Recommendation

ITU-T G.9962 (2018) Amd. 2 (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
Amendment 2

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Recommendation ITU-T G.9962

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

Amendment 2

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
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3.2	ITU-T G.9962 (2018) Amd. 1	2020-07-07	15	11.1002/1000/14225
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Keywords

G.hn; Management; LCMP; Data model;

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

Amendment 2

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 (2019), *Unified high-speed wire-line based home networking transceivers – System architecture and physical layer specification*.

[ITU-T G.9961]   Recommendation ITU-T G.9961 (2019), *Unified high-speed wire-line based home networking transceivers – Data link layer specification*.

[ITU-T G.9963]   Recommendation ITU-T G.9963 (2019), *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*[1].

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

C-NDIM Centralized NDIM

AGC   Automatic Gain Control

BGN   Background Noise

CFR   Channel Frequency Response

DLL   Data Link Layer

DM   Domain Master

DME   DLL Management Entity

DMME   Domain Master Management Entity

FW   Firmware

GM   Global Master

GME   Global Master Entity

LCMP   Layer 2 Configuration and Management Protocol

LLC   Logical Link Control

LSB   Least Significant Bit

MCS   Management, Control and Security

MIMO Multiple Input; Multiple Output

MSB   Most Significant Bit

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

NME   Node Management Entity

NMS   Network Management System

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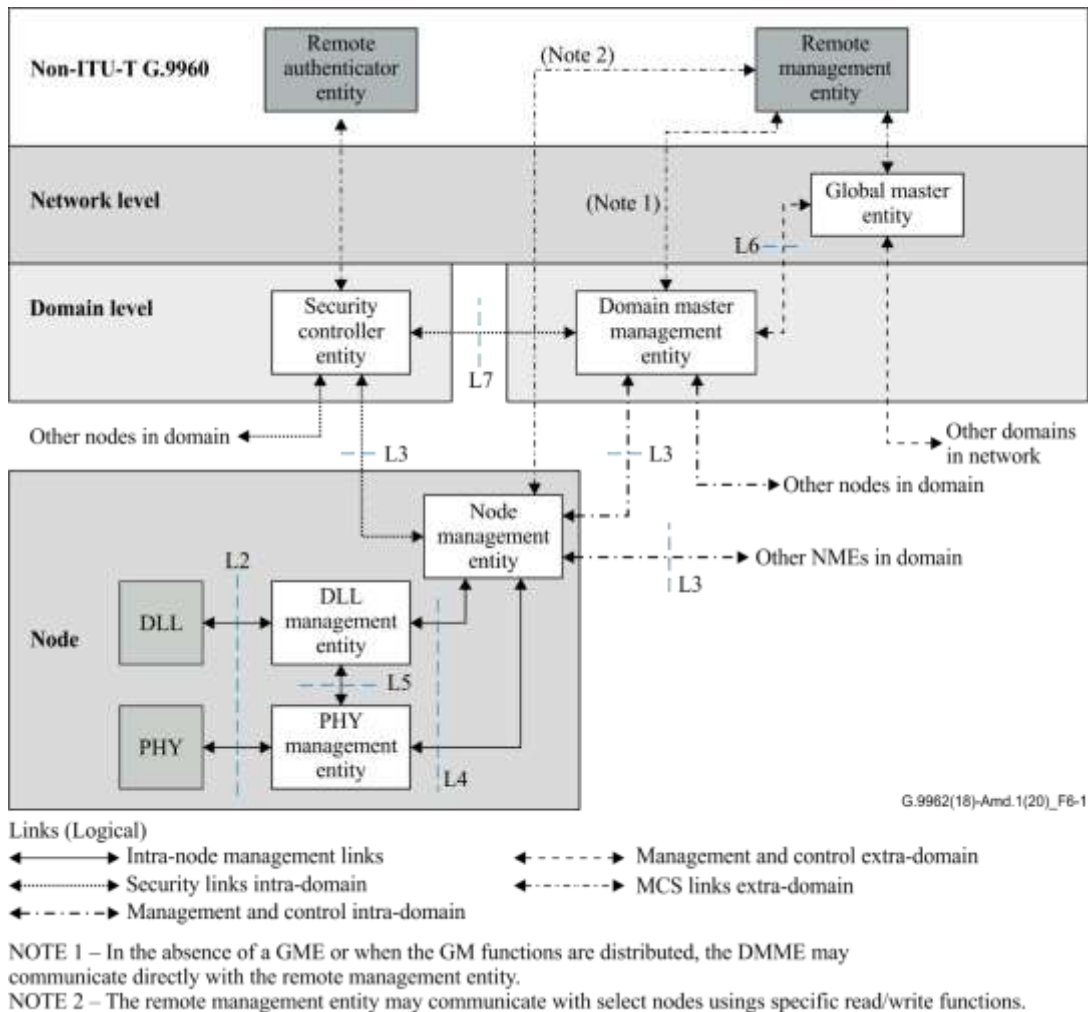
Figure 6-1 – Architecture of management, control and security

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 LCMP protocol (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].
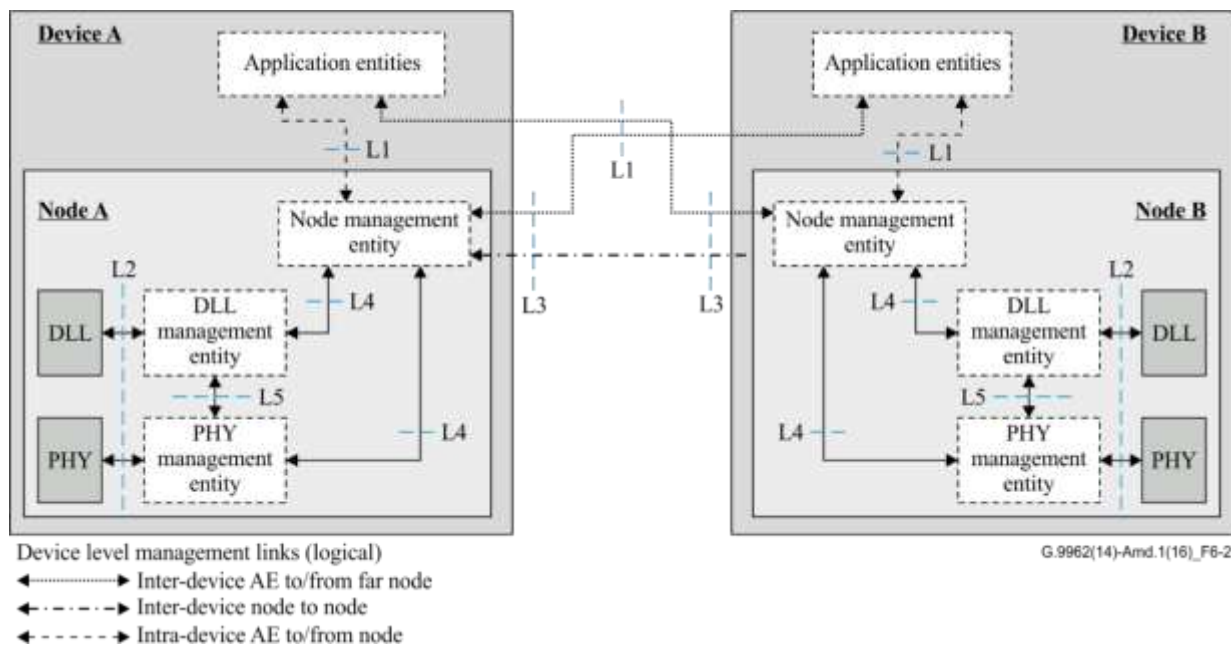
Figure 6-2 – Device level management links

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 L$_1$ 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 L$_7$ 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].
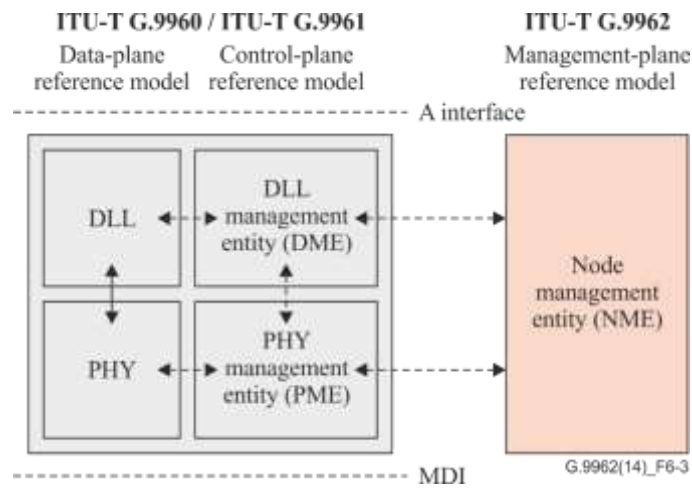
Figure 6-3 – ITU-T G.9962 reference model

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 of 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]).
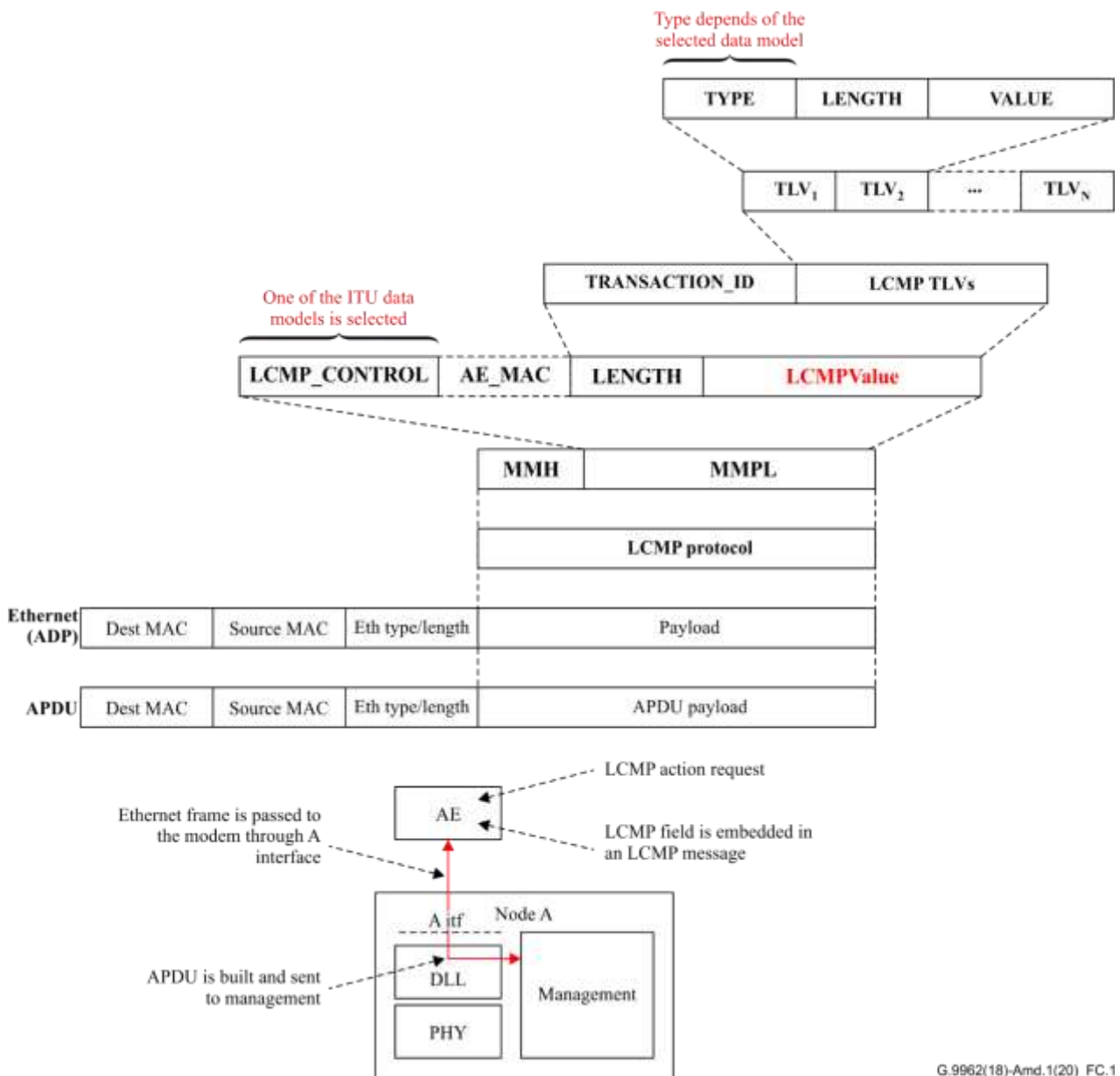
Figure C.1 – Encapsulation of LCMPValue field

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.
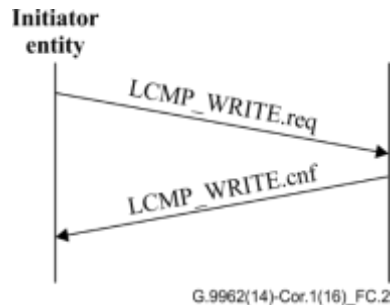
Figure C.2 – LCMP WRITE action

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
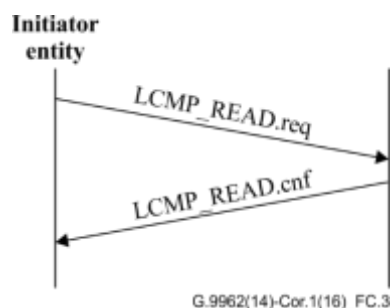
Figure C.3 – READ action

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
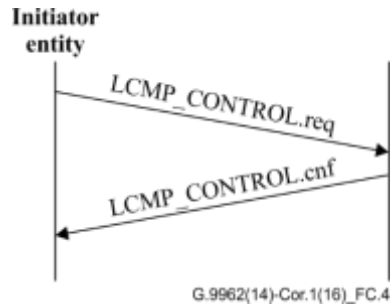
Figure C.4 – CONTROL action

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
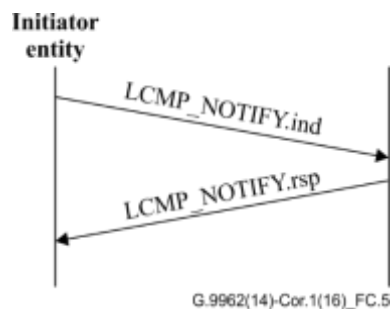
Figure C.5 – NOTIFY action

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 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. 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: • Annex A in the case of accessing the L1 interface data model

Field	Octet	Bits	Description
			• 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: • Annex A in the case of accessing L1 interface data model • 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: • Annex A in the case of accessing L1 interface data model • 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: • Annex A in the case of accessing L1 interface data model • Annex B in the case of accessing L6 interface data
ControlValue	1	Variable	This field is parameter-dependent and shall be filled according to: • Annex A in the case of accessing L1 interface data model • 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: • Annex A in the case of accessing L1 interface data model • Annex B in the case of accessing L6 interface data
NotifyValue	1	Variable	This field is parameter-dependent and shall be filled according to: • Annex A in the case of accessing L1 interface data model • 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
…	…	…	…
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
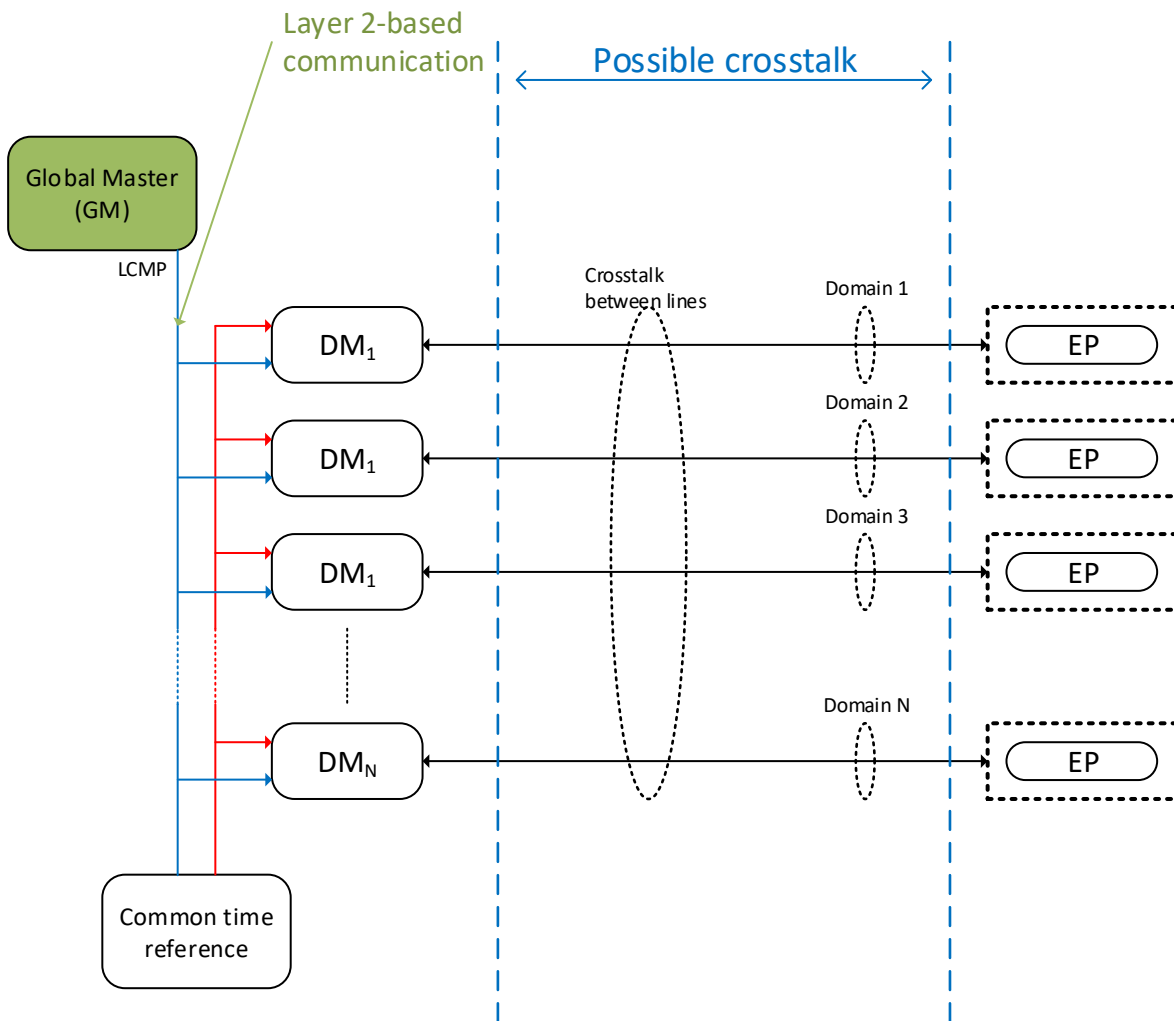
Figure E-1 – Management of interference between domains using centralized coordination

The domains shown in Figure E-1 operate independently and define their own scheduling for the access to 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.2.2 C-NDIM protocol exchanges

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 section 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-3.2 – 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-3.3 – 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-3.4 – 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-3.5 – 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_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-3.6 – 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-3.7 – 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-3.8 – 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-3.9 – 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-3.10 – 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-3.11 – 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-3.12 – 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-3.13 – 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-3.14 – 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-3.15 – 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_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-3.16 – Transmission scheme for MeasBgNoise.req 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-3.17 – Transmission scheme for MeasBgNoise.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-3.18 – 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-3.19 – Transmission scheme for MeasCfrAmp.req 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-3.20 – 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-3.21 – 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_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-3.22 – 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-3.23– 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-3.24 – 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-3.25 – 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_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-3.26 – 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-3.27 – 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-3.28 – 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-3.29 – 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-3.30 – 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-3.31 – 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-3.32 – 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-3.33 – 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-3.34 – 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-3.35 – 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-1th node
EpDid	var	[7:0]	DeviceID of the N-1th 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]	Measure Plan Id
CFR Measure	Var	Var	CFR Measures 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]	Measure configuration. This field shall be formatted as specified in Table 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]	Measure type. The value of this field is specified in Table E-4.2.2.1.1.1
NumMeasure	1-2	[15:0]	Number of measure plans
StorageType	3	[7:0]	Storage type
SymbolsNumber	4	[7:0]	Number of symbols
Time	5	[3:0]	Time averaging
Frecuency	5	[7:4]	Frequency averaging
Offset	6-9	[31:0]	Offset inside MAC cycle to allocate time to perform measures (in 10ns units)
Duration	10-13	[31:0]	Duration of allocated time to perform measures (in 10ns units)

Table E-4.2.2.1.1.1 – Codes for Measure Type

Code	Measure 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 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 an SNR Measurement field

Field	Octet	Bits	Description
Measure configuration	0 - 13	[111:0]	Measure configuration. This field shall be formatted as specified in Table 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 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 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
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	13	[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 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 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: 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 (MBits)
phyRateDown	41-44	[31:0]	Max downstream data Rate when no other lines are transmitting, and full spectrum is allocated (MBits)
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 (MBits)
phyRateDown	Var	[31:0]	Max downstream data Rate when no other lines are transmitting and full spectrum is allocated (MBits)
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]	Measure plan identifier

Table E-4.2.8 – Format of VB_MEASURE_BGN_C ParameterValue

Field	Octet	Bits	Description
planID	1	[7:0]	Measure 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
nextMeasureCarrierPosition	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 measure 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	Measure 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]	Measure 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 measure 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	Measure 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 (See 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_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 measure 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	Measure 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 Mbps) 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 Mbps)
trafficPrio1	3-4	[15:0]	Estimated ingress traffic with priority 1 (in Mbps)
trafficPrio2	5-6	[15:0]	Estimated ingress traffic with priority 2 (in Mbps)
trafficPrio3	7-8	[15:0]	Estimated ingress traffic with priority 3 (in Mbps)
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 Mbps)
effectiveChannel Capacity	15-16	[15:0]	Effective channel capacity (taking into account overheads and tx time)(in Mbps)
desiredChannelC apacity	17-18	[15:0]	Desired channel capacity based on the ingress traffic of the node (in Mbps)
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 MBps)
…	…	…	…
bpsBands	Var	Var	PHY rate for the last band band (N) (in MBps)

Table E-4.2.16 – Format of VB_CYCCHANGE ParameterValue

Field	Octet	Bits	Description
clockEdge	1	[7:0]	1: Change current sync clock edge; 0: Maintain current sync clock edge
seqNumOffset	2-3	[15:0]	Offset to be added to current sequence number to sync with others 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: 0 - common clock; 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 10ns)
clusterId	22-25	[31:0]	Cluster identifier
tmpMacCycleDurExtraTime	26-29	[31:0]	Number of extra Mac cycle ticks (in units of 10 ns) to be temporarily added to the MAC cycle
numCyclesApplyExtraTime	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 10ns units) for relay for the first band
…			…
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 10ns 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

Table E-4.2.17 – Format of VB_ENGINE_CONF ParameterValue

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 measure 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 10ns units)
refUnitFlag	7	[0]	Reference unit flag: 1: This node is reference unit 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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