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Integrated broadband cable telecommunication networks (CABLE); IPv6 Transition Technology Engineering and Operational Aspects; Part 3: DS-Lite

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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee TC CABLE.

The present document is part 3 of a multi-part deliverable. Full details of the entire series can be found in part 1 [34].

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**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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Introduction

Considering the depletion of IPv4 addresses, transition to IPv6 is required in order to enable continued growth of the customer base connected to cable networks and ensure service continuity for existing and new customers. High-quality connectivity to all kinds of IP-based services and networks is essential in today's business and private life.

The present document accommodates an urgent need in the industry to implement and integrate the IPv6 transition technologies as specified by ETSI TS 101 569-1 [1] into their cable networks. The choice of the technology implemented depends on factors such as the business needs, current deployed architectures and plans for cost effectively transition from IPv4 to IPv6.

Current global IPv4 address space was projected to be depleted around the middle of 2012; depletion for the operator was estimated around end 2012. As part of the resulting roll-out of IPv6 in the operator's network, specific measures had to be taken to allow a smooth transition and coexistence between IPv4 and IPv6. ETSI developed requirements to address transition from IPv4 to IPv6 specifying six transition technologies as given by ETSI TS 101 569-1 [1] that were at the time considered to be the most appropriate to assist cable operators to transition there cable networks to IPv6.

Since then the industry has acquired more experience with the technology options settling in the main for DS-Lite across the cable network market and NAT64 IPv6 transition technologies across the mobile market.

The objective of the present document is to define the operational and engineering requirements to enable engineers to implement a seamless transition of the cable networks to IPv6 with the application of the DS-Lite transition technology.

The present document is the final part of a companion of ETSI standards developed in 4 phases to provide the cable sector in particular cable operators engineering and operational staff a standardized approach when integrating one of the five IPv6 transition technologies, NAT64, DS-Lite, 464XLAT, 6RD and MAP-E.

The first phase assessed the different IPv6 transition technology options being defined by industry with recommendation for the most appropriate with consideration of current network architectures, ensuring adequate scale and a cost effective transition approach from IPv4 to IPv6 as the IPv4 addresses deplete. The objective being to examine the pros and cons of the IPv6 transition technologies and recommend the most cost effective solution that would enable the cable operators to minimize the cost of upgrades to their existing network plant whilst maintain continuity of services to their present and new added customers. The details of the study are given by ETSI TR 101 569 [i.5].

In the second phase an ETSI technical specification was developed to specify technical requirements for six transition technologies that industry were considering for use by Cable Operators depending on the current state of their deployed cable network architecture, service model requirements and their IPv6 transition strategy as the IPv4 addresses depleted. These six IPv6 transition technologies are specified by ETSI TS 101 569-1 [1], covering NAT64, DS-Lite, 6RD, NAT44, 464XLAT and MAP-E.

In the third phase ETSI developed a series of conformance test specifications to enable the compliance verification of the five IPv6 transition technologies, NAT64, DS-Lite, 464XLAT, 6RD and MAP-E that were specified during phase 2 standardization. The conformance tests are developed against the requirements given by the ETSI TS 101 569-1 [1]. The series of conformance tests developed for each of the four transition technologies, are as given by ETSI TS 103 238 parts 1 [2] to 3 [4] respectively for NAT64; ETSI TS 103 239 parts 1 [5] to 3 [7] respectively for MAP-E; ETSI TS 103 241 parts 1 [8] to 3 [10] respectively for DS-Lite; ETSI TS 103 242 parts 1 [11] to 3 [13] respectively for XLAT and ETSI TS 103 243 parts 1 [14] to 3 [16] respectively for 6RD.

Phase 4 is the present project phase for development of technical specifications covering the operational and engineering requirements with the present document being part 3 of a multi-part series covering the IPv6 transition technology DS-Lite.

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1 Scope

The present document presents the engineering and operational requirements for the application of the IPv6 transition technology DS-Lite as defined by ETSI TS 101 569-1 [1] (IPv6 Transition Requirements) implemented within an integrated broadband cable network end to end across its network domains.

The present document is part 3 of a multi-part series and presents the operational aspects of the IPv6 transition technology DS-Lite across the cable network domains.

Only those elements of the network that have to be engineered to operate the IPv6 transition technology DS-Lite are presented. Descriptions and interface details of network elements that do not change are already addressed by the relevant equipment cable standards and therefore this information is not included in the present document.

The conformity of the DS-Lite implementation is relevant when assessing its implementation and operational requirements across the cable network to ensure the implementation is correctly engineered to conform to the requirements of the base standard ETSI TS 101 569-1 [1]. These conformance tests are not specified in the present document as they are already specified by ETSI TS 103 241 parts 1 to 3 [8], [9] and [10].

The operational aspects for the IPv6 transition technology DS-Lite are considered when engineered end to end across the cable network domains:

- CPE Home Networking Domain
- Access Network Domain
- Core Network Domain
- Data Center Domain
- DMZ Service Domain
- Transit and Peering Domain
- Management and Monitoring Domain
- Security Domain

The present document specifies the requirements to be considered when the defined IPv6 transition technology DS-Lite is engineered across the cable network domains.

2 References

2.1 Normative 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 referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

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

[1] ETSI TS 101 569-1: "Integrated Broadband Cable Telecommunication Networks (CABLE); Cable Network Transition to IPv6 Part 1: IPv6 Transition Requirements".

[2] ETSI TS 103 238-1: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for NAT64 technology; Part 1: Protocol Implementation Conformance Statement (PICS) proforma".

[3] ETSI TS 103 238-2: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for NAT64 technology; Part 2: Test Suite Structure and Test Purposes (TSS&TP)".

[4] ETSI TS 103 238-3: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for NAT64 technology; Part 3: Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

[5] ETSI TS 103 239-1: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for MAP-E technology; Part 1: Protocol Implementation Conformance Statement (PICS) proforma".

[6] ETSI TS 103 239-2: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for MAP-E technology; Part 2: Test Suite Structure and Test Purposes (TSS&TP)".

[7] ETSI TS 103 239-3: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for MAP-E technology; Part 3: Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

[8] ETSI TS 103 241-1: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for DS-Lite technology; Part 1: Protocol Implementation Conformance Statement (PICS) proforma".

[9] ETSI TS 103 241-2: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for DS-Lite technology; Part 2: Test Suite Structure and Test Purposes (TSS&TP)".

[10] ETSI TS 103 241-3: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for DS-Lite technology; Part 3: Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

[11] ETSI TS 103 242-1: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for 464XLAT technology; Part 1: Protocol Implementation Conformance Statement (PICS) proforma".

[12] ETSI TS 103 242-2: "Integrated broadband cable telecommunication networks (CABLE) Testing; Conformance test specifications for 464XLAT technology; Part 2: Test Suite Structure and Test Purposes (TSS&TP)".

[13] ETSI TS 103 242-3: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for 464XLAT technology; Part 3: Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

[14] ETSI TS 103 243-1: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for 6rd technology; Part 1: Protocol Implementation Conformance Statement (PICS) proforma".

[15] ETSI TS 103 243-2: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for 6rd technology; Part 2: Test Suite Structure and Test Purposes (TSS&TP)".

[16] ETSI TS 103 243-3: "Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for 6rd technology; Part 3: Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

[17] IETF RFC 6333 (August 2011): "Dual-Stack Lite Broadband Deployments Following IPv4 Exhaustion".

[18] IETF RFC 4459 (April 2006): "MTU and Fragmentation Issues with In-the-Network Tunneling".

[19] IETF RFC 6908 (March 2013): "Deployment Considerations for Dual-Stack Lite".

[20] IETF RFC 6334 (August 2011): "Dynamic Host Configuration Protocol for IPv6 (DHCPv6) Option for Dual Stack Lite".

[21] IETF RFC 2460 (December 1998): "Internet Protocol, Version 6 (IPv6) Specification".

[22] IETF RFC 4861 (September 2007): "Neighbor Discovery for IP version 6 (IPv6)".

[23] IETF RFC 4862 (September 2007): "IPv6 Stateless Address Autoconfiguration".

[24] CableLabs CM-SP-DOCSIS2.0-IPv6-I07-130404: "DOCSIS 2.0 + IPv6 Cable Modem Specification".

[25] CableLabs CM-SP-OSSIv3.0-I21-130404: "Operations Support System Interface Specification".

[26] ETSI EN 302 878-4: "Access, Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services - IP Cable Modems; Part 4: MAC and Upper Layer Protocols; DOCSIS 3.0".

[27] CableLabs CM-SP-eRouter-I18-160317: "IPv4 and IPv6 eRouter Specification".

[28] IETF RFC 4361 (February 2006): "Node-specific Client Identifiers for Dynamic Host Configuration Protocol Version Four (DHCPv4)".

[29] Broadband Forum Technical Report TR-069 (November 2013): "CPE WAN Management Protocol v1, Issue 1, Amendment 5".

[30] IETF RFC 3646 (December 2003): "DNS Configuration options for Dynamic Host Configuration Protocol for IPv6 (DHCPv6)".

[31] IETF RFC 6092 (January 2011): "Recommended Simple Security Capabilities in Customer Premises Equipment (CPE) for Providing Residential IPv6 Internet Service".

[32] IETF RFC 2872 (June 2000): "Application and Sub Application Identity Policy Element for use with RSVP".

[33] IETF RFC 6204, (April 2011): "Basic Requirements for IPv6 Customer Edge Routers".

[34] ETSI TS 103 443-1: "Integrated broadband cable telecommunication networks (CABLE); IPv6 Transition Technology Engineering and Operational Aspects; Part 1: General".

[35] IEEE 802.11n-2009™: "IEEE Standard for Information technology-- Local and metropolitan area networks-- Specific requirements-- Part 11: Wireless LAN Medium Access Control (MAC)and Physical Layer (PHY) Specifications Amendment 5: Enhancements for Higher Throughput".

[36] IEEE 802.11g-2003™: "IEEE Standard for Information technology-- Local and metropolitan area networks-- Specific requirements-- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Further Higher Data Rate Extension in the 2.4 GHz Band".

[37] IEEE 802.3-2015™: "IEEE Standard for Ethernet".

[38] IEEE 802.3u-1995™: "IEEE Standards for Local and Metropolitan Area Networks-Supplement - Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units and Repeater for 100Mb/s Operation, Type 100BASE-T (Clauses 21-30)".

[39] IETF RFC 6106: "IPv6 Router Advertisement Options for DNS Configuration".

[40] draft-ietf-pcp-base-12: "Port Control Protocol (PCP)".

[41] draft-ietf-pcp-base-13: "Port Control Protocol (PCP)".

[42] draft-ietf-pcp-base-29: "Port Control Protocol (PCP)".

2.2 Informative 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 referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

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] CableLabs.

NOTE: Available at http://www.cablelabs.com/specs/.

[i.2] IETF RFC 1918: "Address Allocation for Private Internets".

[i.3] draft-ietf-softwire-dual-stack-lite-05: "Dual-Stack Lite Broadband Deployments Following IPv4 Exhaustion.

[i.4] draft-ietf-softwire-gateway-init-ds-lite-05: " Gateway Initiated Dual-Stack Lite Deployment".

[i.5] ETSI TR 101 569: "Access, Terminals, Transmission and Multiplexing (ATTM); Integrated Broadband Cable and Television Networks; Cable Network Transition to IPv6".

3 Definitions and abbreviations

3.1 Definitions

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

4in6: encapsulation of IPv4 packets within IPv6 packet format

NAT44: network address translation from an IPv4 address to another IPv4 address

P Router: label switching router acting as a transit router in the core network of an MPLS network

3.2 Abbreviations

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

6PE	IPv6 Provider Edge
6VPE	IPv6 Virtual Private Network Provider Edge
A+P	Address + Port
AAA	Authentication, Authorization and Accounting
ACL	Access Control List
AF	Address Family
AFTR	Address Family Transition Router
ALG	Application Layer Gateway
ALP	Application-Level Proxy
AMPS	Amplifiers
AS	Autonomous System
ASCII	American Standard Code for Information Interchange
ASIC	Application Specific Integrated Circuit
ATFR	Address Family Transition Router
AV	Audio/Video
B2B	Business to Business
B2C	Business to Customer
B4	Basic Bridging BroadBand element

BCP	Best Current Practice
BFD	Bidirectional Forwarding Detection
BGP	Boarder Gateway Protocol
BNG	Broadband Network Gateway
BW	Bandwidth CPE customer premises equipment
CDP	Cisco Discovery Protocol
CE	Cable Edge
CEF	Cisco Express Forwarding
CLI	Command Line Interface
CMTS	Cable Modem Termination System
CoPP	Control Plane Policing
CPE	Customer Premise Equipment
CPU	Central Processing Unit
DAD	Duplicate Address Detection
DB	Data Base
dCEF	distributed Cisco Express Forwarding
DCU	Destination Class Usage
DF	Do not Fragment flag
DHCP	Dynamic Host Configuration
DMZ	De-Militarized Zone
DNS	Domain Name System
DR	Data Retention
DSCP	Differentiated Services Code Point
DS-Lite	Dual Stack-Lite
DUID	DHCP Unique Identifier
ECMP	Eqwual-Cost-Multi-Path
ECN	Explicit Congestion Notification
EUI	Extended Unique Identifier
FQDN	Fully Qualified Domain Name
FTP	File Transfer Protocol GW Gateway
GB	GigaByte
GRT	Global Routing Table
GW	GateWay
HA	High Availability
HA	High Availability
HD	High Definition
HDCP	typo; replace with DHCP
HFC	Hybrid Fibre Coax
HSRP	Hot Standby Router Protocol
IANA	Internet Assigned Numbers Authority
ICMP	Internet Control Message Protocol
ID	Identifier
IE	Internet Explorer (trade name)
IGP	Interior Gateway Protocol
IMAP	Internet Message Access Protocol
IMIX	Internet Mix
IP	Internet Protocol
IPE	Internal Provider Edge
IP-FIX	Internet Protocol Flow Information Export
IPFIX	IP Flow Information Export PPTP Point-to-Point Tunnelling Protocol
IPSec	IP Security
IPv4	IP version 4
IPv6	IP version 6
IRC	Internet Relay Chat
ISA	Intermediate System Architecture
ISIS	Intermediate System to Intermediate System
ISSU	In-Service Software Upgrade
IXCF	Internet Exchange Communication Function
IX-PE	Internet eXchange Provider Edge
IXPE	Internet Exchange Provider Edge
LAN	Local Area Network
LB	Load Balancing