of implementations.

### E.3 Mapping of C-NDIM messages into LCMP

This clause describes the messages that need to be exchanged between an external application entity implementing a centralized controller and the nodes within the different domains for interference mitigation between domains.

The messages described in this clause shall be mapped into LCMP frames as described in clause 8.22 of [ITU-T G.9961] and Annex C.

### E.3.1 DiscoverRead.req

This message shall be mapped to an LCMP_Read.req LCMP message with the following characteristics:

**Table E.3-1 – Transmission scheme for DiscoverRead.req message**

| | Field | Value |
|---|---|---|
| Addressing | Originating MAC | MAC address of the GM |
| | Destination MAC | Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Multicast |
| LCMP Control | RequestType | 5 |
| LCMPValue | ParameterID(s) (Note) | VB_DOMAINMACS |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.2 DiscoverRead.rsp

This message shall be mapped to an LCMP_Read.cnf LCMP message with the following characteristics:

**Table E.3-2 – Transmission scheme for DiscoverRead.rsp message**

| | Field | Value |
|---|---|---|
| Addressing | Originating MAC | MAC address of the reporting node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| LCMP Control | RequestType | 5 |
| LCMPValue | ParameterID(s) (Note) | VB_DOMAINMACS |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.3 MeasPlanWrite.req

This message shall be mapped to an LCMP_Write.req LCMP message with the following characteristics:

**Table E.3-3 – Transmission scheme for MeasPlanWrite.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASPLAN |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.4 MeasPlanWrite.cnf

This message shall be mapped to an LCMP_Write.cnf LCMP message with the following characteristics:

**Table E.3-4 – Transmission scheme for MeasPlanWrite.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASPLAN |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.5 PSDShapeWrite.req

This message shall be mapped to an LCMP_Write.req LCMP message with the following characteristics:

**Table E.3-5 – Transmission scheme for PSDShapeWrite.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | MAC address of the addressed node or Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Unicast or multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_PSD_SHAPE |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.6 PSDShapeWrite.cnf

This message shall be mapped to an LCMP_Write.cnf LCMP message with the following characteristics:

**Table E.3-6 – Transmission scheme for PSDShapeWrite.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_PSD_SHAPE |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.7    AddInfo1.req

This message shall be mapped to an LCMP_Write.req LCMP message with the following characteristics:

**Table E.3-7 – Transmission scheme for AddInfo1.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_ADDINFO_1 |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.8    AddInfo1.cnf

This message shall be mapped to an LCMP_Write.cnf LCMP message with the following characteristics:

**Table E.3-8 – Transmission scheme for AddInfo1.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_ADDINFO_1 |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.9    Cdta.req

This message shall be mapped to an LCMP_Write.req LCMP message with the following characteristics:

**Table E.3-9 – Transmission scheme for Cdta.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_CDTA |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.10   Cdta.cnf

This message shall be mapped to an LCMP_Write.cnf LCMP message with the following characteristics:

**Table E.3-10 – Transmission scheme for Cdta.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_CDTA |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.11   MacSeqNum.req

This message shall be mapped to an LCMP_Write.req LCMP message with the following characteristics:

**Table E.3-11 – Transmission scheme for MacSeqNum.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | MAC address of the addressed node |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MACSEQNUM |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.12   MacSeqNum.cnf

This message shall be mapped to an LCMP_Write.cnf LCMP message with the following characteristics:

**Table E.3-12 – Transmission scheme for MacSeqNum.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MACSEQNUM |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.13  MeasurePlanCancel.req

This message shall be mapped to an LCMP_Control.req LCMP message with the following characteristics:

**Table E.3-13 – Transmission scheme for MeasurePlanCancel.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASPLAN_CANCEL |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.14  MeasurePlanCancel.cnf

This message shall be mapped to an LCMP_Ctrl.cnf LCMP message with the following characteristics:

**Table E.3-14 – Transmission scheme for MeasurePlanCancel.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASPLAN_CANCEL |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.15  MeasBgnoise.req

This message shall be mapped to an LCMP_Control.req LCMP message with the following characteristics:

**Table E.3-15 – Transmission scheme for MeasBgNoise.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address or the GM |
| | Destination MAC | MAC address of the node |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASURE_BGN_C |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.16 MeasBgnoise.cnf

This message shall be mapped to an LCMP_Ctrl.cnf LCMP message with the following characteristics:

**Table E.3-16 – Transmission scheme for MeasBgnoise.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASURE_BGN_C |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.17 MeasBgnoise.ind

This message shall be mapped to an LCMP_Notify.ind LCMP message with the following characteristics:

**Table E.3-17 – Transmission scheme for MeasBgNoise.ind message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASURE_BGN_IND |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.18 MeasCfrAmp.req

This message shall be mapped to an LCMP_Control.req LCMP message with the following characteristics:

**Table E.3-18 – Transmission scheme for MeasCfrAmp.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | MAC address of the node |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASURE_CFR_AMP_C |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.19 MeasCfrAmp.cnf

This message shall be mapped to an LCMP_Ctrl.cnf LCMP message with the following characteristics:

**Table E.3-19 – Transmission scheme for MeasCfrAmp.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASURE_CFR_AMP_C |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.20 MeasCfrAmp.ind

This message shall be mapped to an LCMP_Notify.ind LCMP message with the following characteristics:

**Table E.3-20 – Transmission scheme for MeasCfrAmp.ind message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASURE_CFR_AMP_IND |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.21 MeasSnrProbe.req

This message shall be mapped to an LCMP_Control.req LCMP message with the following characteristics:

**Table E.3-21 – Transmission scheme for MeasSnrProbe.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | MAC address of the node |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASURE_SNR_C |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.22 MeasSnrProbe.cnf

This message shall be mapped to an LCMP_Ctrl.cnf LCMP message with the following characteristics:

**Table E.3-22 – Transmission scheme for MeasSnrProbe.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASURE_SNR_C |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.23 MeasSnrProbe.ind

This message shall be mapped to an LCMP_Notify.ind LCMP message with the following characteristics:

**Table E.3-23 – Transmission scheme for MeasSnrProbe.ind message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_MEASURE_SNR_IND |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.24 IngressTrafficMon.req

This message shall be mapped to an LCMP_Control.req LCMP message with the following characteristics:

**Table E.3-24 – Transmission scheme for IngressTrafficMon.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | MAC address of the node or Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Unicast or Multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (NOTE) | VB_INGRESS_TRAFFIC_MON |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.25 IngressTrafficMon.cnf

This message shall be mapped to an LCMP_Ctrl.cnf LCMP message with the following characteristics:

**Table E.3-25 – Transmission scheme for IngressTrafficMon.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_INGRESS_TRAFFIC_MON |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.26 IngressTrafficMon.ind

This message shall be mapped to an LCMP_Notify.ind LCMP message with the following characteristics:

**Table E.3-26 – Transmission scheme for IngressTrafficMon.ind message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_INGRESS_TRAFFIC_IND |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.27 CycChange.req

This message shall be mapped to an LCMP_Control.req LCMP message with the following characteristics:

**Table E.3-27 – Transmission scheme for CycChange.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | MAC address of the node |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_CYCCHANGE |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.28  CycChange.cnf

This message shall be mapped to an LCMP_Ctrl.cnf LCMP message with the following characteristics:

**Table E.3-28 – Transmission scheme for CycChange.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_CYCCHANGE |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.29  EngineConf.req

This message shall be mapped to an LCMP_Control.req LCMP message with the following characteristics:

**Table E.3-29 – Transmission scheme for EngineConf.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_ENGINE_CONF |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.30  EngineConf.cnf

This message shall be mapped to an LCMP_Ctrl.cnf LCMP message with the following characteristics:

**Table E.3-30 – Transmission scheme for EngineConf.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_ENGINE_CONF |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.31  ClusterStop.req

This message shall be mapped to an LCMP_Control.req LCMP message with the following characteristics:

**Table E.3-31 – Transmission scheme for ClusterStop.req message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_CLUSTER_STOP |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.32  ClusterStop.cnf

This message shall be mapped to an LCMP_Ctrl.cnf LCMP message with the following characteristics:

**Table E.3-32 – Transmission scheme for ClusterStop.cnf message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the node |
| | Destination MAC | MAC address of the GM |
| | Transmission Type | Unicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_CLUSTER_STOP |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.33  KeepAlive.ind

This message shall be mapped to an LCMP_Notify.ind LCMP message with the following characteristics:

**Table E.3-33 – Transmission scheme for KeepAlive.ind message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_KEEP_ALIVE_IND |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.34  CycQueryExt.ind

This message shall be mapped to an LCMP_Notify.ind LCMP message with the following characteristics:

**Table E.3-34 – Transmission scheme for CycQueryExt.ind message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_CYCQUERY_EXT |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.35  CycQueryNotifExt.ind

This message shall be mapped to an LCMP_Notify.ind LCMP message with the following characteristics:

**Table E.3-35 – Transmission scheme for CycQueryNotifExt.ind message**

| | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
| | Destination MAC | Reserved MAC Address 01-19-A7-52-76-96 |
| | Transmission Type | Multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_CYCQUERYNOTIF_EXT |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

### E.3.36  AlignSyncLost.ind

This message shall be mapped to an LCMP_Notify.ind LCMP message with the following characteristics:

**Table E.3-36 – Transmission scheme for AlignSyncLost.ind message**

|  | Field | Value |
|---|---|---|
| **Addressing** | Originating MAC | MAC address of the GM |
|  | Destination MAC | Reserved MAC Address 01-19-A7-52-76-96 |
|  | Transmission Type | Multicast |
| **LCMP Control** | RequestType | 5 |
| **LCMPValue** | ParameterID(s) (Note) | VB_ALIGN_SYNCLOST |
| NOTE – See Tables E.4-1.1, E.4-1.2 and E.4-1.3 for a list of values for the field ParameterID. In write operations, LCMPValue also includes the ParameterValue field corresponding to the indicated parameter as described in Annex C. | | |

## E.4    ParameterIDs and corresponding ParameterValues used in Annex E

### E.4.1    List of ParameterIds

**Table E.4-1.1 – List of ParameterIds (Write/Read operation)**

| ParameterId | Parameter name | Associated ParameterValue definition |
|---|---|---|
| $00_{16}$-$0F_{16}$ | Reserved by ITU-T | Reserved by ITU-T |
| $10_{16}$ | VB_DOMAINMACS | See Table E.4-2.1 |
| $11_{16}$ | VB_MEASPLAN | See Table E.4-2.2 |
| $12_{16}$ to $14_{16}$ | Reserved by ITU-T | Reserved by ITU-T |
| $15_{16}$ | VB_PSD_SHAPE | See Table E.4-2.3 |
| $16_{16}$ | VB_ADD_INFO1 | See Table E.4-2.4 |
| $17_{16}$ | VB_CDTA | See Table E.4-2.5 |
| $18_{16}$ | VB_MACSEQNUM | See Table E.4-2.6 |
| $19_{16}$ to $FF_{16}$ | Reserved by ITU-T | Reserved by ITU-T |

**Table E.4-1.2 – List of ParameterIds (Control operation)**

| ParameterId | Parameter name | Associated ParameterValue definition |
|---|---|---|
| $00_{16}$-$10_{16}$ | Reserved by ITU-T | Reserved by ITU-T |
| $11_{16}$ | VB_MEASPLAN_CANCEL | See Table E.4-2.7 |
| $12_{16}$ | VB_MEASURE_BGN_C | See Table E.4-2.8 |
| $13_{16}$ | VB_MEASURE_CFR_AMP_C | See Table E.4-2.10 |
| $14_{16}$ | Reserved by ITU-T | Reserved by ITU-T |
| $15_{16}$ | VB_MEASURE_SNR_C | See Table E.4-2.12 |
| $16_{16}$ | VB_INGRESS_TRAFFIC_MON | See Table E.4-2.14 |
| $18_{16}$ | VB_ENGINE_CONF | See Table E.4-2.17 |
| $19_{16}$ | VB_CLUSTER_STOP | See Table E.4-2.18 |
| $1A_{16}$ to $FF_{16}$ | Reserved by ITU-T | Reserved by ITU-T |

**Table E.4-1.3 – List of ParameterIds (Notify operation)**

| ParameterId | Parameter name | Associated ParameterValue definition |
|---|---|---|
| $00_{16}$-$10_{16}$ | Reserved by ITU-T | Reserved by ITU-T |
| $11_{16}$ | VB_MEASURE_BGN_IND | See Table E.4-2.9 |
| $12_{16}$-$15_{16}$ | Reserved by ITU-T | Reserved by ITU-T |
| $16_{16}$ | VB_MEASURE_CFR_AMP_IND | See Table E.4-2.11 |
| $17_{16}$ | VB_CYCCHANGE | See Table E.4-2.16 |
| $18_{16}$ | VB_MEASURE_SNR_IND | See Table E.4-2.13 |
| $19_{16}$ | VB_INGRESS_TRAFFIC_IND | See Table E.4-2.15 |
| $1A_{16}$ | VB_KEEP_ALIVE_IND | See Table E.4-2.19 |
| $1B_{16}$ | VB_CYCQUERY_EXT | See Table E.4-2.20 |
| $1C_{16}$ | VB_CYCQUERYNOTIF_EXT | See Table E.4-2.21 |
| $1D_{16}$ | VB_ALIGN_SYNCLOST | See Table E.4-2.22 |
| $1E_{16}$ to $FF_{16}$ | Reserved by ITU-T | Reserved by ITU-T |

### E.4.2    ParameterValue definition

**Table E.4-2.1 – Format of VB_DOMAINMACS ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| DmMac | 1-6 | [47:0] | MAC of the DM |
| DmDid | 7 | [7:0] | DeviceID of the DM |
| ExtSeed | 8-9 | [15:0] | Extended seed used by the DM |
| NumEps | 10 | [7:0] | Number of nodes (N) associated to the DM |
| EpMac | 11-16 | [47:0] | MAC of the first node |
| EpDid | 17 | [7:0] | DeviceID of the first node |
| … | … | … | … |
| EpMac | var | [47:0] | MAC of the N-1$^{th}$ node |
| EpDid | var | [7:0] | DeviceID of the N-1$^{th}$ node |
| NetworkChange | Var | [0] | Network change flag. True if a change has occurred in the network since the last time this message was sent |
| Reserved | | [7:1] | Reserved by ITU-T (Note) |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table E.4-2.2 – Format of VB_MEASPLAN ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| MeasPlanID | 1 | [7:0] | Measurement Plan Id |
| CFR measure | Var | Var | Channel frequency response (CFR) measurements configuration. This field shall be formatted as specified in Table E.4-2.2.1 |
| BGN measure | Var | Var | Background noise measures configuration. This field shall be formatted as specified in Table E.4-2.2.2. |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table E.4-2.2.1 – Format of a CFR measurement field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| Measure configuration | 0-13 | [111:0] | Measurement configuration. This field shall be formatted as specified in Table E.4-2.2.1.1 |
| CFR device plans | 14-27 | [111:0] | CFR Measurement device #1 plan. This field shall be formatted as specified in Table E.4-2.2.1.2 |
| | 28-41 | [111:0] | CFR Measurement device #2 plan. This field shall be formatted as specified in Table E.4-2.2.1.2 |
| | … | … | … |

**Table E.4-2.2.1.1 – Format of a CFR measurement configuration field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| MeasureType | 0 | [7:0] | Measurement type. The value of this field is specified in Table E.4-2.2.1.1.1 |
| NumMeasure | 1-2 | [15:0] | Number of measurement plans |
| StorageType | 3 | [7:0] | Storage type |
| SymbolsNumber | 4 | [7:0] | Number of symbols |
| Time | 5 | [3:0] | Time averaging |
| Frequency | 5 | [7:4] | Frequency averaging |
| Offset | 6-9 | [31:0] | Offset inside MAC cycle to allocate time to perform measurements (in 10 ns units) |
| Duration | 10-13 | [31:0] | Duration of allocated time to perform measurements (in 10 ns units) |

**Table E.4-2.2.1.1.1 – Codes for Measurement Type**

| Code | Measurement Type |
|---|---|
| 0 | SNR |
| 1 | CFR module |
| 2 | CFR module-phase |
| 3-255 | Reserved by ITU-T |

**Table E.4-2.2.1.2 – Format of a CFR measurement device field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| StartSeqNumber | 0-1 | [15:0] | Sequence number (MAC cycle) to start measuring |
| EndSeqNumber | 2-3 | [15:0] | Last sequence number (MAC cycle) to measure |
| DeviceType | 4 | 0 | Node type of the transmitting<br>0 – DM ; 1 – EP |
| Reserved | 4 | [7:1] | Reserved by ITU-T (Note) |
| DevId | 5 | [7:0] | DeviceID of the node to measure |
| ExtSeed | 6-7 | [15:0] | Extended seed of the node to measure |
| MeasureDeviceMAC | 8-13 | [47:0] | REGID of the device to measure |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. ||||

**Table E.4-2.2.2 – Format of a BGN measurement field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| Measure configuration | 0-13 | [111:0] | Measurement configuration. This field shall be formatted as specified in Table E.4-2.2.1.1 |
| BGN device plans | 14-27 | [111:0] | BGN measurement device #1 plan. This field shall be formatted as specified in Table E.4-2.2.2.1 |
|  | 28-41 | [111:0] | BGN measurement device #2 plan. This field shall be formatted as specified in Table E.4-2.2.2.1 |
|  | … | … | … |

**Table E.4-2.2.2.1 – Format of an SNR measurement device plan field**

| Field | Octet | Bits | Description |
|---|---|---|---|
| StartSeqNumber | 0-1 | [15:0] | Sequence number (MAC cycle) to start measuring |
| EndSeqNumber | 2-3 | [15:0] | Last sequence number (MAC cycle) to measure |
| DeviceType | 4 | 0 | Transmitting Device type<br>0 – DM ; 1 – EP |
| Reserved | 4 | [7:1] | Reserved by ITU-T (Note) |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. ||||

**Table E.4-2.3 – Format of VB_PSD_SHAPE ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| seqNumber | 1-2 | [15:0] | Sequence number (MAC cycle) to apply the power spectral density (PSD) change |
| numDm | 3 | [7:0] | Number of domains described in this message (N) |
| macDm | 4-9 | [47:0] | MAC address of the first domain |
| numBands | 10-11 | [15:0] | Number of different segments (M) of the spectrum with different PSD attenuations for the first domain |

**Table E.4-2.3 – Format of VB_PSD_SHAPE ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| stopCarrier | 12-13 | [15:0] | Carrier index corresponding to the stop subcarrier of the first segment of the first domain for which this PSD attenuation information is applicable (Note) |
| attPSD | 14 | [7:0] | Attenuation in dB to be applied to the PSD for the first segment of the first domain |
| … | … | | … |
| stopCarrier | var | [15:0] | Carrier index corresponding to the stop subcarrier of the last segment of the first domain for which this PSD attenuation information is applicable (Note) |
| attPSD | var | [7:0] | Attenuation in dBs to be applied to the PSD for the last segment of the first domain |
| macDm | Var | [47:0] | MAC address of the last domain (N-1) |
| numBands | Var | [15:0] | Number of different segments (M) of the spectrum with different PSD attenuations for the last domain |
| stopCarrier | Var | [15:0] | Carrier index corresponding to the stop subcarrier of the first segment of the last domain for which this PSD attenuation information (#1) |
| attPSD | Var | [7:0] | Attenuation in dBs to be applied to the PSD for the first segment of the last domain |
| … | … | | … |
| stopCarrier | Var | [15:0] | Carrier index corresponding to the stop subcarrier of the last segment of the last domain for which the PSD level info (#N) |
| attPSD | Var | [7:0] | Attenuation in dBs to be applied to the PSD (#N) |
| NOTE – The PSD level is applied from the previous stop subcarrier + 1. The first segment starts at the first allowed subcarrier allowed for transmission. | | | |

**Table E.4-2.4 – Format of VB_AddInfo1 ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| MAC | 1-6 | [47:0] | MAC of the DM |
| Reserved | 7-16 | [79:0] | Reserved for HomeGrid Forum for firmware (FW) version |
| qosRate | 17-18 | [15:0] | Downstream / Upstream rate |
| maxLengthTxop | 19-20 | [15:0] | Maximum transmission opportunity duration |
| Reserved | 21-24 | [31:0] | Reserved by ITU-T (Note) |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table E.4-2.5 – Format of VB_CDTA ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| seqNumber | 1-2 | [15:0] | Sequence number (MAC cycle) to apply the changes |
| numDm | 3 | [7:0] | Number of domains (N) described in this message |
| qosRate | 4 | [7:0] | Downstream / Upstream rate to apply in the domain |
| defaultQosRate | 5 | [7:0] | Default Downstream / Upstream rate |
| forceChannelEstimation | 6 | [7:0] | 1: Forces a new channel estimation<br>0: do not force channel estimation |
| numBandsFirstPSD | 7 | [7:0] | PSD to apply when waiting for engine info before transmitting |
| nBoostBands | 8 | [7:0] | number of bands |
| bandCarrierDef | 9-28 | [159:0] | Bands definition:<br>Each position of this array conveys the last carrier of a band. |
| macDm | 29-34 | [47:0] | MAC address of the first domain |
| numBands | 35-36 | [15:0] | Number of defined bands (M) |
| phyRateUp | 37-40 | [31:0] | Max upstream data Rate when no other lines are transmitting, and full spectrum is allocated (Mbit/s) |
| phyRateDown | 41-44 | [31:0] | Max downstream data Rate when no other lines are transmitting, and full spectrum is allocated (Mbit/s) |
| stopCarrier | 45-46 | [15:0] | Carrier index corresponding to the stop of the PSD level info in the first band |
| attLevel | 47 | [7:0] | Attenuation in dBs to be applied to the PSD in the first band |
| … | … | | … |
| stopCarrier | Var | [15:0] | Carrier index corresponding to the stop of the PSD level info in the last band |
| attLevel | Var | [7:0] | Attenuation in dBs to be applied to the PSD in the last band (#M-1) |
| … | … | | … |
| macDm | Var | [47:0] | MAC address of the last domain |
| numBands | Var | [15:0] | Number of defined bands (M) |
| phyRateUp | Var | [31:0] | Max upstream data Rate when no other lines are transmitting, and full spectrum is allocated (Mbit/s) |
| phyRateDown | Var | [31:0] | Max downstream data rate when no other lines are transmitting, and full spectrum is allocated (Mbit/s) |
| stopCarrier | Var | [15:0] | Carrier index corresponding to the stop of the PSD level info in the first band |
| attLevel | Var | [7:0] | Attenuation in dBs to be applied to the PSD in the last band |
| … | … | | … |
| stopCarrier | Var | [15:0] | Carrier index corresponding to the stop of the PSD level info in the first band (#N) |
| attLevel | Var | [7:0] | Attenuation in dBs to be applied to the PSD in the last band |

**Table E.4-2.6 – Format of VB_MACSEQNUM ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| macSeqNum | 1-2 | [15:0] | Current sequence number (MAC cycle) |

**Table E.4-2.7 – Format of VB_MEASPLAN_CANCEL ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| MeasPlanID | 1 | [7:0] | Measurement plan identifier |

**Table E.4-2.8 – Format of VB_MEASURE_BGN_C ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| planID | 1 | [7:0] | Measurement plan identifier |
| type | 2 | [3:0] | Data type (See Table E.4-2.8.1) |
| data | 2 | [7:4] | Data format (See Table E.4-2.8.2) |

**Table E.4-2.8.1 – Format of Data Type field**

| Description | Value |
|---|---|
| MEASURE_FORMAT_FIXED_POINT | 0 |
| MEASURE_FORMAT_FLOAT | 1 |

**Table E.4-2.8.2 – Format of Data Type field**

| Description | Value |
|---|---|
| MEASURE_DB | 0 |
| MEASURE_LINEAR | 1 |

**Table E.4-2.9 – Format of VB_MEASURE_BGN_IND ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| MACMeasurer | 1-6 | [47:0] | REGID of the node doing the measurement |
| numCarriers | 7-8 | [15:0] | Number of measured subcarriers |
| nextMeasureCarrier Position | 9 | [7:0] | Inter spacing carrier index |
| validMeasure | | 0 | 1 valid, 0 otherwise |
| phyMedium | | [3:1] | Phoneline = 0, Powerline = 1 or Coaxial = 2 |
| mimoMeas | 10 | 4 | 1 if measurement is MIMO, 0 otherwise |
| mimoInd | | 5 | 1 the mode is MIMO, 0 otherwise |
| Reserved | | [7:6] | Reserved by ITU-T (Note) |
| rxg1Compensation | 11 | [7:0] | Compensation of AGC to be subtracted if needed (dB) |
| rxg2Compensation | 12 | [7:0] | Compensation of AGC to be subtracted if needed (dB) |
| firstCarrier | 13-14 | [15:0] | First carrier index |
| typeFormat | 15 | [3:0] | Out format type of BGN (0=fixed point, 1 float) |
| dataFormat | | [7:4] | Out format data of BGN (0=dB, 1 linear) |
| outFormatSize | 16 | [7:0] | Out format total length of each sample in bits |
| outFormatIntegerSize | 17 | [7:0] | Out format length of integer part in bits |
| measureSamples | Var | Var | Measurement samples, each element size depend on out format total length |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table E.4-2.10 – Format of VB_MEASURE_CFR_AMP_C ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| planID | 1 | [7:0] | Measurement plan identifier |
| type | 2 | [3:0] | Data type (See Table E.4-2.10.1) |
| data | 2 | [7:4] | Data format (See Table E.4-2.10.2) |
| MACMeasured | 3-8 | [47:0] | REGID of the node measured |

**Table E.4-2.10.1 – Format of Data Type field**

| Description | Value |
|---|---|
| MEASURE_FORMAT_FIXED_POINT | 0 |
| MEASURE_FORMAT_FLOAT | 1 |

**Table E.4-2.10.2 – Format of Data Type field**

| Description | Value |
|---|---|
| MEASURE_DB | 0 |
| MEASURE_LINEAR | 1 |

**Table E.4-2.11 – Format of VB_MEASURE_CFR_AMP_IND ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| ParameterId | 0 | [7:0] | VB_MEASURE_CFR_AMP_IND |
| MACMeasurer | 1-6 | [47:0] | MAC of measurer |
| MACMeasured | 7-12 | [47:0] | MAC of measured device |
| numCarriers | 13-14 | [15:0] | Number of measured carriers |
| nextMeasureCarrierPosition | 15 | [7:0] | Inter spacing carrier index |
| validMeasure | 16 | 0 | 1 valid, 0 otherwise |
| phyMedium | | [3:1] | Phone = 0, PLC = 1 or Coax = 2 |
| mimoMeas | | 4 | 1 if measurement is MIMO, 0 otherwise |
| mimoInd | | 5 | 1 if my mode is MIMO, 0 otherwise |
| Reserved | | [7:6] | Reserved by ITU-T (Note) |
| rxg1Compensation | 17 | [7:0] | Compensation of AGC to be subtracted if needed (dB) |
| rxg2Compensation | 18 | [7:0] | Compensation of AGC to be subtracted if needed (dB) |
| firstCarrier | 19-20 | [15:0] | First carrier index |
| typeFormat | 21 | [3:0] | Out format type of BGN (0=fixed point, 1 float) |
| dataFormat | | [7:4] | Out format data of BGN (0=dB, 1 linear) |
| outFormatSize | 22 | [7:0] | Out format total length of each sample in bits |
| outFormatIntegerSize | 23 | [7:0] | Out format length of integer part in bits |
| measureSamples | Var | Var | Measurement samples, each element size depend on out format total length |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table E.4-2.12 – Format of VB_MEASURE_SNR_C ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| type | 1 | [3:0] | Data type (see Table E.4-2.12.1) |
| freqAvg | | [7:4] | Frequency averaging (See Table E.4-2.12.2) |
| timeAvg | 2 | [3:0] | Time averaging |
| Reserved | | [7:4] | Reserved by ITU-T (Note) |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table E.4-2.12.1 – Format of Data Type field**

| Description | Value |
|---|---|
| MEASURE_FORMAT_FIXED_POINT | 0 |
| MEASURE_FORMAT_FLOAT | 1 |

**Table E.4-2.12.2 – Averaging table**

| Description | Value |
|---|---|
| The averaging requested is 1 | 0 |
| The averaging requested is 2 | 1 |
| The averaging requested is 4 | 2 |
| The averaging requested is 8 | 3 |
| The averaging requested is 16 | 4 |
| The averaging requested is 32 | 5 |
| The averaging requested is 64 | 6 |

**Table E.4-2.13 – Format of VB_MEASURE_SNR_IND ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| MACMeasurer | 1-6 | [47:0] | MAC of measurer |
| numCarriers | 7-8 | [15:0] | Number of measured carriers |
| nextMeasureCarrierPosition | 9 | [7:0] | Inter spacing carrier index |
| validMeasure | 10 | 0 | 1 valid, 0 otherwise |
| phyMedium | | [3:1] | Phoneline = 0, Powerline = 1 or Coaxial = 2 |
| mimoMeas | | 4 | 1 if measurement is MIMO, 0 otherwise |
| mimoInd | | 5 | 1 if my mode is MIMO, 0 otherwise |
| Reserved | | [7:6] | Reserved by ITU-T (Note) |
| rxg1Compensation | 11 | [7:0] | Compensation of AGC to be subtracted if needed (dB) |
| rxg2Compensation | 12 | [7:0] | Compensation of AGC to be subtracted if needed (dB) |
| firstCarrier | 13-14 | [15:0] | First carrier index |
| outFormatSize | 15 | [7:0] | Out format total length of each sample in bits |
| outFormatIntegerSize | 16 | [7:0] | Out format length of integer part in bits |
| measureSamples | Var | Var | Measurement samples, each element size depend on out format total length |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table E.4-2.14 – Format of VB_INGRESS_TRAFFIC_MON ParameterValue**

| Field | Octet | Bits | Description |
|-------|-------|------|-------------|
| threshold | 1-2 | [15:0] | DM shall send a notification message when desiredChannelCapacity changes above this threshold (in Mbit/s) from previous reported value. |
| measWin | 3-4 | [15:0] | Time interval used to measure ingress traffic (in ms). It shall be rounded to a multiple of MAC cycle duration. |
| period | 5-6 | [15:0] | Time interval used to send periodic traffic reports. It shall be rounded to a multiple of MAC cycle duration internally. If it is set to 0, periodic reports will be disabled. If periodic traffic reports are enabled, MeasWindow field shall be omitted. |
| timeout | 7-8 | [15:0] | After sending a traffic report, DMs wait for a new resources distribution from VB engine. If there is no response from the VB engine in *timeout* ms, the traffic report shall be resent. If periodic traffic reports are enabled or *timeout* is set to 0, the *timeout* is disabled meaning that DMs do not expect any response from the VB engine. |

**Table E.4-2.15 – Format of VB_INGRESS_TRAFFIC_IND ParameterValue**

| Field | Octet | Bits | Description |
|-------|-------|------|-------------|
| trafficPrio0 | 1-2 | [15:0] | Estimated ingress traffic with priority 0 (in Mbit/s) |
| trafficPrio1 | 3-4 | [15:0] | Estimated ingress traffic with priority 1 (in Mbit/s) |
| trafficPrio2 | 5-6 | [15:0] | Estimated ingress traffic with priority 2 (in Mbit/s) |
| trafficPrio3 | 7-8 | [15:0] | Estimated ingress traffic with priority 3 (in Mbit/s) |
| maxBuffPrio0 | 9 | [7:0] | Maximum buffer usage for priority 0 (in %) |
| maxBuffPrio0 | 10 | [7:0] | Maximum buffer usage for priority 0 (in %) |
| maxBuffPrio0 | 11 | [7:0] | Maximum buffer usage for priority 0 (in %) |
| maxBuffPrio0 | 12 | [7:0] | Maximum buffer usage for priority 0 (in %) |
| channelCapacity | 13-14 | [15:0] | Channel capacity based on the bps estimated by the node (in Mbit/s) |
| effectiveChannel Capacity | 15-16 | [15:0] | Effective channel capacity (taking into account overheads and tx time) (in Mbit/s) |
| desiredChannelC apacity | 17-18 | [15:0] | Desired channel capacity based on the ingress traffic of the node (in Mbit/s) |
| macEfficiency | 19 | [7:0] | MAC efficiency (in %) |
| numBpsBands | 20-21 | [15:0] | Number of reporting bands (N) |
| bpsBands | Var | Var | PHY rate for the first band (in Mbit/s) |
| … | … | … | … |
| bpsBands | Var | Var | PHY rate for the last band band (N) (in Mbit/s) |

**Table E.4-2.16 – Format of VB_CYCCHANGE ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| clockEdge | 1 | [7:0] | 1: Change current sync clock edge;<br>0: Maintain current sync clock edge |
| seqNumOffset | 2-3 | [15:0] | Offset to be added to current sequence number to sync with other DMs in the cluster |

**Table E.4-2.17 – Format of VB_ENGINE_CONF ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| alignMode | 1 | [7:0] | Alignment mode:<br>0 – common clock;<br>1 – g.hn |
| DMMAC | 2-7 | [47:0] | Reference node MAC address |
| refDid | 8 | [7:0] | Reference node device Id |
| macCycle | 9-12 | [31:0] | MAC Cycle duration (in units of 10 ns) |
| absOffset | 13 | [7:0] | Shows if IDSync frames location is related to a downstream slot or it is an absolute value |
| syncFrmOffset | 14-17 | [31:0] | Location of sync frames in the MAC cycle |
| maxDurSyncFrm | 18-21 | [31:0] | Maximum duration of sync frames (in units of 10 ns) |
| clusterId | 22-25 | [31:0] | Cluster identifier |
| tmpMacCycleDur ExtraTime | 26-29 | [31:0] | Number of extra Mac cycle ticks (in units of 10 ns) to be temporarily added to the MAC cycle |
| numCyclesApply ExtraTime | 30 | [7:0] | Number of cycles to apply the tmpMacCycleDurExtraTime |
| numRelays | 31 | [7:0] | Number of synchronization relays |
| numSeeds | 32-33 | [15:0] | Number of seeds to be assigned (M) |
| defaultRate | 34 | [7:0] | Default Qos Rate to use first when connection with engine is lost |
| currentRate | 35 | [7:0] | Current Qos Rate to use upon reception of this message |
| numBandsFirstPSD | 36 | [7:0] | PSD to apply first when waiting for engine info before transmitting |
| nBoostBands | 37 | [7:0] | Number of potential boosted bands (N) |
| boostBandLastCarrier #1 | 38-39 | [15:0] | definition of band #1: the last carrier of this band. |
| … | | | … |
| boostBandLastCarrier #N | Var | | definition of band #N: the last carrier of this band. |
| relayMAC #1 | Var | [47:0] | MAC address of sync relay for the first band |
| deviceId #1 | Var | [7:0] | Device Id of sync relay for the first band |
| syncFrmOffset #1 | Var | [31:0] | Offset to transmit sync frame for relay for the first band |
| duration #1 | Var | [31:0] | Duration of the sync TXOP (in 10 ns units) for relay for the first band |

**Table E.4-2.17 – Format of VB_ENGINE_CONF ParameterValue**

| … | | | … |
|---|---|---|---|
| relayMAC #N | Var | [47:0] | MAC address of sync relay for the last band |
| deviceId #N | Var | [7:0] | Device Id of sync relay for the last band |
| syncFrmOffset #N | Var | [31:0] | Offset to transmit sync frame for relay for the last band |
| duration #N | Var | [31:0] | Duration of the sync TXOP (in 10 ns units) for relay for the last band |
| dmMAC #1 | Var | [47:0] | MAC address of the first Domain Master that shall apply the given seed and DID |
| dmSeed #1 | Var | [15:0] | Seed to be applied by the first DM |
| did #1 | Var | [15:0] | DeviceID to be used by the first DM |
| … | | | … |
| dmMAC #M | Var | [47:0] | MAC address of the last Domain Master that shall apply the given seed and DID |
| dmSeed #M | Var | [15:0] | Seed to be applied by the last DM |
| did #N | Var | [15:0] | DeviceID to be used by the last DM |

**Table E.4-2.18 – Format of VB_CLUSTER_STOP ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| stopTxFlag | 1 | [7:0] | 1: Cancel ongoing measurement plan and Stop transmissions; 0: Do not stop transmissions |

**Table E.4-2.19 – Format of VB_KEEP_ALIVE_IND ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| driverState | 1 | [7:0] | VB driver state |
| engineState | 2 | [7:0] | VB engine state |
| Reserved | 3-4 | [15:0] | Reserved by ITU-T (Note) |
| period | 5-6 | [15:0] | Number of MAC cycles to send each keep alive message |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table E.4-2.20 – Format of VB_CYCQUERY_EXT ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| aeMac | 1-6 | [47:0] | MAC address to send the CycQuery result |
| resetStats | 7 | [0] | Reset sync statistics |
| Reserved | | [7:1] | Reserved by ITU-T (Note) |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table E.4-2.21 – Format of VB_CYCQUERYNOTIF_EXT ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| ParameterId | 0 | [7:0] | VB_CYCQUERYNOTIF_EXT |
| seqNum | 1-2 | [15:0] | Sequence number (MAC Cycle) |
| macClock | 3-6 | [31:0] | MAC Clock (in 10 ns units) |
| refUnitFlag | 7 | [0] | Reference unit flag:<br>1: This node is reference unit<br>0: otherwise |
| Reserved | | [7:1] | Reserved by ITU-T (Note) |
| nodeMac | 8-13 | [47:0] | Node MAC address |
| syncDetDid #0 | 14-17 | [7:0] | Detected Device Id (idx #0) |
| Reserved | | [31:8] | Reserved by ITU-T (Note) |
| hitCount #0 | 18-21 | [31:0] | Number of detections (idx #0) |
| reliability #0 | 22-25 | [31:0] | Reliability: number of MAC cycles without detecting this node (idx #0) |
| adcOutRms #0 | 26-29 | [31:0] | Rx power (idx #0) |
| … | | | … |
| syncDetDid #4 | 78-81 | [7:0] | Detected Device Id (idx #4) |
| Reserved | | [31:8] | Reserved by ITU-T (Note) |
| hitCount #4 | 82-85 | [31:0] | Number of detections (idx #4) |
| reliability #4 | 86-89 | [31:0] | Reliability: number of MAC cycles without detecting this node (idx #4) |
| adcOutRms #4 | 90-93 | [31:0] | Rx power (idx #4) |
| NOTE – Bits that are reserved shall be set to zero by the transmitter and ignored by the receiver. | | | |

**Table E.4-2.22 – Format of VB_ALIGN_SYNCLOST ParameterValue**

| Field | Octet | Bits | Description |
|---|---|---|---|
| syncDid | 1 | [7:0] | DeviceID lost |

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