Final draft ETSI ES 203 385 V1.1.1 (2014-09)

CABLE;
DOCSIS® Layer 2 Virtual Private Networking

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Reference

DES/CABLE-00008

Keywords

access, broadband, cable, data, IP, IPcable, L2VPN, modem

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Foreword

This final draft ETSI Standard (ES) has been produced by ETSI Technical Committee Integrated broadband cable telecommunication networks (CABLE), and is now submitted for the ETSI standards Membership Approval Procedure.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**may not**", "**need**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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1 Scope

The present document describes requirements on both CMTSs and CMs in order to implement a DOCSIS® Layer-2 Virtual Private Network (DOCSIS® L2VPN) feature.

The L2VPN feature allows cable operators to offer a Layer 2 Transparent LAN Service (TLS) to commercial enterprises.

In order to speed time to market, CM-TR-L2VPN-DG-V02 [i.8] offers guidelines to CMTS manufacturers as to how to phase the implementation of requirements defined in the present document. Phase designations are only applicable to CMTS products. Cable modems are expected to support all required L2VPN features in Phase 1.

The present document corresponds to the CableLabs L2VPN specification CM-SP-L2VPN-I12 [i.19].

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

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2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] IEEE 802.1AX-2008: "IEEE Standard for Local and metropolitan area networks--Link Aggregation".

[2] IEEE 802.1Q (August 2011): "IEEE Standard for Local and metropolitan area networks - Media Access, Control (MAC) Bridges and Virtual Local Area Networks".

NOTE: Available at http://standards.ieee.org/findstds/standard/802.1Q-2011.html.

[3] ETSI ES 201 488-3: "Access and Terminals (AT); Data Over Cable Systems; Part 3: Baseline Privacy Plus Interface Specification".

[4] IETF Internet draft-ietf-mpls-ldp-ipv6-09 (July 15, 2013): "Updates to LDP for IPv6".

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[22] IETF RFC 5036: "LDP Specification", October 2007.

[23] IETF RFC 5286: "Basic Specification for IP Fast Reroute: Loop-Free Alternates", September 2008.

[24] IETF RFC 5925: "The TCP Authentication Option", June 2010.

[25] IETF RFC 6074: "Provisioning, Auto-Discovery, and Signaling in Layer 2 Virtual Private Networks (L2VPNs)", January 2011.

[26] IETF RFC 6624: "Layer 2 Virtual Private Networks Using BGP for Auto-Discovery and Signaling", May 2012.

[27] ETSI ES 201 488-2: "Access and Terminals (AT); Data Over Cable Systems; Part 2: Radio Frequency Interface Specification".

[28] Recommendation ITU-T Y.1731 (November 2013): "OAM functions and mechanisms for Ethernet based networks".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] DPoE-SP-ARCHv1.0-I01-110225, February 25, 2011: "DOCSIS Provisioning of EPON, DPoE™ Architecture Specification", Cable Television Laboratories, Inc.

[i.2] DPoE-SP-DEMARCv1.0-I02-130614, June 14, 2013: "DOCSIS Provisioning of EPON, DPoE™ Demarcation Device Specification", Cable Television Laboratories, Inc.

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[i.15] IETF RFC 3985: "Pseudo Wire Emulation Edge-to-Edge (PWE3) Architecture", March 2005.

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[i.18] IETF RFC 4664: "Framework for Layer 2 Virtual Private Networks (L2VPNs)", September 2006.

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3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

bridged network: set of IEEE 802 LANs interconnected by IEEE 802.1d [i.20] MAC bridges

compliant Cable Modem (CM): CM that implements the present document

DOCSIS® L2PDU: Layer 2 Packet Data Unit of a DOCSIS MAC Frame

NOTE: Follows a MAC Header with FC_TYPE=00. This definition means that a MAC Management message with FC_TYPE=11 is *not* considered to be a DOCSIS® L2PDU, even though the form of a MAC Management Message Header is the same form as an L2PDU.

DOCSIS® MAC Frame: unit of transmission on the DOCSIS® cable RF interface, consisting of a MAC Header and a (possibly null) Data PDU

NOTE: The FC_TYPE field of MAC Header identifies the Data PDU as either a Packet PDU (FC_TYPE=00), or a MAC-specific PDU (FC_TYPE=11).

Downstream Service Identifier (DSID): 20-bit value in a DOCSIS® extended header that identifies a stream of packets distributed to the same cable modem or group of cable modems

NOTE: The DSID value is unique within a MAC Domain. For sequenced packets, the DSID identifies the resequencing context for downstream packet bonding in the CM.

flooding: operation of an L2 Bridge in which it replicates an L2PDU addressed to a group MAC or unlearned individual MAC address to all Bridge Ports other than the L2PDU's ingress port

Group MAC (GMAC) address: IEEE 6-byte MAC address with the first transmitted bit (the group bit) set to 1, indicating that the address refers to a group of MAC hosts

NOTE: In the canonical representation of MAC addresses used for Ethernet transmission, the Group bit is the least significant bit of the first byte. The all-1s broadcast MAC address is considered to be a GMAC address.

individual MAC address: IEEE 6-byte MAC address with the first transmitted bit (the group bit) set to 0, indicating that the address refers to a single MAC host

NOTE: For the Ethernet MAC addresses of DOCSIS®, the group bit is the least significant bit of the first byte of the MAC address.

IPCablecom: architecture and a series of specifications that enable the delivery of real time services (such as telephony) over the cable television networks using cable modems

L2 forwarder: network element that forwards layer 2 packets from one L2 interface to another L2 interface

NOTE: A Layer 2 Forwarder may operate in Point-to-Point or Multipoint forwarding mode, i.e. forwarding between only two interfaces without learning; or Multipoint, forwarding unicast-destined packets only to the interface from which a MAC address was learned.

L2 interface: physical interface port or virtual circuit on which an L2PDU is transmitted

NOTE: Physical L2 interface ports include an Ethernet NSI at a CMTS or the CMCI port at a CM. Virtual circuit L2 Interfaces include a CMTS Network System Interface (NSI) PseudoWire (PW) and a CMTS single-CM BPI Security Association. An L2 Interface may or may not have an ifIndex assigned to it.

L2 Protocol Data Unit (L2PDU): sequence of bytes consisting of a Destination MAC Address (DMAC), Source MAC Address (SMAC), (optional) Tag Header(s), EtherType/Length, L2 Payload, and CRC

L2 Virtual Private Network (L2VPN): set of LANs and the L2 Forwarders between them that enable hosts attached to the LANs to communicate with Layer 2 Protocol Data Units (L2PDUs)

NOTE: A single L2VPN forwards L2PDUs based only on the Destination MAC (DMAC) address of the L2PDU, transparent to any IP or other Layer 3 address. A cable operator administrative domain supports multiple L2VPNs, one for each subscriber enterprise to which Transparent LAN Service is offered.

L2VPN identifier: octet string that uniquely identifies an L2VPN within a cable operator administrative domain, corresponding to a single subscriber enterprise

L3 forwarder: network element that forwards a Layer 3 PDU from an ingress interface to one or more egress interfaces

NOTE: Also called a Router.

learning: operation of a layer 2 Bridge by which it associates the Source MAC (SMAC) address of an incoming L2PDU with the Bridge Port from which it arrived

management L2VPN: L2VPN for the post-registration SNMP traffic to eCM or eSAFE devices

NOTE: May be combined with a Provisioning L2VPN.

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Multipoint L2 Forwarding: operation of an L2 Forwarder among multiple L2 networks that forwards individual MAC destined packets only to the interface from which a source MAC address was learned and that floods group MAC destined packets to all interfaces

non-compliant CM: CM that does not implement the present document

Point-to-Point L2 Forwarding: operation of an L2 Forwarder between only two L2 networks with no source MAC address learning

provisioning L2VPN: L2VPN for the pre-registration traffic of DHCP, TOD, and TFTP that provisions eCMs and eSAFE hosts

NOTE: May be combined with a Management L2VPN.

resequencing Downstream Service Identifier (DSID): downstream service identifier for which the CMTS signals packet resequencing attributes

Security Association (SA): association between the CMTS and a set of CMs in a MAC Domain that enables encrypted communication between the CMTS and the CM set

NOTE: A Single CM SA is one with a single CM, and enables a private point-to-point L2 Network connection between the CMTS and the CPE LAN of that CM. A Security Association Descriptor (SA-Descriptor) is a multiple-part message element defined in the DOCSIS® Baseline Privacy specification ES 201 488-3 [3] that includes a Security Association ID (SAID).

Security Association ID (SAID): 14-bit identifier that appears in a BPI Extended Header (BPI-EH) of a DOCSIS® PDU packet to identify the key used to encrypt the packet

tag header: 16-bit Tag Protocol ID (0x8100) followed by a 16-bit Tag Control field

NOTE: The Tag Control field consists of a 3-bit User Priority field, a 1-bit Canonical Format Indicator, and a 12-bit VLAN ID IEEE 802.1Q [2].

Transparent LAN Service (TLS): service offering of a cable operator that implements a private L2VPN among the CPE networks of the CMs of single subscriber enterprise

Virtual LAN (VLAN): *subset* of the LANs of an IEEE 802.1Q [2] Bridged Network to which a VLAN Identifier (VLAN ID) is assigned

NOTE: An L2VPN may consist of several VLANs, each with different VLAN IDs, and even of VLANs on different IEEE 802.1Q [2] Bridged Networks with the same VLAN ID.

Virtual LAN Identifier (VLAN ID): 12-bit number that identifies a VLAN within an IEEE 802.1Q [2] Bridged Network

NOTE: An IEEE 802.1Q [2] stacked VLAN ID consists of an outer Service 12-bit VLAN ID and an inner Customer 12-bit VLAN ID.

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3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Attachment Circuit
AGI	Attachment Group Identifier
ARP	Address Resolution Protocol
AS	Autonomous System
ASCII	American Standard Code for Information Interchange
ASN	Autonomous System Numbers
ATM	Asynchronous Transfer Mode
BEB	Backbone Edge Bridge
BGP	Border Gateway Protocol
BPI	Baseline Privacy Interface
BPKM	Baseline Privacy Key Management
B-VID	Backbone Service Instance Identifier

CCM	Continuity Check Message

NOTE: See IEEE 802.1Q [2].

CE-ID	Customer Edge Identifier
CFI	Canonical Format Indicator
CM	Cable Modem
CMCI	Cable Modem to CPE Interface
CMIM	CM Interface Mask
CMTS	Cable Modem Termination System
CPE	Customer Premise Equipment
CRC	Cyclic Redundancy Check
DA	Destination Address
DAC	DEMARC Automatic Configuration
DEI	Drop Eligibility Indicator
DEMARC	DPoE Demarcation Device
DHCP	Dynamic Host Configuration Protocol
DIME	Downstream IP Multicast Encryption
DMAC	Destination MAC
DOCSIS®	Data-Over-Cable Service Interface Specifications
DPoE	DOCSIS® Provisioning of EPON
DS	Downstream
DSC	Dynamic Service Change
DSCP	Differentiated Services Code Point
DSD	Dynamic Service Delete
DSG	DOCSIS® Set-top Gateway
DSID	Downstream Service Identifier
DST	DOCSIS® Spanning Tree
DSTP	DOCSIS® Spanning Tree Protocol
DSx	Dynamic Service addition, change or deletion
DUT	Downstream Unencrypted Traffic
eCM	Embedded Cable Modem
eMTA	Embedded Multimedia Terminal Adapter
EPL	Ethernet Private Line
EPON	Ethernet Passive Optical Network
eRouter	Embedded DOCSIS® Router
eSAFE	Embedded Service/Application Functional Entity
eSTB	Embedded Set-top Box
ETH-RDI	Ethernet Remote Defect Indication
eVLAN	embedded VLAN
EVPL	Ethernet Virtual Private Line
EXP	Experimental bits
FD	Frame Delay
FDB	Forwarding Database
FEC	Forwarding Equivalence Class
FLM	Frame Loss Measurement
FRR	Fast Reroute
GEI	General Extension Information
GMAC	Group MAC address
IANA	Internet Assigned Numbered Authority
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IGMP	Internet Group Management Protocol
IGP	Interior Gateway Protocol
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
L2	Layer 2
L2CP	Layer 2 Control Protocol
L2PDU	Layer 2 Protocol Data Unit
L2TP	Layer 2 Tunnelling Protocol
L2VPN	Layer 2 Virtual Private Network

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