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Integrated broadband cable telecommunication networks (CABLE); Testing; Conformance test specifications for NAT64 technology; Part 2: Test Suite Structure and Test Purposes (TSS&TP)

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Contents

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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 produced for the transition technologies accommodates an urgent need in the industry to define requirements that enable seemless transition of Cable Networks to IPv6. 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.

A plethora of transition technologies have been proposed in IETF, other standardization organizations and by manufacturers of IP technology to allow coexistence of IPv4 and IPv6 hosts, access and core networks as well as services. Each of these technology options is specified, implemented and deployed in various forms and stages. The present document is based on the requirements of ETSI TS 101 569-1 [1].

The present document is part 2 of a multi-part deliverable covering the conformance test specification for NAT64 technology:

Part 1: "Protocol Implementation Conformance Statement (PICS) proforma";

Part 2: "Test Suite Structure and Test Purposes (TSS&TP)";

Part 3: "Abstract Test Suite (ATS) and Protocol Implementation eXtra Information for Testing (PIXIT)".

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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document provides the Test Suite Structure and Test Purposes (TSS&TP) descriptions for the IPv6 transition technology NAT64 to validate its implementation within a cable communications networks.

The tests are in reference to [1], the ETSI specifications for IPv6 transition technology.

The ISO standard for the methodology of conformance testing (ISO/IEC 9646-1 [i.1] and ISO/IEC 9646-2 [i.2]) as well as the ETSI rules for conformance testing (ETS 300 406 [i.3]) are used as a basis for the test methodology.

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 reference 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".

2.2 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 reference 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] ISO/IEC 9646-1 (1994): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 1: General concepts".

[i.2] ISO/IEC 9646-2 (1994): "Information technology -- Open Systems Interconnection -- Conformance testing methodology and framework -- Part 2: Abstract Test Suite specification".

[i.3] ETSI ETS 300 406 (1995): "Methods for testing and Specification (MTS); Protocol and profile conformance testing specifications; Standardization methodology".

3 Abbreviations

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

ALG	Application Layer Gateway
ATS	Abstract Test Suite
B4	(NAT64) Basic Bridging BroadBand element

CPE	Customer Premises Equipment
DF	Do not Fragment flag (in IPv4 header)
FTP	File Transfer Protocol
GRT	Global Routing Table
GW	GateWay
HTML	HyperText Markup Language
ICMP	Internet Control Message Protocol
IP	Internet Protocol
IPv4	IP version 4
IPv6	IP version 6
IUT	Implementation Under Test
LSN	Large Scale NAT
MSS	(TCP) Maximum Segment Size
MTS	Methods for Testing and Specification
MTU	Maximum Transmission Unit
NAT	Network Address Translation/Network Address Translator
NPU	Network Processing Unit
PICS	Protocol Implementation Conformance Statement
PPTP	Point to Point Tunelling Protocol
RTSP	Real Time Streaming Protocol
SIP	Session Initiation Protocol
TC	Test Case
TCP	Transmission Control Protocol
TP	Test purpose
VRF	Virtual Routing and Forwarding

4 Test Suite Structure

The identifier of the TP is built according to table 1 as recommended in the MTS methodologies.

Table 1: TP naming convention

TP/<root>/<gr>/<sgr>/<x>/<nn>		
<root> = root	NAT64	Mapping of Address and Port – Encapsulation Mode
<gr> = group	LSN	Large Scale NAT
<sgr> = sub-group	BF	Basic Function
	NP	NAT Pools
	AW	Address Withdrawal
	FRAG	Fragmentation
	MSSC	Maximum Segment Size Clamping
	SPR	Static Port Reservation
	NT	NAT Timers
	ALG	Application Layer Gateways
	RT	Routing Tables
	AA	Anycast Addressing
	RED	Redundancy
	LB	Load-balancing
	FE	Failure Events
<x> = type of testing	BV	Valid Behaviour tests
<nn> = sequential number		01 to 99
NOTE: A sub-group may not apply for all groups.		

5 Test Purposes

Proposes a TP proforma which is used in the present document. The fields of this proforma as used in the present document are explained in table 2.

Table 2: TP proforma field description

TP Header	
TP ID	The TP ID is a unique identifier according to the TP naming conventions in tables
Test objective	Short description of test purpose objective according to the requirements from the base standard.
Reference	The reference indicates the clauses of the reference standard specifications in which the conformance requirement is expressed.
TP Behaviour	
Initial conditions (optional)	The initial conditions define in which initial state the IUT has to be to apply the actual TP. In the corresponding "Test Case" (TC), when the execution of the initial condition does not succeed, it leads to the assignment of an Inconclusive verdict.
Expected behaviour (TP body)	Definition of the events, which are parts of the TP objective, and the IUT are expected to perform in order to conform to the base specification. In the corresponding TC, "Pass" or "Fail" verdicts can be assigned there.

5.1 TPs for LSN

5.1.1 Basic Function

TP Id	TP/NAT64/LSN/BF/BV/01
Test objective	Check that the IUT supports the functionality of NAT64 1:1 NAT mapping
Reference	[1]:6.5.7.9 1:1 IP Mapping
Initial conditions	
with { the IUT being properly provisioned and the interfaces are connected & functional }	
Expected behaviour	
ensure that { **when {** the IUT receives multiple IPv6 packets containing IPv6 transport header containing source address indicating client IPv6 address containing destination address indicating IUT GW IPv6 prefix first 64 bits indicating IUT IPv4 embedded into the IPv6 address in last 64 bits from multiple client devices } **then {** the IUT does a 1:1 NAT mapping for each public IPv6 Client address sourced and the IUT forwards packets to the destination with different IPv4 public addresses } }	

P Id	TP/NAT64/LSN/BF/BV/02
Test objective	Check that the IUT supports the functionality of NAT64 1:n NAT mapping with port translation
Reference	[1]:6.4.4.4 Feature: Shared/Split Resources
Initial conditions	

with {
the IUT was properly provisioned
the interfaces are connected & functional
}	

Expected behaviour	

ensure that {
when {
the IUT receives multiple IPv6 packets
containing IPv6 transport header
containing source address
indicating client IPv6 address
containing destination address
indicating IUT GW IPv6 prefix first 64 bits
indicating IUT IPv4 embedded into the IPv6 address in last 64 bits
from multiple client devices
}
then {
the IUT does a 1:n NAT mapping for multiple public IPv6 B4 addresses sourced
and the IUT forwards packets to the destination with the same public IPv4 source address
}
}	

5.1.2 NAT Pools

TP Id	TP/NAT64/LSN/NP/BV/01
Test objective	Check that the IUT supports the functionality of multiple NAT pools per prefix
Reference	[1]:6.4.6.10 Feature: NAT Grouping resource Sharing // [1]:6.4.4.4] Feature: Shared/Split Resources
Initial conditions	

with {
the IUT was properly provisioned
the interfaces are connected & functional and,
the six clients being configured with two separate prefixes, one prefix for three clients.
}	

Expected behaviour	

ensure that {
when {
the IUT receives multiple IPv6 packets
containing IPv6 transport header
containing source address
indicating client IPv6 address
containing destination address
indicating IUT GW IPv6 prefix first 64 bits
indicating IUT IPv4 embedded into the IPv6 address in last 64 bits
from multiple client devices
}
then {
the IUT does a 1:n NAT mapping for multiple public IPv6 client addresses sourced
and the IUT forwards packets to the destination with some of the same and some different public IPv4 source address matching the NAT pools dependent on the prefix assigned
}
}	

5.1.3 Address Withdrawal

P Id	TP/NAT64/LSN/AW/BV/01
Test objective	Check that the IUT supports LSN GW address withdrawal on cache failure
Reference	[1]:6.4.6.16 NAT64 Address Withdrawal
Initial conditions	
with { the IUT was properly provisioned the interfaces are connected & functional }	
Expected behaviour	
ensure that { **when {** the IUT receives multiple IPv6 packets containing IPv6 transport header containing source address indicating client IPv6 address containing destination address indicating IUT GW IPv6 prefix first 64 bits indicating IUT IPv4 embedded into the IPv6 address in last 64 bits containing TCP payload **and** the cache is removed } **then {** the IUT withdraws its Gateway Prefix } }	

P Id	TP/NAT64/LSN/AW/BV/02
Test objective	Check that the IUT supports LSN GW address withdrawal on route failure
Reference	[1]:6.4.6.16 NAT64 Address Withdrawal
Initial conditions	
with { the IUT was properly provisioned the interfaces are connected & functional }	
Expected behaviour	
ensure that { **when {** the IUT receives multiple IPv6 packets containing IPv6 transport header containing source address indicating client IPv6 address containing destination address indicating IUT GW IPv6 prefix first 64 bits indicating IUT IPv4 embedded into the IPv6 address in last 64 bits containing TCP payload **and** the routes are removed for the next hop } **then {** the IUT withdraws its Gateway Prefix } }	

P Id	TP/NAT64/LSN/AW/BV/03
Test objective	Check that the IUT supports LSN GW address withdrawal on hardware failure
Reference	[1]:6.4.6.16 NAT64 Address Withdrawal
Initial conditions	

with {
the IUT was properly provisioned
the interfaces are connected & functional
}	

Expected behaviour	

ensure that {
when {
the IUT receives multiple IPv6 packets
containing IPv6 transport header
containing source address
indicating client IPv6 address
containing destination address
indicating IUT GW IPv6 prefix first 64 bits
indicating IUT IPv4 embedded into the IPv6 address in last 64 bits
containing TCP payload
and the processing hardware simulates a failure
}
then {
the IUT withdraws its Gateway Prefix
}
}	

5.1.4 Fragmentation

TP Id	TP/NAT64/LSN/FRAG/BV/01
Test objective	Check that the IUT fragments an HTML IPv4 packet downstream
Reference	[1]:6.4.6.20 LSN Fragmentation and Buffering
Initial conditions	

with {
the IUT was properly provisioned
the interfaces are connected & functional
the physical MTU (Phy-MTU) size being equal or greater than the IPv4 or IPv6 packet between all devices
and the NAT64 MTU being higher than the IPv4 packet
}	

Expected behaviour	

ensure that {
when {
the IUT receives an HTML IPv4 packet from the internet
containing source address
indicating a private IPv4 address
containing the DF bit
indicating the value 0.
with a packet size greater than the NAT64-Tunnel-MTU
}
then {
the IUT fragments the IPv4 packet before it encapsulates it in IPv6
and the IUT forwards correctly formatted fragmented packets
}
}	

5.1.5 MSS Clamping

TP Id	TP/NAT64/LSN/MSSC/BV/01
Test objective	Check that the IUT functions with MSS clamping
Reference	[1]:6.4.9 Technical Viability
Initial conditions	
with { the physical MTU (Phy-MTU) size being equal or greater than the IPv6 packet between all devices and the MTU (IPv6-MTU) being lower than the originating IPv6 packet and the MSS value is below that of the TCP segment size of the incoming packet }	
Expected behaviour	
ensure that { **when {** the IUT receives an HTML IPv4 packet containing source address indicating a private IPv4 address with a segment size greater than the IUT MSS value } **then {** and the IUT drops the packet & returns a packet-too-big message to the originator } }	

5.1.6 Static Port & IP Reservation

TP Id	TP/NAT64/LSN/SPR/BV/01
Test objective	Check that the IUT functions with static port reservation per prefix downstream
Reference	[1]:6.4.6.22 Feature: Port Reservation
Initial conditions	
with { the IUT was properly provisioned the interfaces are connected & functional the static entries of well known ports for a singular prefix is configured on the IUT }	
Expected behaviour	
ensure that { **when {** the IUT receives multiple IPv4 packets downstream containing IPv4 transport header containing source address indicating client IPv4 public address containing destination address indicating client IPv4 public static address } **then {** Traffic using the static port forward is forwarded to an internal client by the IUT } }	

5.1.7 NAT Timers

TP Id	TP/NAT64/LSN/NT/BV/01
Test objective	Check that the IUT TCP_time_wait timer expires when required
Reference	[1]:6.4.6.4 NAT64 LSN timers

Initial conditions

with {
the IUT being properly provisioned
and the interfaces are connected & functional
and **the IUT TCP_time_wait timer being set**
and the IUT having received an IPv6 packet
containing TCP payload
indicating port numbers
}

Expected behaviour

ensure that {
when {
the TCP_time_wait timer expires
and the IUT having received a second IPv6 packet
containing source address
indicating a different IPv6 address to the first IPv6 packet
containing TCP payload
indicating the same port numbers as the first originating packet
}
then {
the IUT decapsulates the IPv4 packet
and the IUT forwards it on
}
}

5.1.8 Application Layer Gateway

TP Id	TP/NAT64/LSN/ALG/BV/01
Test objective	Check that the IUT supports FTP forwarding through an ALG
Reference	[1]:6.4.1 LSN Feature Summary

Initial conditions

with {
the IUT being properly provisioned
and the interfaces are connected & functional
and the IUT being configured with FTP ALG set to active
and the FTP client being authenticated with the FTP server
}

Expected behaviour

ensure that {
when {
the IUT receives multiple IPv6 packets
containing IPv6 transport header
containing source address
indicating client IPv6 address
containing destination address
indicating IUT GW IPv6 prefix first 64 bits
indicating IUT IPv4 embedded into the IPv6 address in last 64 bits
containing TCP payload
indicating port number 20
}
then {
the IUT forwards the FTP packet to the FTP server
the IUT creates the corresponding NAT binding
}
}

TP Id	TP/NAT64/LSN/ALG/BV/02
Test objective	Check that the IUT supports SIP forwarding through an ALG
Reference	[1]:6.4.1 LSN Feature Summary

Initial conditions

```
with {
    the IUT being properly provisioned
    and the interfaces are connected & functional
    and the IUT being configured with SIP ALG set to active
    and the SIP client being authenticated with the SIP server
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives multiple IPv6 packets
            containing IPv6 transport header
                containing source address
                    indicating client IPv6 address
                containing destination address
                    indicating IUT GW IPv6 prefix first 64 bits
                    indicating IUT IPv4 embedded into the IPv6 address in last 64 bits
                containing TCP payload
                    indicating port number 5060
    }
    then {
        the IUT forwards the SIP packet to the SIP client
        the IUT creates the corresponding NAT binding
    }
}
```

TP Id	TP/NAT64/LSN/ALG/BV/03
Test objective	Check that the IUT supports RTSP forwarding through an ALG
Reference	[1]:6.4.1 LSN Feature Summary

Initial conditions

```
with {
    the IUT being properly provisioned
    and the interfaces are connected & functional
    and the IUT being configured with RTSP ALG set to active
    and an RTSP session is setup from a client on behind the CPE and a server behind the LSN
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives multiple IPv6 packets
            containing IPv6 transport header
                containing source address
                    indicating client IPv6 address
                containing destination address
                    indicating IUT GW IPv6 prefix first 64 bits
                    indicating IUT IPv4 embedded into the IPv6 address in last 32 bits
                containing TCP payload
                    indicating port number 5060
    }
    then {
        the IUT forwards the RTSP packet to the RTSP server
        the IUT creates the corresponding NAT binding
    }
}
```

TP Id	TP/NAT64/LSN/ALG/BV/04
Test objective	Check that the IUT supports PPTP forwarding through an ALG
Reference	[1]:6.4.1 LSN Feature Summary

Initial conditions

```
with {
    the IUT being properly provisioned
    and the interfaces are connected & functional
    and the IUT being configured with PPTP ALG set to active
    and a PPTP session is setup from a client on behind the CPE and a server behind the LSN
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives multiple IPv6 packets
            containing IPv6 transport header
                containing source address
                    indicating client IPv6 address
                containing destination address
                    indicating IUT GW IPv6 prefix first 64 bits
                    indicating IUT IPv4 embedded into the IPv6 address in last 32 bits
                containing TCP payload
                    indicating port number 5060
    }
    then {
        the IUT forwards the PPTP packet to the PPTP server
        the IUT creates the corresponding NAT binding
    }
}
```

TP Id	TP/NAT64/LSN/ALG/BV/05
Test objective	Check that the IUT supports ICMP translation
Reference	[1]:6.4.1 LSN Feature Summary

Initial conditions

```
with {
    the IUT being properly provisioned
    and the interfaces are connected & functional
}
```

Expected behaviour

```
ensure that {
    when {
        the IUT receives multiple ICMP IPv6 packets
            containing IPv6 transport header
                containing source address
                    indicating client IPv6 address
                containing destination address
                    indicating IUT GW IPv6 prefix first 64 bits
                    indicating IUT IPv4 embedded into the IPv6 address in last 64 bits
    }
    then {
        the IUT forwards the ICMP packets in IPv4 after translation
    }
}
```

5.1.9 Routing Tables

TP Id	TP/NAT64/LSN/RT/BV/01
Test objective	Check that the IUT supports forwarding from GRT TO VRF
Reference	[1]:6.4.1 LSN Feature Summary
Initial conditions	
with { the IUT being properly provisioned, and the interfaces are connected & functional, and the routing tables are configured GRT upstream ingress & VRF upstream egress }	
Expected behaviour	
ensure that { **when {** the IUT receives multiple IPv6 packets containing IPv6 transport header containing source address indicating client IPv6 address containing destination address indicating IUT GW IPv6 prefix first 64 bits indicating IUT IPv4 embedded into the IPv6 address in last 64 bits } **then {** the IUT forwards the IPv4 packets once translated } }	

TP Id	TP/NAT64/LSN/RT/BV/02
Test objective	Check that the IUT supports forwarding from VRF TO GRT
Reference	[1]:6.4.1 LSN Feature Summary
Initial conditions	
with { the IUT being properly provisioned, and the interfaces are connected & functional, and the routing tables are configured VRF upstream ingress & GRT upstream egress }	
Expected behaviour	
ensure that { **when {** the IUT receives multiple IPv6 packets containing IPv6 transport header containing source address indicating client IPv6 address containing destination address indicating IUT GW IPv6 prefix first 64 bits indicating IUT IPv4 embedded into the IPv6 address in last 64 bits } **then {** the IUT forwards the IPv4 packets once translated } }	

5.1.10 Anycast Addressing

TP Id	TP/NAT64/LSN/AA/BV/01
Test objective	Check that the IUT supports Anycast GW addressing
Reference	[1]:6.4.6.14 Feature: Anycast Gateway Address
Initial conditions	
with { the IUT is properly provisioned the interfaces are connected & functional the IUT is configured with an Anycast address]	
Expected behaviour	
ensure that { **when {** the IUT receives multiple IPv6 packets containing IPv6 transport header containing source address indicating client IPv6 address containing destination address indicating IUT GW IPv6 prefix first 64 bits indicating IUT IPv4 embedded into the IPv6 address in last 64 bits from multiple client devices **then {** and the IUT forwards packets to the destination } }	

5.1.11 Redundancy

TP Id	TP/NAT64/LSN/RED/BV/01
Test objective	Check that the IUT supports Redundant NPUs
Reference	[1]:6.4.1 NAT64 LSN Technology Feature Summary
Initial conditions	
with { the IUT is properly provisioned the interfaces are connected & functional the IUT is configured with redundant NPUs]	
Expected behaviour	
ensure that { **when {** the IUT receives multiple IPv6 packets containing IPv6 transport header containing source address indicating client IPv6 address containing destination address indicating IUT GW IPv6 prefix first 64 bits indicating IUT IPv4 embedded into the IPv6 address in last 32 bits from multiple client devices the active NPU is removed from the IUT **then {** the IUT forwards packets to the destination before the NPU removal and the IUT forwards packets to the destination after the NPU removal } }	

5.1.12 Load-Balancing

TP Id	TP/NAT64/LSN/LB/BV/01
Test objective	Check that the IUT supports load-balancing across NPUs
Reference	[1]:6.4.4.5 Feature: Traffic Based Load Balanced NPUs
Initial conditions	
with { the IUT is properly provisioned the interfaces are connected & functional the IUT is configured with multiple NPUs]	
Expected behaviour	
ensure that { **when {** the IUT receives multiple IPv6 packets containing IPv6 transport header containing source address indicating client IPv6 address containing destination address indicating IUT GW IPv6 prefix first 64 bits indicating IUT IPv4 embedded into the IPv6 address in last 32 bits from multiple client devices **then {** the IUT forwards packets to the destination using all NPUs in the system according to load-balancing rules } }	

5.1.13 Failure Events

TP Id	TP/NAT64/LSN/FE/BV/01
Test objective	Check that the IUT withdraws its IPv6 prefix when all NPUs fail
Reference	[1]:6.4.6.16 Feature: NAT64 Address Withdrawal
Initial conditions	
with { the IUT is properly provisioned the interfaces are connected & functional the IUT is configured with multiple NPUs]	
Expected behaviour	
ensure that { **when {** the IUT receives multiple IPv6 packets containing IPv6 transport header containing source address indicating client IPv6 address containing destination address indicating IUT GW IPv6 prefix first 64 bits indicating IUT IPv4 embedded into the IPv6 address in last 32 bits from multiple client devices and all NPUs are removed from the IUT **then {** the IUT forwards packets to the destination using all NPUs in the system before NPU removal and the IUT withdraws its IPv6 prefix when all NPUs in the system are removed } }	

TP Id	TP/NAT64/LSN/FE/BV/02
Test objective	Check that the IUT withdraws its IPv6 prefix when the NAT64 instance is shut down
Reference	[1]:6.4.6.16 Feature: NAT64 Address Withdrawal
Initial conditions	
with { the IUT is properly provisioned the interfaces are connected & functional the IUT is configured with multiple NPUs]	
Expected behaviour	
ensure that { **when {** the IUT receives multiple IPv6 packets containing IPv6 transport header containing source address indicating client IPv6 address containing destination address indicating IUT GW IPv6 prefix first 64 bits indicating IUT IPv4 embedded into the IPv6 address in last 32 bits from multiple client devices and the NAT64 function on the IUT is shut down **then {** the IUT forwards packets to the destination using all NPUs in the system before NPU removal and the IUT withdraws its IPv6 prefix when the NAT64 function is shut down } }	

Annex A (informative): Bibliography

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History

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V1.1.1	January 2015	Publication