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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Integrated broadband cable telecommunication networks (CABLE).

Modal verbs terminology

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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".

NOTE: Available at <http://tools.ietf.org/html/draft-ietf-mpls-ldp-ipv6-09>.

- [5] MEF Technical Specification 30.1 (April 2013): "Service OAM Fault Management Implementation Agreement: Phase 2".
- [6] MEF Technical Specification 35 (April 2012): "Service OAM Performance Monitoring Implementation Agreement".
- [7] CM-SP-MULPIv3.0-I22-130808 (August 8, 2013): "DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification", Cable Television Laboratories, Inc.
- [8] CM-SP-OSSIV3.0-I21-130404 (April 4, 2013): "DOCSIS 3.0 Operations Support System Interface Specification", Cable Television Laboratories, Inc.

- [9] Internet Assigned Numbers Authority (IANA) (June 27, 2014): "MPLS Pseudowire Types Registry".

NOTE: Available at <http://www.iana.org/assignments/pwe3-parameters/pwe3-parameters.xhtml#pwe3-parameters-2>.

- [10] IETF RFC 2544: "Benchmarking Methodology for Network Interconnect Devices", March 1999.
- [11] IETF RFC 2918: "Route Refresh Capability for BGP-4", September 2000.
- [12] IETF RFC 3031: "Multiprotocol Label Switching Architecture", January 2001.
- [13] IETF RFC 3032: "MPLS Label Stack Encoding", January 2001.
- [14] IETF RFC 3931: "Layer Two Tunneling Protocol - Version 3 (L2TPv3)", March 2005.
- [15] IETF RFC 4385: "Pseudowire Emulation Edge-to-Edge (PWE3). Control Word for Use over an MPLS PSN", February 2006.
- [16] IETF RFC 4447: "Pseudowire Setup and Maintenance Using the Label Distribution Protocol (LDP)", April 2006.
- [17] IETF RFC 4448: "Encapsulation Methods for Transport of Ethernet over MPLS Networks", April 2006.
- [18] IETF RFC 4667: "Layer 2 Virtual Private Network (L2VPN) Extensions for Layer 2 Tunneling Protocol (L2TP)", September 2006.
- [19] IETF RFC 4761: "Virtual Private LAN Service (VPLS) Using BGP for Auto-Discovery and Signaling", January 2007.
- [20] IETF RFC 4762: "Virtual Private LAN Service (VPLS) Using Label Distribution Protocol (LDP) Signaling", January 2007.
- [21] IETF RFC 4893: "BGP Support for Four-octet AS Number Space", May 2007.
- [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.

- [i.3] DPoE-SP-IPNEv1.0-I06-130808, August 8, 2013: "DOCSIS Provisioning of EPON, IP Network Element Requirements", Cable Television Laboratories, Inc.
- [i.4] DPoE-SP-MEFv2.0-I02-130808, August 8, 2013: "DOCSIS Provisioning of EPON, Metro Ethernet Forum Specification", Cable Television Laboratories, Inc.
- [i.5] DPoE-SP-MULPIv1.00-I06-130808, August 8, 2013: "DOCSIS Provisioning of EPON, DPoE™ MAC and Upper Layer Protocols Requirements", Cable Television Laboratories, Inc.
- [i.6] CM-SP-eDOCSIS-I26-130808, August 8, 2013: "eDOCSIS Specification", Cable Television Laboratories, Inc.
- [i.7] CM-SP-eRouter-I10-130808, August 8, 2013: "Data-Over-Cable Service Interface Specifications, eRouter Specification", Cable Television Laboratories, Inc.
- [i.8] CM-TR-L2VPN-DG-V02-121206, December 6, 2012: "L2VPN Development Guidelines Technical Report", Cable Television Laboratories, Inc.
- [i.9] MEF 6.1.1: "Layer 2 Control Protocol Handling Amendment to MEF 6.1", January 2012.
- [i.10] ETSI TS 101 909-6 (V1.1.1): "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 6: Media Terminal Adapter (MTA) device provisioning"
- [i.11] IETF RFC 2685: "Virtual Private Network Identifier", September 1999.
- [i.12] IETF RFC 3107: "Carrying Label Information in BGP-4", May 2001.
- [i.13] IETF RFC 3209: "RSVP-TE: Extensions to RSVP for LSP Tunnels", December 2001.
- [i.14] IETF RFC 3270: "Multi-Protocol Label Switching (MPLS) Support of Differentiated Services", May 2002.
- [i.15] IETF RFC 3985: "Pseudo-Wire Emulation Edge-to-Edge (PWE3) Architecture", March 2005.
- [i.16] IETF RFC 4363: "Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions", January 2006.
- [i.17] IETF RFC 4364: "BGP/MPLS IP Virtual Private Networks (VPNs)", February 2006.
- [i.18] IETF RFC 4664: "Framework for Layer 2 Virtual Private Networks (L2VPNs)", September 2006.
- [i.19] CM-SP-L2VPN-I12-I31120, November 20, 2013: "Layer 2 Virtual Private Networks", Cable Television Laboratories, Inc.
- [i.20] IEEE 802.1D: "IEEE Standard for Local and metropolitan area networks: Media Access Control (MAC) Bridges".

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.

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.

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 |