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Foreword

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

The present document is part 5 of a multi-part deliverable. Full details of the entire series can be found in part 1 [25].

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 464XPAT 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.2].

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, DSLite, 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 part 1 [2] to 3 [4] respectively for NAT64; ETSI TS 103 239 part 1 [5] to 3 [7] respectively for MAP-E; ETSI TS 103 241 part 1 [8] to 3 [10] respectively for DS-Lite; ETSI TS 103 242 part 1 [11] to 3 [13] respectively for XLAT and ETSI TS 103 243 part 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 5 of a multi-part series covering the IPv6 transition technology 464XPAT.

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1 Scope

The present document presents the engineering and operational requirements for the application of the IPv6 transition technology 464XPAT 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 5 of a multi-part series and presents the operational aspects of the IPv6 transition technology 464XPAT across the cable network domains.

Only those elements of the network that have to be engineered to operate the IPv6 transition technology 464XPAT 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 464XPAT 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 103 242 part 1 [11] to 3 [13].

The operational aspects for the IPv6 transition technology 464XPAT are considered when engineered end to end across the cable network domains;

- CPE Home Networking Domain
- Access Network Domain
- Core Network Domain
- Data Centre 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 464XPAT 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 4459 (April 2006): "MTU and Fragmentation Issues with In-the-Network Tunnelling".

[18] IETF RFC 6877 (April 2013): "464XLAT - Combination of Stateful and Stateless Translation".

[19] IETF RFC 6145 (April 2011): "IP/ICMP Translation Algorithm".

[20] IETF RFC 6791 (November 2012): "Stateless Source Address Mapping for ICMPv6 Packets".

[21] IETF RFC 6052: "IPv6 Addressing of IPv6/IPv4 Translators".

[22] IETF RFC 6146 (April 2011): "Stateful NAT64: Network Address and Protocol Translation from IPv6 Clients to IPv4 Servers".

[23] IETF RFC 7269 (June 2014): "NAT64 Deployment Options and Experience".

[24] IETF RFC 6147: "DNS64: DNS Extension for Network Address Translation from IPv6 Clients toIPv4 Servers", April 2011.

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

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

[i.3] ETSI TS 103 443-2: "Integrated broadband cable telecommunication networks (CABLE); IPv6 Transition Technology Engineering and Operational Aspects; Part 2: NAT64".

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

Stateful Translation: process of converting IPv4 to IPv6 addresses and vice versa whereby the translating device maintains a mapping table with entries binding IPv6 addresses to IPv4 addresses

NOTE: In this case, an IPv4 address can be mapped to any IPv6 address (certain restrictions apply to the usable address space).

Stateless Translation: process of converting IPv4 to IPv6 addresses and vice versa by applying a well-defined mapping algorithm

NOTE: In this case, an IPv4 address is always mapped to the same IPv6 address (a specific IPv6 range is reserved for the algorithm to operate in).

3.2 Abbreviations

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

6PE	IPv6 Provider Edge
6RD	IPv6 Rapid Deployment
AAAA	Quad-A Resource Record
ALG	Application Layer Gateway
AMPS	Amplifiers
ASCII	American Standard Code for Information Interchange
ASIC	Application Specific Integrated Circuit
B4	Basic Bridging BroadBand element
BGP	Boarder Gateway Protocol
BNG	Broadband Network Gateway
CLAT	Customer-side transLATor
CMTS	Cable Modem Termination System
CPE	Customer Premises Equipment
CPU	Central Processing Unit
DHCP	Dynamic Host Configuration
DMZ	Demilitarised Zone
DNS	Domain Name System
DOCSIS 3.0	Data over Cable System Interface Specification version 3.0
DR	Data Retention
DSCP	Differentiated Services Code Point
DS-Lite	Dual Stack-Lite
FTP	File Transfer Protocol GW Gateway
GRT	Global Routing Table
GW	GateWay
HA	High Availability
HFC	Hybrid Fibre Coax
ICMP	Internet Control Message Protocol
ID	Identifier
IGP	Interior Gateway Protocol
IMIX	Internet Mix
IP	Internet Protocol
IPFIX	IP Flow Information Export
IPv4	IP version 4
IPv6	IP version 6
IRB	Integrated Routing and Bridging
IXPE	Internet Exchange Provider Edge
LAN	Local Area Network
LI	Lawful Intercept
LSN	Large Scale NAT
MAP-E	Mapping of Address and Port - Encapsulation mode
MPLS	MultiProtocol Label Switching
MSS	Maximum Segment Size
MTU	Maximum Transmission Unit
NAT	Network Address Translation
NAT44	Network Address Translation IPv4 to IPv4
NAT64	Network Address Translation IPv6 to IPv4
NFv9	Netflow Version 9
NPU	Network Processing Unit
PCP	Port Control Protocol
PE	Provider Edge
PLAT	Provider-side ransLATor
PMTU	Path Maximum Transport Unit
PPTP	Point-to-Point Tunnelling Protocol
PPTP	Point-to-Point Tunnelling Protocol
QoS	Quality of Service
RADIUS	Remote Authentication Dial-In User Service
RDT	Reliable Data Transfer

RFC	Request For Comments
RG	Residential Gateway
RTCP	Real-Time Transmission Control Protocol
RTP	Real-Time Protocol
RTSP	Real-Time Streaming Protocol
SEND	SEcure Neighbour Discovery
SIIT	Stateless IP/ICMP Translator
SIP	Session Initiated Protocol
SVI	Switched Virtual Interface
SYSLOG	Syslog Protocol
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
VRF	Virtual Routing and Forwarding
XLAT	transLATor
XML	eXtensible Markup Language

4 General Considerations

4.1 Background

The present document is part of a series of ETSI technical specifications specifying requirements to engineer and operate the 464XPAT transition technology end to end across a cable operator's network. Its implementation would ensure the network provider can continue to provide business continuity throughout the depletion of publicly routable IPv4 addresses and the subsequent rollout and migration to IPv6 in the operator's network.

To aid this transition some sectors of industry are currently evaluating 464XPAT but it has been considered as a last resort technology. This technology allows customers to access services natively over IPv6 and through translation over IPv4.

4.2 General Overview

An objective of deploying the IPv6 transition technology is to provide a seamless experience to users accessing IPv6 network services through legacy IPv4 only networks and to enable current and new content to be delivered seamlessly to IPv4 users by deploying network address translation IPv4 to IPv6 (464XLAT).

It should be noted that Cable broadband access networks may vary in build and design with characteristics that may be vendor equipment specific. Consequently there may be aspects to the engineering and operation of the IPv6 transition technology 464XLAT that are dependent on the network build and vendor specific equipment deployed.

The present document does not offer information that may be vendor and network build specific since such information may be confidential to the network operator and/or based on proprietary data.

The present document assumes the reader is familiar with the cable network architecture requirements since the description of the various elements within a cable network across its domains are already defined by ETSI standards and standards developed by CableLabs [i.1]. The present document details only the changes to the network aspects when operating the transition technology 464XLAT.

The present document uses network address translation IPv4 to IPv6 (464XLAT) technology to provide a seamless Internet experience to users accessing IPv4 Internet services from an IPv6 only client through a cable network enabling service providers to transparently deliver and enable new and existing services to IPv6 internet users with little or no change in their existing network infrastructure.

The network elements required to implement the IPv6 transition technology 464XPAT across the cable network domains is as illustrated by figure 1.