International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.9962

(07/2013)

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

Recommendation ITU-T G.9962

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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.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G.9962	2013-07-12	15	11.1002/1000/11901
1.1	ITU-T G.9962 (2013) Amd.1	2013-08-29	15	11.1002/1000/12005

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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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 common management parameters and protocols for all ITU-T G.996x-series Recommendations. More specifically, this Recommendation includes the following:

– architecture and reference model for the management layer;

– management parameters aligned with the data model objects defined in [b-ITU-T G.9980], [b-BBF TR-069] and [b-BBF TR-181 I2A6] for transparent integration with remote management functionality;

– management protocols necessary for device configuration, status and performance management, fault monitoring, and diagnostics and security; and

– global master (GM) functionality that facilitates coordination of multiple ITU-T G.9960/1 domains.

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 (2011), *Unified high-speed wireline-based home networking transceivers – System architecture and physical layer specification*.

[ITU-T G.9961] Recommendation ITU-T G.9961 (2010), *Unified high-speed wire-line based home networking transceivers – Data link layer specification*.

[ITU-T G.9963] Recommendation ITU-T G.9963 (2011), *Unified high-speed wireline-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*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 bandplan [ITU-T G.9960]: A specific range of the frequency spectrum that is associated with a domain. Multiple bandplans may be used in the same domain provided that each bandplan used is a subset of the largest bandplan specified for the domain and a superset of the smallest bandplan specified for the domain. The bandplan is defined by a lower frequency and upper frequency except for RF, which is defined by a bandwidth and centre frequency.

3.1.2 broadcast [ITU-T G.9960]: A type of communication where a node sends the same frame simultaneously to all other nodes in the home network or in the domain.

3.1.3 client [ITU-T G.9961]: An application entity distinguished in the network by its unique address (e.g., MAC address).

3.1.4 DEVICE_ID [ITU-T G.9960]: A unique identifier allocated to a node operating in the domain by the domain master during registration.

3.1.5 domain [ITU-T G.9961]: A part of an ITU-T G.9960/1 home network comprising the domain master and all those nodes that are registered with the same domain master. In the context of this Recommendation, use of the term 'domain' without a qualifier means 'G.9960/1 domain', and use of the term 'alien domain' means 'non-ITU-T G.9960/1 domain'. Additional qualifiers (e.g., 'power-line') may be added to either 'domain' or 'alien domain'.

3.1.6 domain ID [ITU-T G.9960]: A unique identifier of a domain.

3.1.7 domain master (DM) [ITU-T G.9961]: A node that manages (coordinates) all other nodes of the same domain (i.e., assigns bandwidth resources and manages user priorities). A node with domain master capabilities has all the capabilities of an endpoint node and may act as a relay node.

3.1.8 domain name: A 32-byte domain identifier assigned by the user for admission of nodes to the particular domain.

3.1.9 endpoint node [ITU-T G.9961]: This term is used in this Recommendation according to the context to differentiate between the domain master node functionalities and non-domain master node functionalities.

3.1.10 global master (GM) [ITU-T G.9960]: 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.

3.1.11 home network [ITU-T G.9960]: Two or more nodes that can communicate with each other either directly or through a relay node at the physical layer, or through an inter-domain bridge above the physical layer. A home network consists of one or more domains. In the context of this Recommendation, use of the term "home network" means "ITU-T G.9960 home network". Use of the term "alien home network" means "non-ITU-T G.9960 home network". Use of the term "network" without a qualifier means any combination of "ITU-T G.9960 home network", "non-ITU-T G.9960 home network" and "access network". Use of the term "alien network" means any combination of "non-ITU-T G.9960 home network" and "access network".

3.1.12 logical (functional) interface [ITU-T G.9960]: An interface in which the semantic, syntactic, and symbolic attributes of information flows are defined. Logical interfaces do not define the physical properties of signals used to represent the information. It is defined by a set of primitives.

3.1.13 medium [ITU-T G.9960]: A wire-line facility, of a single wire class, allowing physical connection between nodes. Nodes connected to the same medium may communicate on the physical layer, and may interfere with each other unless they use orthogonal signals (e.g., different frequency bands, different time periods).

3.1.14 multicast [ITU-T G.9960]: A type of communication where a node sends the same frame simultaneously to one or more other nodes in the home network.

3.1.15 node [ITU-T G.9960]: Any network device that contains an ITU-T G.9960 transceiver. In the context of this Recommendation, use of the term "node" without a qualifier means "ITU-T G.9960 node", and use of the term "alien node" means "non-ITU-T G.9960 node". Additional qualifiers (e.g., "relay") may be added to either "node" or "alien node".

3.1.16 reference point [ITU-T G.9960]: A location in a signal flow, either logical or physical, that provides a common point for observation and/or measurement of the signal flow.

3.1.17 registration [ITU-T G.9960]: The process used by a node to join the domain.

3.1.18 sub-carrier (OFDM sub-carrier) [ITU-T G.9960]: The centre frequency of each orthogonal frequency division multiplexing (OFDM) sub-channel onto which bits may be modulated for transmission over the sub-channel.

3.1.19 throughput [ITU-T G.9960]: The amount of data transferred from the A-interface of a source node to the A-interface of a destination node over some time interval, expressed as the number of bits per second.

3.1.20 unicast [ITU-T G.9960]: A type of communication where a node sends a frame to another single node.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 ITU-T G.996x: The family of Recommendations comprised by ITU-T G.9960, ITU-T G.9961, ITU-T G.9963 and ITU-T G.9964.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Alternating Current
ACS	Auto-Configuration Server
AE	Application Entity
APDU	Application Protocol Data Unit
CRC	Cyclic Redundancy Check
DLL	Data Link Layer
DM	Domain Master
DME	DLL Management Entity
DMME	Domain Master Management Entity
DNI	Domain Name Identifier
DOD	Domain identifier
GM	Global Master
GME	Global Master Entity
LCDU	Link Control Data Unit
LFH	Logical link control Frame Header
LLC	Logical Link Control
LPCS	Logical link control Protocol data unit Check Sequence
LPDU	Logical link control Protocol Data Unit
LPH	Logical link control Protocol data unit Header
LSB	Least Significant Bit
MCS	Management, Control and Security

MIC	Message Integrity Code
MPDU	Media access control Protocol Data Unit
MSB	Most Significant Bit
NME	Node Management Entity
NMK	Network Membership Key
NMS	Network Management System
NN	Node-to-Node
PHY	Physical
PME	PHY Management Entity
PMI	Physical Medium-independent Interface
REGID	Registration Identifier
RF	Radio Frequency
SC	Security Controller
SCE	Security Controller Entity
SM	Sub-carrier Mask
SOAP	Simple Object Access Protocol

5 Conventions

5.1 Bit ordering convention

A block of data composed of multiple octets shall be ordered by octet numbers in ascending order: 'octet 0' for the first octet, 'octet 1' for the second octet, and so on. If a block of data is segmented into multiple fields, the size of each field shall be expressed in terms of bits. The field is not necessarily an integer number of octets. The location of each field within a block of data shall be described as follows:

- The octets of an N-octet data block are ordered with numbers from 0 (first octet) to N–1 (last octet).
- The block is divided into non-overlapping groups of octets. Each group contains an integer number of consecutive octets, numbered from J to J+V–1, where V is the size of the group, and is described as a bit string with 'bit 0', the LSB of the octet with the smallest number (J), and 'bit (8×V–1)', the MSB of the octet with the largest number (J+V–1).
- Each group is divided into one or more fields, where the boundaries of each field are determined by the LSB and the MSB of the bits of the group that contains this field.

Any block of data or part of it shall be passed over the protocol stack with the octet having the smallest number, i.e., octet 0 shall be the first octet of the block to be passed. Within each group of octets, LSB (bit 0), of each octet shall be passed first.

Table 5-1 shows an example of a field description used throughout this Recommendation. The 'Octet' column represents the octet numbers for a group of octets to which a specific field belongs, and the 'Bits' column represents the bit location within this group of octets. In the presented example, there are 4 groups of octets:

- Group 1 = Octet 0, fields A, B, C, D
- Group 2 = Octets 1 and 2, fields E, F

- Group 3 = Octet 3, field G
- Group 4 = Octets 4 to 7, field H.

Figure 5-1 illustrates a mapping of these fields onto corresponding octets based on the example given in Table 5-1.

Table 5-1 – An example of field description

Field	Octets	Bits	Description
A	0	[2:0]	…
B		[3]	…
C		[4]	…
D		[7:5]	…
E	1 to 2	[1:0]	…
F		[15:2]	…
G	3	[7:0]	…
H	4 to 7	[31:0]	…

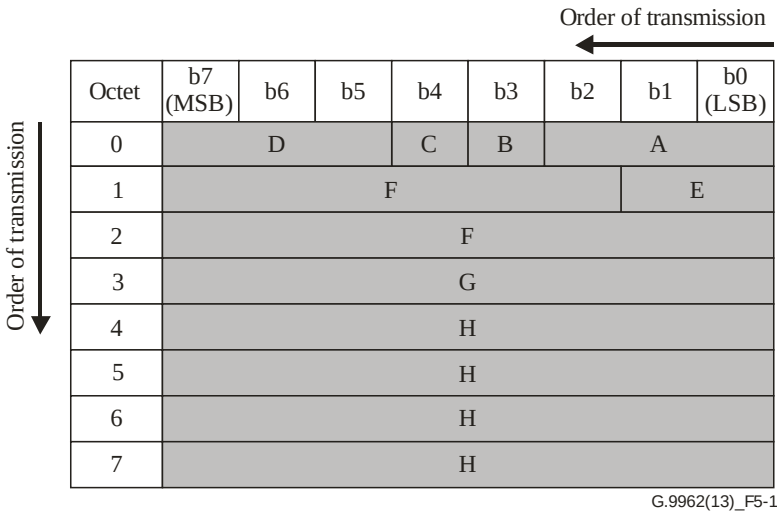


Figure 5-1 – An example of mapping fields onto groups of octets

5.2 Reserved fields and values

The entire or part of the field reserved by ITU-T shall be set to zero by the transmitter and ignored by the receiver. Values of the field that are reserved by ITU-T shall not be used.

6 Architecture and reference model

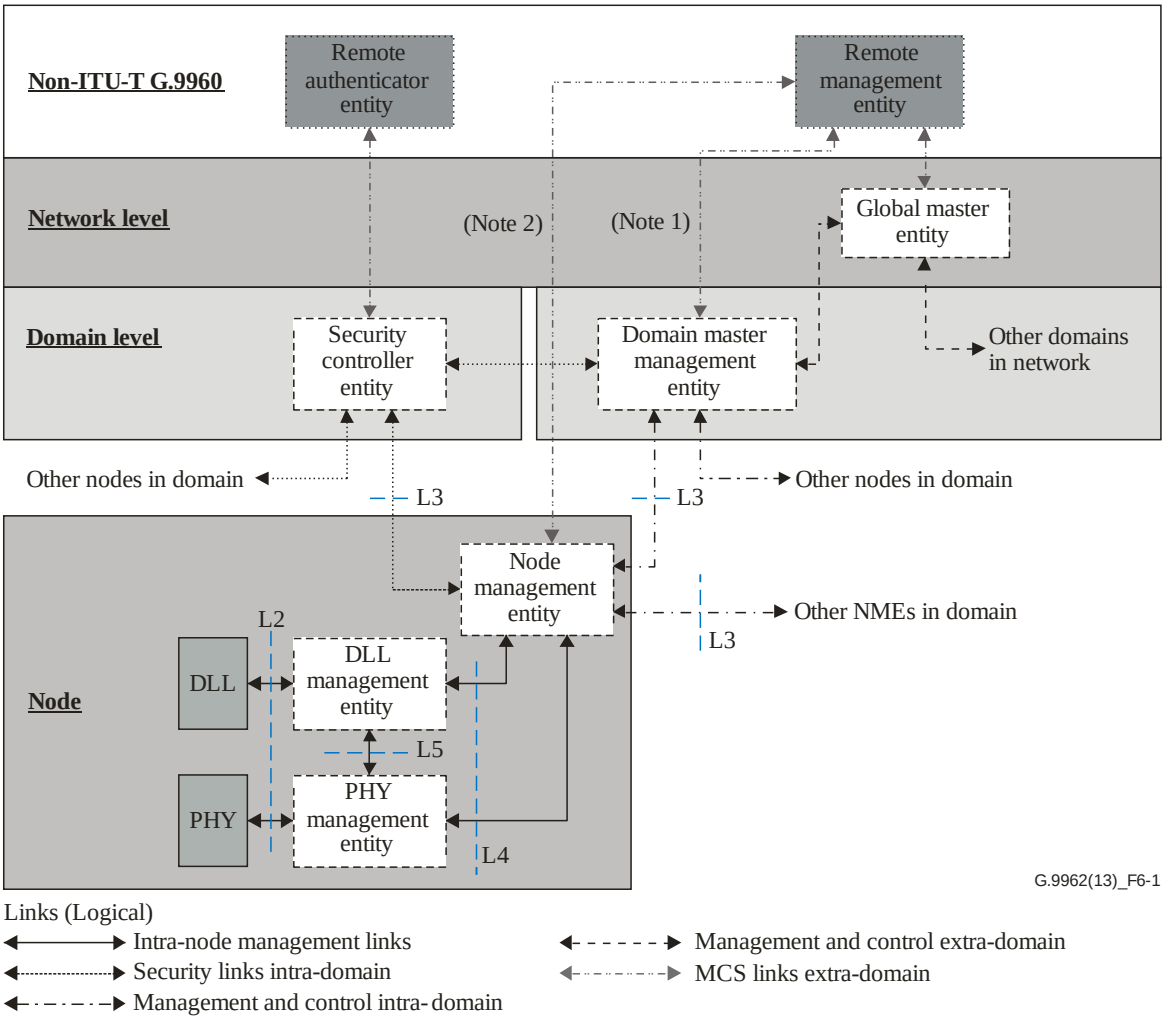
6.1 Architecture

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 entities manage and control their specific areas of responsibility (e.g., security for the SCE) within the domain. The two entities are still within Layer 2, as they are solely functioning to facilitate Layer 2 activities. The 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 SC and the GM or, in its absence the DM, are considered to be non-ITU-T G.9960 entities and are 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 the scope of [ITU-T G.9960]. The internal operation and structure of the SC is also out of scope, only its operations facing into the domain are within the scope of [ITU-T G.9960], e.g., operations as represented by its messaging and functions as described in clauses 8 and 9 of [ITU-T G.9961].



NOTE 1 – In the absence of a GME or when the GM functions are distributed, the DMME may communicate directly with the Remote Management entity.

NOTE 2 – The Remote Management entity may communicate with select nodes using specific read/write functions:

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. Nodes may exchange management and control messages between NMEs to facilitate communications between nodes. 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].

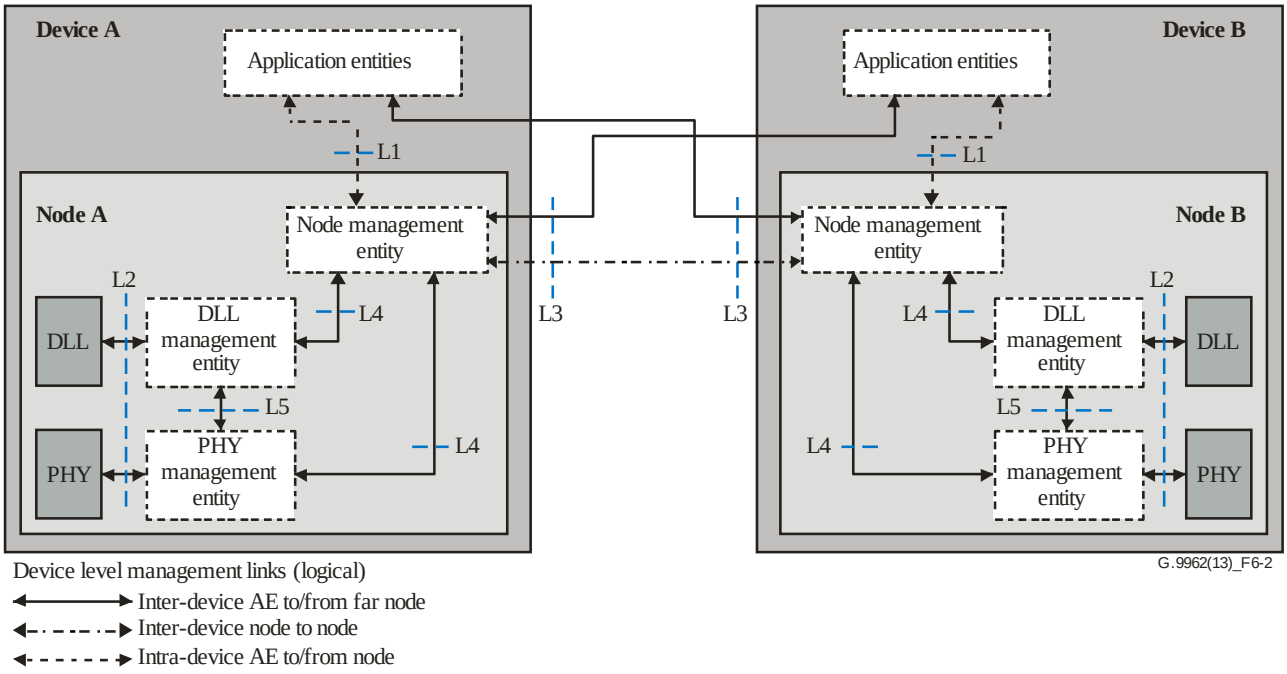


Figure 6-2 – Device level management links

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 interact for the management of the 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

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

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.

6.1.2.4 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.

6.1.2.6 Note regarding DMME and GME communications

While it may occur with certain implementations that the DMME and GME are located within the same physical device, there still remains the need to pass messages between these entities. The formats of these intra-device messages are then vendor specific. In case the DMME and GME are physically separated, the messages passed between them are for further study.

6.1.3 Security entities

6.1.3.1 Security controller entity (SCE)

The security controller (SC) manages security for the domain as specified in clause 9 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.

6.1.3.2 Note regarding DMME and SCE communications

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. 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].

6.2 Logical interfaces for control and management planes

A logical interface is one that has no specific physical attributes. It is a reference point across where messages pass to and from an entity. Logical interfaces may be defined for both control and management planes.

While the A-interface, as defined in [ITU-T G.9960], is the demarcation point between the application entities (AEs) and the nodes (at the data link layer (DLL)), there are several logical interfaces to entities within the node and domain (L1 to L5) as shown in Figures 6-1 and 6-2. This clause describes these logical interfaces and their use.

Those control and management plane messages to/from an entity are considered to have passed to/from the relevant entity within the node via its logical interface, e.g., messages destined for the DME pass across the L2 interface shown above while messages destined to the NME pass across the L1 or L3 interfaces, depending on the remote entity.

6.3 Reference model

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

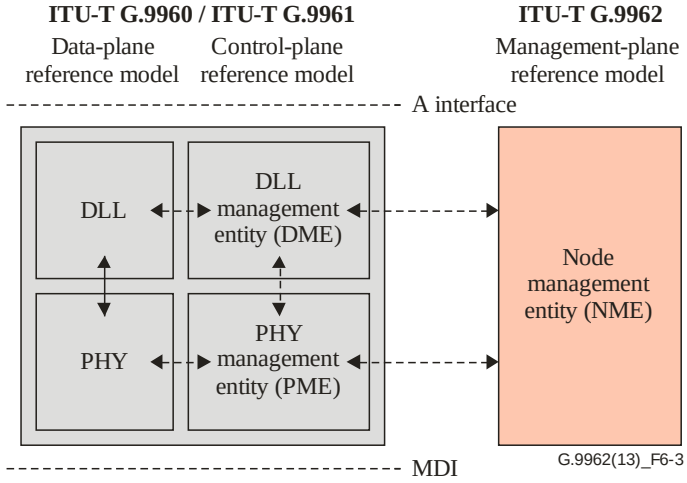


Figure 6-3 – ITU-T G.9962 reference model

7 ITU-T G.996x data model

The following clauses describe the ITU-T G.996x data model. The ITU-T G.996x data model is constructed with multiple objects, which represent different management categories. Each object contains one or more management parameters. An object may contain another object as its member. The read/write attribute of a management parameter is defined as follows:

- R – The parameter can be read, but cannot be written by the NME (e.g., error counters). Writing to this parameter shall not take any effect.
- W – The parameter can be written, but cannot be read by the NME (e.g., password information). Read-out value for this parameter shall be 0.
- R/W – The parameter can be written or read by the NME. For some parameters, written value may be different from read-out value.

Parameters make use of a limited subset of the default SOAP data types [b-W3C SOAP]. The notation used to represent the data type of a management parameter is defined as follows:

- boolean – 1 (true) or 0 (false)
- unsignedInt – Unsigned integer in the range 0 to 4294967295, inclusive
- unsignedLong – Unsigned long integer in the range 0 to 18446744073709551615, inclusive
- int – Integer in the range –2147483648 to +2147483647, inclusive
- long – Long integer in the range –9223372036854775808 to 9223372036854775807, inclusive
- string(α) – string with maximum size of α characters
- hexBinary(α) – Hex encoded binary with maximum length of α characters.

7.1 Information on the ITU-T G.996x family

Table 7-1 specifies management parameters pertaining to an ITU-T G.996x interface (i.e., node). The base object is the root object of the ITU-T G.996x-series data model that may include several interfaces. These parameters are applicable to all nodes.

Table 7-1 – Information on the ITU-T G.996x family

Name	Type	R/W	Description
InterfaceNumberOfEntries	unsignedInt	R	The number of entries in the interface table
Interface{i}	Object	–	ITU-T G.996x interface object (see clause 7.2)
Diagnostics	Object	–	ITU-T G.996x diagnostics object (see clause 7.8)

7.1.1 InterfaceNumberOfEntries

This parameter represents the number of entries *i* in the Interface[*i*] table, which contains the management parameters associated with each of the ITU-T G.996x interfaces connected to this device. Clause 7.2 specifies these management parameters.

7.2 Interface information

Table 7-2 specifies management parameters pertaining to an ITU-T G.996x node. These parameters are applicable to all nodes.

Table 7-2 – ITU-T G.996x interface information (Interface)

Name	Type	R/W	Description
Enable	boolean	R/W	Enable the node
Status	unsignedInt	R	Current operational state of the node
Name	string(64)	R/W	Alphanumeric name of the node
MACAddress	hexBinary(6)	R	MAC address of the node
FirmwareVersion	string(64)	R	Firmware version
StandardVersion	string(128)	R	Standard version
MaxBandplan	unsignedInt	R/W	Maximum bandplan supported
MediumType	hexBinary(1)	R/W	Medium type
TargetDomainNames	hexBinary(128)	R/W	A set of domain names to which the node wishes to be registered
DeviceId	unsignedInt	R	Device identifier of the node (DEVICE_ID)
MaxBitRate	unsignedInt	R	Maximum PHY data rate of the node
NodeTypeDMCapable	boolean	R/W	Domain master capability indicator
NodeTypeDMConfig	boolean	R/W	Domain master preference indicator
NodeTypeDMStatus	boolean	R	Domain master selection indicator
NodeTypeSCCapable	boolean	R/W	Security controller capability indicator
NodeTypeSCStatus	boolean	R	Security controller selection indicator
TAIFG	unsignedInt	R	The value of T_{AIFG}

Table 7-2 – ITU-T G.996x interface information (Interface)

Name	Type	R/W	Description
AssociatedDeviceNumberOfEntries	unsignedInt	R/W	The number of entries in the AssociatedDevice
Alias	String(64)	R/W	A non-volatile handle used to reference this instance.
LastChange	unsignedInt	–	The accumulated time in *seconds* since the interface entered its current operational state.
LowerLayers	String(1024)	W	Comma-separated list (maximum length 1024) of strings. Each list item represents the path name of an interface object that is stacked immediately below this interface object
NotchedAmateurRadioBands	HexBinary(3)	R/W	Notched amateur radio bands
SMNumberOfEntries	unsignedInt	R/W	The number of entries in the SM_MaskedSubcarrier object
SM_MaskedBand	object	–	Regional masked subcarriers object (see clause 7.7
Stats	object	–	Throughput statistics information – see clause 7.3
DMInfo	object	–	Domain master information – see clause 7.4
SCInfo	object	–	Security controller information – see clause 7.5
AssociatedDevice{i}	object	–	Associated node information – see clause 7.6

7.2.1 Enable

This parameter represents an enable/disable control of the node. Changing from "0" to "1" enables the node whereas changing from "1" to "0" disables the node. Writing the same value shall not have any impact on the node operation.

7.2.2 Status

This parameter represents the current operational state of the node. It shall be formatted according to Table 7-3.

Table 7-3 – Valid values of Status

Value	Description
0	The node is in full-power mode (L0) as specified in clause 5.1.7 of [ITU-T G.9960]. It can transmit and receive network traffic (i.e., APDUs) at its maximum capacity. This mode shall be considered as the operational state "Up" defined in [b-BBF TR-181 I2A6].
1	The node is in efficient-power mode (L1) as specified in clause 5.1.7 of [ITU-T G.9960]. It can transmit and receive network traffic at its maximum capacity.

Table 7-3 – Valid values of Status

Value	Description
	This mode shall be considered as the operational state "Up" defined in [b-BBF TR-181 I2A6].
2	The node is in low-power mode (L2) as specified in clause 5.1.7 of [ITU-T G.9960]. It can transmit and receive network traffic at reduced capacity. This mode shall be considered as the operational state "Up" defined in [b-BBF TR-181 I2A6].
3	The node is in idle mode (L3) as specified in clause 5.1.7 of [ITU-T G.9960]. It cannot transmit and receive network traffic, but may transmit and receive management traffic (i.e., LCDUs). This mode shall be considered as the operational state "Dormant" defined in [b-BBF TR-181 I2A6].
4	The node is down. This mode shall be considered as the operational state "Down" defined in [b-BBF TR-181 I2A6].
5	The node is turned on, but not ready to transmit and receive network traffic. This mode shall be considered as the operational state "Unknown" defined in [b-BBF TR-181 I2A6].
6	The node is in a fault/error condition. This mode shall be considered as the operational state "Error" defined in [b-BBF TR-181 I2A6].
7-255	Reserved by ITU-T.

7.2.3 Name

This parameter represents the alphanumeric name of the node assigned by the NME. It consists of up to 64 ASCII characters.

7.2.4 MACAddress

This parameter represents the node MAC address, denoted as REGID in [ITU-T G.9961].

7.2.5 FirmwareVersion

This parameter represents the firmware version of the node. It consists of up to 64 ASCII characters.

7.2.6 StandardVersion

This parameter represents the standard version that the node supports. It shall be formatted as a comma separated list of tuples of two strings separated with a comma. The first element of each tuple represents an ITU-T G.996x Recommendation (see Table 7-4) while the second element of the tuple represents the amendment version of the indicated Recommendation that this node supports (value 0 corresponds to the base Recommendation)

For example, to indicate support for ITU-T G.9960 base document and ITU-T G.9961 Amendment 1, the corresponding string shall be defined as "G9960,0,G9961,1".

Table 7-4 – Valid values of Recommendation

Value	Description
G9960	Indicates support for Recommendation ITU-T G.9960
G9961	Indicates support for Recommendation ITU-T G.9961
G9962	Indicates support for Recommendation ITU-T G.9962
G9963	Indicates support for Recommendation ITU-T G.9963
G9964	Indicates support for Recommendation ITU-T G.9964

7.2.7 MaxBandplan

This parameter represents the largest bandplan that the node can support. It shall be formatted according to Table 7-5.

Table 7-5 – Valid values of MaxBandplan

Value	Description
1	25 MHz bandplan
2	50 MHz bandplan
3	100 MHz bandplan
4	200 MHz bandplan
0, 5-255	Reserved by ITU-T.

7.2.8 MediumType

This parameter represents the medium type that the node currently operates on. It shall be formatted according to Table 7-6.

Table 7-6 – Valid values of MediumType

Value	Description
00000001_2	Power line baseband
00000010_2	Phone line baseband
00000100_2	Coax baseband
00001000_2	Coax RF
00010000_2	Plastic optical fibre
Other values	Reserved by ITU-T.

7.2.9 TargetDomainNames

This parameter represents the target domain names configured by the user, as described in clause 8.6.1 of [ITU-T G.9961]. It can contain up to four 32-byte domain names. It shall be represented as a comma-separated list (maximum length 1024) of strings. Each list item shall be a target domain name.

When registering, the node should try to register to one of these domains in the given order.

7.2.10 DeviceId

This parameter represents the identifier of the node, denoted as DEVICE_ID in [ITU-T G.9960].

7.2.11 MaxBitRate

This parameter represents the maximum PHY data rate that the node is capable of transmitting. It shall be formatted in Mbits per second.

7.2.12 NodeTypeDMCapable

This parameter represents the capability of the node to support a domain master function. Setting NodeTypeDMCapable to 1 indicates that the node includes a domain master function.

7.2.13 NodeTypeDMConfig

This parameter represents the preference of the node to become a domain master. Setting NodeTypeDMConfig to 1 indicates that the node is configured to be a domain master (see clause 8.6.6.1.2 of [ITU-T G.9961]).

7.2.14 NodeTypeDMStatus

This parameter indicates whether or not the node is a domain master.

7.2.15 NodeTypeSCCapable

This parameter represents the capability of the node to support a security controller function. Setting NodeTypeSCCapable to 1 indicates that the node can serve as a security controller.

7.2.16 NodeTypeSCConfig

For further study.

7.2.17 NodeTypeSCStatus

This parameter indicates whether or not the node is the active security controller.

7.2.18 T_{AIFG}

This parameter represents the T_{AIFG}, as defined in clause 8.4 of [ITU-T G.9961]. It is represented as an unsigned integer in units of 1.28 µs.

7.2.19 AssociatedDeviceNumberOfEntries

This parameter represents the number of entries *i* in the AssociatedDevice[*i*], which contains the management parameters associated with other nodes connected to this node. Clause 7.6 specifies these management parameters.

7.2.20 Alias

A non-volatile handle used to reference this instance. Alias provides a mechanism for an ACS to label this instance for future reference.

7.2.21 LastChange

This parameter represents the accumulated time in seconds since the interface entered its current operational state (see clause 7.2.2).

7.2.22 LowerLayers

This is a comma-separated list (maximum length 1024) of strings. Each list item shall be the path name of an interface object that is stacked immediately below this interface object.

NOTE – Since the ITU-T G.9960/1 interface is a layer 1 interface, it is expected that LowerLayers will not be used.

7.2.23 NotchedAmateurRadioBands

This parameter represents a bit map representing usage of international amateur bands (0 = masked, 1 = unmasked). The LSB represents the lowest band (1.8-2.0 MHz), the following bit represents the second lowest band (3.5-4.0 MHz), and so on. The maximum value for this parameter is $3FF_{16}$.

International Radio amateur bands are described in Table D.1 of [ITU-T G.9964] and conveyed by the DM in the Amateur radio band descriptor (see Table 8-77 of [ITU-T G.9961]).

7.2.24 SMNumberOfEntries

This parameter represents the number of entries *i* in the SM_MaskedBand[*i*] table, which contains the list of regional masked bands. Valid values for *i* are between 0 and 32. Clause 7.7 specifies this list of masked bands. This information is conveyed by the DM in the SM descriptor (see Table 8-77 of [ITU-T G.9961]).

7.3 Throughput statistics information

Table 7-7 specifies management parameters pertaining to the throughput statistics of the node. The base object, Stats is a member of the object, Interface. All parameters described in this clause are free-running counters, represented by unsigned integer. These parameters are reset in the following conditions: When Status transitions to "Up" after the node is enabled by the NME

Table 7-7 – Throughput statistics information

Name	Type	R/W	Description
BytesSent	unsignedLong	R	The total number of data bytes transmitted (outbound direction: MAC to PHY)
BytesReceived	unsignedLong	R	The total number of data bytes received (inbound direction: PHY to MAC)
PacketsSent	unsignedLong	R	The total number of data packets transmitted
PacketsReceived	unsignedLong	R	The total number of data packets received
ErrorsSent	unsignedInt	R	The total number of outbound data packets that could not be transmitted because of errors
ErrorsReceived	unsignedInt	R	The total number of received data packets that contained errors
UnicastPacketsSent	unsignedLong	R	The total number of transmitted data packets that were addressed to unicast address
UnicastPacketsReceived	unsignedLong	R	The total number of received data packets that were addressed to unicast address
DiscardPacketsSent	unsignedInt	R	The total number of outbound data packets that were discarded
DiscardPacketsReceived	unsignedInt	R	The total number of received data packets that were discarded
MulticastPacketsSent	unsignedLong	R	The total number of transmitted data packet that were addressed to multicast address
MulticastPacketsReceived	unsignedLong	R	The total number of received data packet that were addressed to multicast address
BroadcastPacketsSent	unsignedLong	R	The total number of transmitted data packet that were addressed to broadcast address

Table 7-7 – Throughput statistics information

Name	Type	R/W	Description
BroadcastPacketsReceived	unsignedLong	R	The total number of received data packet that were addressed to broadcast address
UnknownProtoPacketsReceived	unsignedInt	R	The total number of received data packet that were discarded because of an unknown or unsupported protocol.
MgmtBytesSent	unsignedLong	R	The total number of management bytes transmitted
MgmtBytesReceived	unsignedLong	R	The total number of management bytes received
MgmtPacketsSent	unsignedLong	R	The total number of management packets transmitted
MgmtPacketsReceived	unsignedLong	R	The total number of management packets received
BlocksSent	unsignedLong	R	The total number of transmitted LPDUs
BlocksReceived	unsignedLong	R	The total number of received LPDUs
BlocksResent	unsignedInt	R	The total number of LPDUs that were retransmitted
BlocksErrorReceived	unsignedInt	R	The total number of received LPDUs that contained errors

7.3.1 BytesSent

This parameter represents the total number of MPDU bytes transmitted or retransmitted by the node through a physical medium (i.e., PMI defined in clause 5.2.1 of [ITU-T G.9960]), which correspond to data LPDUs (i.e., data packets) and framing overhead (e.g., LFH, LPH, LPCS defined in clause 8.1 of [ITU-T G.9961]). It does not include transmitted bytes contributed by management LPDUs (i.e., management packets).

NOTE – LPDUs in "mixed LLC frame blocks" are considered data LPDUs.

7.3.2 BytesReceived

This parameter represents the total number of MPDU bytes received by the node through a physical medium, which correspond to data LPDUs and framing overhead. It does not include received bytes contributed by management LPDUs. It may include blocks with errors.

NOTE – LPDUs in "mixed LLC frame blocks" are considered data LPDUs.

7.3.3 PacketsSent

This parameter represents the total number of APDUs requested for transmission by a higher layer (i.e., outbound APDUs at the x1 reference point defined in clause 5.2.1 of [ITU-T G.9960]) that were transmitted by the node through the physical medium. It does not include transmitted LCDUs.

7.3.4 PacketsReceived

This parameter represents the total number of APDUs delivered to a higher layer (i.e., inbound APDUs at the x1 reference point) that were received by the node through the physical medium. It does not include received LCDUs.

7.3.5 ErrorsSent

This parameter represents the total number of APDUs that were requested for transmission by a higher layer (i.e., outbound APDUs at the x1 reference point defined in clause 5.2.1 of [ITU-T G.9960]) but could not be transmitted because of errors (e.g., APDUs containing CRC errors).

7.3.6 ErrorsReceived

This parameter represents the total number of received APDUs that contained errors preventing them from being delivered to a higher layer (i.e., inbound APDUs at the x1 reference point defined in clause 5.2.1 of [ITU-T G.9960]). The causes of error that shall be considered are: incorrect CRC, incorrect MIC, incorrect MIC size, and incorrect size of packet.

7.3.7 UnicastPacketsSent

This parameter represents the total number of APDUs that were requested for transmission by a higher layer (i.e., outbound APDUs at the x1 reference point) and which were addressed to a unicast address at this layer. It includes APDUs that were discarded or not sent.

7.3.8 UnicastPacketsReceived

This parameter represents the total number of received APDUs that were delivered to a higher layer (i.e., inbound APDUs at the x1 reference point) and which were addressed to a unicast address at this layer.

7.3.9 DiscardPacketsSent

This parameter represents the total number of APDUs that were requested for transmission by a higher layer (i.e., outbound APDUs at the x1 reference point) but chosen to be discarded even though no errors had been detected to prevent their being transmitted (e.g., buffer overflow).

7.3.10 DiscardPacketsReceived

This parameter represents the total number of received APDUs that were chosen to be discarded even though no errors had been detected to prevent their being delivered.

7.3.11 MulticastPacketsSent

This parameter represents the total number of APDUs that were requested for transmission by a higher layer (i.e., outbound APDUs at the x1 reference point) and which were addressed to a multicast address at this layer. It includes APDUs that were discarded or not sent.

7.3.12 MulticastPacketsReceived

This parameter represents the total number of received APDUs that were delivered to a higher layer (i.e., inbound APDUs at the x1 reference point) and which were addressed to a multicast address at this layer.

7.3.13 BroadcastPacketsSent

This parameter represents the total number of APDUs that were requested for transmission by a higher layer (i.e., outbound APDUs at the x1 reference point) and which were addressed to a broadcast address at this layer. It includes APDUs that were discarded or not sent.

7.3.14 BroadcastPacketsReceived

This parameter represents the total number of received APDUs that were delivered to a higher layer (i.e., inbound APDUs at the x1 reference point) and which were addressed to a broadcast address at this layer.

7.3.15 UnknownProtoPacketsReceived

This parameter represents the total number of APDUs received by the management that were discarded because of an unknown or unsupported protocol.

7.3.16 MgmtBytesSent

This parameter represents the total number of MPDU bytes transmitted by the node through a physical medium, which correspond to management LPDUs and framing overhead.

7.3.17 MgmtBytesReceived

This parameter represents the total number of MPDU bytes received by the node through a physical medium, which correspond to management LPDUs and framing overhead.

7.3.18 MgmtPacketsSent

This parameter represents the total number of LCDUs requested for transmission by a management layer (i.e., outbound LCDUs generated in LLC defined in clause 8.1.3 of [ITU-T G.9961]) that were transmitted by the node through a physical medium.

7.3.19 MgmtPacketsReceived

This parameter represents the total number of LCDUs delivered to a management layer (i.e., inbound LCDUs) that were received by the node through a physical medium.

7.3.20 BlocksSent

This parameter represents the total number of LPDUs that were transmitted by the node through a physical medium, regardless of new or retransmitted LPDUs.

7.3.21 BlocksReceived

This parameter represents the total number of LPDUs that were received by the node through a physical medium, with or without errors.

7.3.22 BlocksResent

This parameter represents the total number of LPDUs that were retransmitted.

7.3.23 BlocksErrorReceived

This parameter represents the total number of received LPDUs that contained errors.

Note the following relationships hold:

- PacketsSent + ErrorsSent + DiscardPacketsSent = UnicastPacketsSent + MulticastPacketsSent + BroadcastPacketsSent.
- PacketsReceived = UnicastPacketsReceived + MulticastPacketsReceived + BroadcastPacketsReceived.
- Retransmission rate = BlocksResent/BlocksSent.
- Block error rate = BlocksErrorReceived/BlocksReceived.

7.4 Domain master information

Table 7-8 specifies management parameters pertaining to the domain master functionality. The base object, DMInfo is a member of the object, Interface. These parameters are set by the domain master.

Table 7-8 – Domain master information

Name	Type	R/W	Description
DomainName	hexBinary(32)	R	Domain name of the domain to which the node is registered
DomainNameIdentifier	hexBinary(2)	R	Domain name identifier of the domain to which the node is registered (DNI)
DomainId	unsignedInt	R	Domain identifier of the domain to which the node is registered (DOD)
MACCycleDuration	unsignedInt	R/W	MAC cycle duration
SCDeviceId	unsignedInt	R/W	DEVICE_ID of security controller
SCMACAddress	hexBinary(6)	R/W	MAC address of security controller
ReregistrationTimePeriod	unsignedInt	R/W	Time period for re-registration
TopologyPeriodicInterval	unsignedInt	R/W	Time interval between two periodic topology updates
MinSupportedBandplan	unsignedInt	R/W	Minimum bandplan supported.
MaxSupportedBandplan	unsignedInt	R/W	Maximal bandplan supported.

7.4.1 DomainName

This parameter represents the domain name to which the node is registered.

7.4.2 DomainNameIdentifier

This parameter represents the domain name identifier of the domain to which the node is registered, denoted as DNI in [ITU-T G.9961].

7.4.3 DomainId

This parameter represents the identifier of the domain to which the node is registered, denoted as DOD in [ITU-T G.9960].

7.4.4 MACCycleDuration

This parameter represents the MAC cycle duration, as specified in clause 8.4 of [ITU-T G.9961]. It is represented as an unsigned integer in units of 0.5 ms. The valid range is from 10 (5 ms) to 200 (100 ms). In case of power line, writing to this parameter shall have no effect and the read value shall be 0, which is a special value indicating that the MAC cycle is synchronized with 2 AC cycles as defined in clause 8.6.3.1 of [ITU-T G.9961].

7.4.5 SCDeviceId

This parameter represents the DEVICE_ID of the security controller selected by the domain master.

7.4.6 SCMACAddress

This parameter represents the REGID of the security controller selected by the domain master.

7.4.7 ReregistrationTimePeriod

This parameter represents the time interval for periodic re-registration, as specified in clause 8.8.5.8 of [ITU-T G.9961]. It is represented as an unsigned integer in units of 2 s. The valid range is from 5 (10 s) to 63 (126 s).

7.4.8 TopologyPeriodicInterval

This parameter represents the time interval that a node sends out the periodic topology update using TM_NodeTopologyChange.ind message, as specified in clause 8.8.5.8.1 of [ITU-T G.9961]. It is represented as an unsigned integer in units of 0.1 s. The valid range is from 1 (0.1 s) to 255 (25.5 s). The special value 0 represents an infinite interval (i.e., no periodic topology update).

7.4.9 MinSupportedBandplan

This field indicates the value of the minimal bandplan capability for a node that is allowed to register to the domain. It shall be formatted according to Table 7-5.

7.4.10 MaxSupportedBandplan

This field indicates the value of the maximal bandplan capability for a node that is allowed to register to the domain. It shall be formatted according to Table 7-5.

7.5 Security controller information

Table 7-9 specifies management parameters pertaining to the security controller functionality. The base object, SCInfo is a member of the object, Interface. These parameters are set by the security controller.

Table 7-9 – Security controller information

Name	Type	R/W	Description
ModesSupported	hexBinary(1)	R/W	Security modes supported by the security controller
ModeEnabled	hexBinary(1)	R	Security mode enabled by the security controller
MICSize	unsignedInt	R/W	MIC size
Location	boolean	R	Security controller is above the L1 reference point

7.5.1 ModesSupported

This parameter represents the security mode that the node can support. It shall be formatted according to Table 7-10.

Table 7-10 – Valid values of ModeSupported

Value	Description
00000001_2	NN mode
00000010_2	NMK mode
Other values	Reserved by ITU-T

7.5.2 ModeEnabled

This parameter represents the security mode that the node is operating. It shall be formatted according to Table 7-11.

Table 7-11 – Valid values of ModeEnabled

Value	Description
00000000_2	Security is disabled
00000001_2	NN mode
00000010_2	NMK mode
Other values	Reserved by ITU-T

7.5.3 MICSize

This parameter represents the selected MIC size. It shall be formatted according to Table 7-12.

Table 7-12 – Valid values of MICSize

Value	Description
0	4-byte MIC
1	8-byte MIC
2	16-byte MIC
3-255	Reserved by ITU-T

7.5.4 Location

This parameter indicates the security controller is above the L1 reference point. It shall be set to 1 if the security controller is above the L1 reference point, and set to 0 otherwise.

7.6 Associated node information

Table 7-13 specifies management parameters pertaining to associated node information. The base object AssociatedDevice[*i*] is a member of the object Interface. It contains information of the associated node *i*, which is visible by the node represented by Interface. The number of associated nodes *i* is defined in the parameter AssociatedDeviceNumberOfEntries of the object Interface.

Table 7-13 – Associated node information

Name	Type	R/W	Description
MACAddress	hexBinary(6)	R	MAC address of the associated node *i*
DeviceId	unsignedInt	R	DEVICE_ID of the associated node *i*
TxPhyRate	unsignedInt	R	PHY data rate in transmit direction to the associated node *i*
RxPhyRate	unsignedInt	R	PHY data rate in receive direction from the associated node *i*
Active	boolean	R	Indicate the presence of the associated node *i*

7.6.1 MACAddress

This parameter represents the MAC address of the associated node *i*, denoted as REGID in [ITU-T G.9961].

7.6.2 DeviceId

This parameter represents the identifier of the associated node *i*, denoted as DEVICE_ID in [ITU-T G.9960].

7.6.3 TxPhyRate

This parameter represents the maximum PHY data rate that the node is capable of transmitting to this associated node *i*. It shall be formatted as BitsPerSecond, defined in Note 1 to Table 8-48 of [ITU-T G.9961].

7.6.4 RxPhyRate

This parameter represents the maximum PHY data rate that the node is capable of receiving from this associated node *i*. It shall be formatted as BitsPerSecond, defined in Note 1 to Table 8-48 of [ITU-T G.9961].

7.6.5 Active

This parameter indicates the presence of the associated node *i*. This field shall be set to 1 if and only if the Status of the associated node *i* is 0, 1, or 2.

7.7 SM_MaskedBand table information

Table 7-14 specifies the list of masked bands to be applied to the ITU-T G.9960/1 interface. The base object SM_MaskedBand[i] is a member of the object Interface. It contains information of the masked band *i*, which is visible by the ITU-T G.9960/1 interface represented by Interface.

Table 7-14 – SM_MaskedBand information

Name	Type	R/W	Description
StartSubCarrier	unsignedInt	R	Index of the lowest frequency sub-carrier in the band to be masked
StopSubCarrier	unsignedInt	R	Index of the highest frequency sub-carrier in the band to be masked

7.7.1 StartSubCarrier

This parameter represents the index of the lowest frequency sub-carrier in the band to be masked, as specified in Table 8-79 of [ITU-T G.9961].

7.7.2 StopSubCarrier

This parameter represents the index of the highest frequency sub-carrier in the band to be masked, as specified in Table 8-79 of [ITU-T G.9961].

7.8 Diagnostics

Table 7-15 specifies the ITU-T G.996x diagnostics object. The base object diagnostics is a member of the root object ITU-T G.996x.

Table 7-15 – Diagnostics information

Name	Type	R/W	Description
DiagnoseMACAddress	hexBinary(6)	R/W	MAC address of the originating ITU-T G.996x interface of the link that is being diagnosed. See clause 7.8.1
Interface	unsignedInt	R/W	ITU-T G.996x interface that is being diagnosed. See clause 7.8.2
PHYThroughput	object	–	See clause 7.9
Performance monitoring	object	–	See clause 7.11

7.8.1 DiagnoseMACAddress

This parameter represents the MAC address of the originating ITU-T G.996x interface of the link that is being diagnosed.

NOTE – This MAC address may belong to another node of the domain.

7.8.2 Interface

This parameter represents the ITU-T G.996x interface of the device over which the diagnosis is performed.

7.9 PHYThroughput information

Table 7-16 specifies the PHYThroughput object. The base object PHYThroughput is a member of the object diagnostics.

Table 7-16 – PHYThroughput information

Name	Type	R/W	Description
Diagnosis State	String(32)	R/W	Indicates availability of diagnostics data. See clause 7.9.1
ResultNumberOfEntries	unsignedInt	R	The number of entries in Table 7-18 – PhyThroughputResult information
PhyThroughputResult{i}	object	–	PhyThroughputResult object. See clause 7.10

7.9.1 DiagnosticsState

This parameter indicates availability of diagnostic data for PHYThroughput measurements. It shall be formatted according to Table 7-17.

Table 7-17 – Valid values of DiagnosticsState

Value	Description
None	No Diagnostic State is available
Requested	Diagnostic information has been requested but is still not available
Completed	Diagnostic information has been requested and is available
Error	Error during test

If the ACS sets the value of this parameter to Requested, the node shall initiate the corresponding diagnostic test. When writing, the only allowed value is Requested. To ensure the use of the proper test parameters (the writable parameters in Diagnostics object), the test parameters shall be set either prior to or at the same time as setting the DiagnosticsState to Requested.

When the test is completed, the value of this parameter shall be either Complete (if the test completed successfully), or one of the Error values listed above.

After the diagnostics are complete, the value of all result parameters (all read-only parameters in Diagnostics object) shall be retained by the node until either these diagnostics are run again or the node reboots. After a reboot, if the node has not retained the result parameters from the most recent test, it shall set the value of this parameter to None.

7.9.2 ResultNumberOfEntries

This parameter represents the number of entries *i* in the PHYThroughput[*i*] table, which contains the PHYThroughput information associated with each of the ITU-T G.996x interfaces connected to the ITU-T G.996x interface under diagnosis. Clause 7.11 specifies these management parameters.

7.10 PHYThroughputResult information

Table 7-18 specifies the PHY throughput measurement results for a given link for the ITU-T G.996x interface being diagnosed. These parameters are applicable to all nodes.

Table 7-18 – PHYThroughputResult information

Name	Type	R/W	Description
LinkState	String(32)	R	Indicates the state of the link between the ITU-T G.996x interface with MAC address DiagnoseMACAddress and the ITU-T G.996x interface with MAC address DestinationMACAddress. See clause 7.10.1
DestinationMACAddress	hexBinary(6)	R	MAC address of the destination node of the link being measured. See clause 7.10.2.
TxPhyRate	unsignedInt	R	PHY data rate in transmit direction in the link between the originating ITU-T G.996x interface of the link being diagnosed and the ITU-T G.996x interface with MAC address DestinationMACAddress. See clause 7.10.3
RxPhyRate	unsignedInt	R	PHY data rate in receive direction in the link between the originating ITU-T G.996x interface of the link being diagnosed and the ITU-T G.996x interface with MAC address DestinationMACAddress. See clause 7.10.4

7.10.1 LinkState

This parameter indicates the state of the link under test. It shall be formatted according to Table 7-19.

Table 7-19 – Valid values of LinkState

Value	Description
Direct	There is a direct link between the ITU-T G.996x interface with MAC address DiagnoseMACAddress and the ITU-T G.996x interface with MAC address DestinationMACAddress
NonDirect	There is no direct link between the ITU-T G.996x interface with MAC address DiagnoseMACAddress and the ITU-T G.996x interface with MAC address DestinationMACAddress (e.g., the link between the two nodes is through relay)

7.10.2 DestinationMACAddress

This parameter represents the node MAC address, denoted as REGID in [ITU-T G.9961] of the destination node of the link being measured.

7.10.3 TxPhyRate

This parameter represents the maximum PHY data rate that the node with MAC address DiagnoseMACAddress is capable of transmitting to the node with MAC address DestinationMACAddress. It shall be formatted as BitsPerSecond, defined in Note 1 to Table 8-48 of [ITU-T G.9961].

7.10.4 RxPhyRate

This parameter represents the maximum PHY data rate that the node with MAC address DiagnoseMACAddress is capable of receiving from the node with MAC address DestinationMACAddress. It shall be formatted as BitsPerSecond, defined in Note 1 to Table 8-48 of [ITU-T G.9961].

7.11 Performance monitoring information

Table 7-20 specifies the PerformanceMonitoring object. The base object PerformanceMonitoring is a member of the object diagnostics.

Table 7-20 – PerformanceMonitoring information

Name	Type	R/W	Description
Diagnosis State	String(32)	R/W	Indicates availability of diagnostics data. See clause 7.11.1. The rest of the Read-only parameters in this table are not valid when Diagnosis State is either in "None" or "Error" state
SampleInterval	unsignedInt	R/W	Time in seconds between automatic collection of performance monitoring data. A value of zero disables automatic collection of data. See clause 7.11.2
CurrentStart	dateTime	R	Start time for the current interval. See clause 7.11.3
CurrentEnd	dateTime	R	Start time for the current interval. See clause 7.11.4
NodesNumberOfEntries	unsignedInt	R	The number of entries in the NodesResult – Table 7-22. See clause 7.11.5
Node{i}	object	–	Node object (see clause 7.12)
SNRGroupLength	unsignedInt	R/W	Length of the group of SNR values for channel

Table 7-20 – PerformanceMonitoring information

Name	Type	R/W	Description
			object. See clause 7.11.7
ChannelsNumberOfEntries	unsignedInt	R	The number of entries in the ChannelsResult table. See clause 7.11.6
Channel{i}	object	–	Channel object (see clause 7.13)

7.11.1 DiagnosticsState

This parameter shall be formatted according to Table 7-21.

Table 7-21 – Valid values of DiagnosticsState

Value	Description
None	No Diagnostic State is available
Requested	Diagnostic information has been requested but it is still not available
Completed	Diagnostic information has been requested and is available
Error	Error during test

If the ACS sets the value of this parameter to Requested, the node shall initiate the corresponding diagnostic test. When writing, the only allowed value is Requested. To ensure the use of the proper test parameters (the writable parameters in Diagnostics object), the test parameters shall be set either prior to or at the same time as setting the DiagnosticsState to Requested.

When the test is completed, the value of this parameter shall be either Complete (if the test completed successfully), or one of the Error values listed above.

After the diagnostic is complete, the value of all result parameters (all read-only parameters in Diagnostics object) shall be retained by the node until either this diagnostic is run again, or the node reboots. After a reboot, if the node has not retained the result parameters from the most recent test, it shall set the value of this parameter to None.

7.11.2 SampleInterval

Time in seconds between automatic collection of performance monitoring data. A value of zero disables automatic collection of data.

The node may impose a minimum sample interval, in which case an attempt to set a (non-zero) interval that is less than this minimum shall set the interval to the minimum and shall not be regarded as an error.

If SampleInterval is a simple fraction of a day, e.g., 900 (a quarter of an hour) or 3600 (an hour), the device may choose to align sample intervals with time of day, but is not required to do so.

7.11.3 CurrentStart

Start time for the current interval.

When automatic collection is enabled, i.e., SampleInterval is non-zero, the current interval started at the most recent automatic sample.

When automatic collection is disabled, i.e., SampleInterval is zero, the current interval started two manual samples ago.

7.11.4 CurrentEnd

End time for the current interval.

When automatic collection is enabled, i.e., SampleInterval is non-zero, the current interval ended at the most recent manual sample since the most recent automatic sample. If there has been no such manual sample, the current interval is empty.

When automatic collection is disabled, i.e., SampleInterval is zero, the current interval ended at the most recent manual sample.

7.11.5 NodesNumberOfEntries

This parameter represents the number of entries *i* in the Node[*i*] table, which contains the performance monitoring parameters associated with each of the ITU-T G.996x interfaces connected through a ITU-T G.996x domain (either directly or via relay node) to the ITU-T G.996x interface being diagnosed. Clause 7.12 specifies these management parameters.

7.11.6 ChannelNumberOfEntries

This parameter represents the number of entries *i* in the Channel[*i*] table, which contains the performance monitoring parameters associated with each of the ITU-T G.996x links present to the ITU-T G.996x interface being diagnosed. Clause 7.13 specifies these management parameters.

7.11.7 SNRGroupLength

This parameter represents the number of subcarriers in a group to be used for averaging SNR values when providing SNR information for a channel. Valid values for this field are 1; 2; 4; 8; 16; 32; 64; 128 and 256.

7.12 Node information

Table 7-22 specifies the Node performance monitoring measurement results for a given node for the ITU-T G.996x interface being diagnosed. These parameters are applicable to all nodes.

Table 7-22 – Node information

Name	Type	R/W	Description
BytesSent	unsignedLong	R	The total number of data bytes transmitted (outbound direction: MAC to PHY). See clause 7.3.1
BytesReceived	unsignedLong	R	The total number of data bytes received (inbound direction: PHY to MAC). See clause 7.3.2
PacketsSent	unsignedLong	R	The total number of data packets transmitted. See clause 7.3.3
PacketsReceived	unsignedLong	R	The total number of data packets received. See clause 7.3.4
ErrorsSent	unsignedInt	R	The total number of outbound data packets that could not be transmitted because of errors. See clause 7.3.5
ErrorsReceived	unsignedInt	R	The total number of received data packets that contained errors. See clause 7.3.6
UnicastPacketsSent	unsignedLong	R	The total number of transmitted data packets that were addressed to unicast address. See clause 7.3.7

Table 7-22 – Node information

Name	Type	R/W	Description
UnicastPacketsReceived	unsignedLong	R	The total number of received data packets that were addressed to unicast address. See clause 7.3.8
DiscardPacketsSent	unsignedInt	R	The total number of outbound data packets that were discarded. See clause 7.3.9
DiscardPacketsReceived	unsignedInt	R	The total number of received data packets that were discarded. See clause 7.3.10
MulticastPacketsSent	unsignedLong	R	The total number of transmitted data packet that were addressed to multicast address. See clause 7.3.11
MulticastPacketsReceived	unsignedLong	R	The total number of received data packet that were addressed to multicast address. See clause 7.3.12
BroadcastPacketsSent	unsignedLong	R	The total number of transmitted data packet that were addressed to broadcast address. See clause 7.3.13
BroadcastPacketsReceived	unsignedLong	R	The total number of received data packet that were addressed to broadcast address. See clause 7.3.14
UnknownProtoPacketsReceived	unsignedInt	R	The total number of received data packet that were discarded because of an unknown or unsupported protocol. See clause 7.3.15
MgmtBytesSent	unsignedLong	R	The total number of management bytes transmitted. See clause 7.3.16
MgmtBytesReceived	unsignedLong	R	The total number of management bytes received. See clause 7.3.17
MgmtPacketsSent	unsignedLong	R	The total number of management packets transmitted. See clause 7.3.18
MgmtPacketsReceived	unsignedLong	R	The total number of management packets received. See clause 7.3.19
BlocksSent	unsignedLong	R	The total number of transmitted LPDUs. See clause 7.3.20
BlocksReceived	unsignedLong	R	The total number of received LPDUs. See clause 7.3.21
BlocksResent	unsignedInt	R	The total number of LPDUs that were retransmitted. See clause 7.3.22
BlocksErrorReceived	unsignedInt	R	The total number of received LPDUs that contained errors. See clause 7.3.23

7.13 Channel information

Table 7-23 specifies the Channel performance measurement results for a given link for the ITU-T G.996x interface being diagnosed. These parameters are applicable to all nodes.

Table 7-23 – Channel information

Name	Type	R/W	Description
TimeStamp	dateTime	R	See clause 7.13.1
snr	String	R/W	Comma-separated list of unsigned integers (maximum 4096), expressed in 0.1 dB. Result of signal-to-noise-ratio measurement for the channel from the ITU-T G.996x interface with DiagnoseMACAddress MAC address to the ITU-T G.996x interface with REGID DestinationMACAddress MAC address. See clause 7.13.2

7.13.1 Timestamp

Time at which channel data were last collected.

7.13.2 snr

This parameter is the result of an SNR test performed over the link between SourceMACAddress and DestinationMACAddress. It shall be formatted as a comma-separated list of *N*/*M* unsigned integers that represents the result of signal-to-noise-ratio measurement averaging in groups of *M* subcarriers. The number *N* depends on the bandplan used by the node and corresponds to the OFDM control parameter *N* of each medium as defined in [ITU-T G.9964]. The number *M* corresponds to the parameter SNRGroupLength described in clause 7.11.7.

Annex A to Annex U

Annex A to Annex U have been intentionally left blank.

Annex V

Versioning dependencies between this Recommendation and other Recommendations of the ITU-T G.996x-series

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

For details on the versioning mechanism, see clause 8.19 of [ITU-T G.9961].

The versioning dependencies between this Recommendation and other Recommendations of the ITU-T G.996x-series are described in Table V.1. The number indicated in the following table represents the minimum amendment that is compatible with this Recommendation.

Table V.1 – Versioning dependencies

ITU-T G.9960	ITU-T G.9961	ITU-T G.9962	ITU-T G.9963 (Note 2)	ITU-T G.9964
0	0	N/A	0	0

NOTE 1 – The following values apply to this table:
- A value of zero indicates the base document of a Recommendation.
- A value of X indicates that this Recommendation is not dependent on the indicated Recommendation
- A value of N/A indicates this Recommendation.

NOTE 2 – Applicable if [ITU-T G.9963] is supported.

Bibliography

[b-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 (CWMP)*.

[b-BBF TR-069] CPE WAN Management Protocol, Broadband Forum

[b-BBF TR-181 I2A6] Device data model for TR-069, Issue 2 Amendment 6, Broadband Forum.
See also http://www.broadband-forum.org/cwmp/tr-181-2-6-0.html for the root object definitions.

[b-W3C SOAP] Simple Object Access Protocol (SOAP) 1.2, W3C, 2007.

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Printed in Switzerland
Geneva, 2015