IPv6 Ready

SRv6

SRv6 Conformance Test Specification

Technical Document
Revision 0.0.1

Table of Contents

Acknowledgments

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Introductions

The IPv6 forum plays a major role to bring together industrial actors, to develop and deploy the new generation of IP protocols. Contrary to IPv4, which started with a small closed group of implementers, the universality of IPv6 leads to a huge number of implementations. Interoperability has always been considered as a critical feature in the Internet community. Due to the large number of IPv6 implementations, it is important to give to the market a strong signal proving the interoperability degree of various products.

To avoid confusion in the mind of customers, a unique logo program has been defined. The IPv6 logo gives confidence to users that IPv6 is currently operational. It is also a clear indication that the technology will still be used in the future. This logo program contributes to the feeling that IPv6 is available and ready to be used.

Segment Routing over IPv6 (SRv6) leverages IPv6 extension headers for source routing. SRv6 provides the ability to code directly into each packet header where the traffic should be sent and how the traffic should be treated. Note this document only tests SRv6, and has no testable items for SR MPLS.

Definitions

MTU	Maximum Transmission Unit
RUT	Router Under Test
SR	Segment Routing
SRH	Segment Routing Header
TLLA	Target Link-layer Address
TN	Test Node
TR	Test Router

Test Organization

This document organizes tests by group based on related test methodology or goals. Each group begins with a brief set of comments pertaining to all tests within that group. This is followed by a series of description blocks; each block describes a single test. The format of the description block is as follows:

Test Label	The **Test Label** is the first line of the test page. It will have the following form: IP.A.B Where each component indicates the following: IP – Test Suite Identifier A – Group Number B – Test Number Scripts implementing this test suite should follow this convention, and may also append a character in the set [a-z] indicating a particular test part.
Purpose	The **Purpose** is a short statement describing what the test attempts to achieve. It is usually phrased as a simple assertion of the feature or capability to be tested.
Advanced Functionality	The **Advanced Functionality** gives an indication of whether the test case is covered by one or more optional functions as defined in the Advanced Functionality Tests. These tests may be omitted if the functionality is not supported by the Node Under Test. If this is not in a test case, there are no advanced functionalities listed.
References	The **References** section lists cross-references to the specifications and documentation that might be helpful in understanding and evaluating the test and results
Test Setup	The **Test Setup** section describes the configuration of all devices prior to the start of the test. Different parts of the procedure may involve configuration steps that deviate from what is given in the test setup. If a value is not provided for a protocol parameter, then the protocol's default is used for that parameter.
Procedure and Expected Behavior	The **Procedure and Expected Behavior** table contains the step-by-step instructions for carrying out the test. These steps include such things as enabling interfaces, unplugging devices from the network, or sending packets from a test station. The test procedure also cues the tester to make observations of expected behavior, as needed, as not all steps require observation of results. If any behavior is expected for a procedure, it is to be observed prior to continuing to the next step. Failure to observe any behavior prior to continuing constitutes a failed test. Note, that while test numbers continue between test parts, each test part is to be executed independently (Following Common Test Setup and Cleanup as indicated), and are not cascaded from the previous part.
Possible Problems	The **Possible Problems** section contains a description of known issues with the test procedure, which may affect test results in certain situations.

References

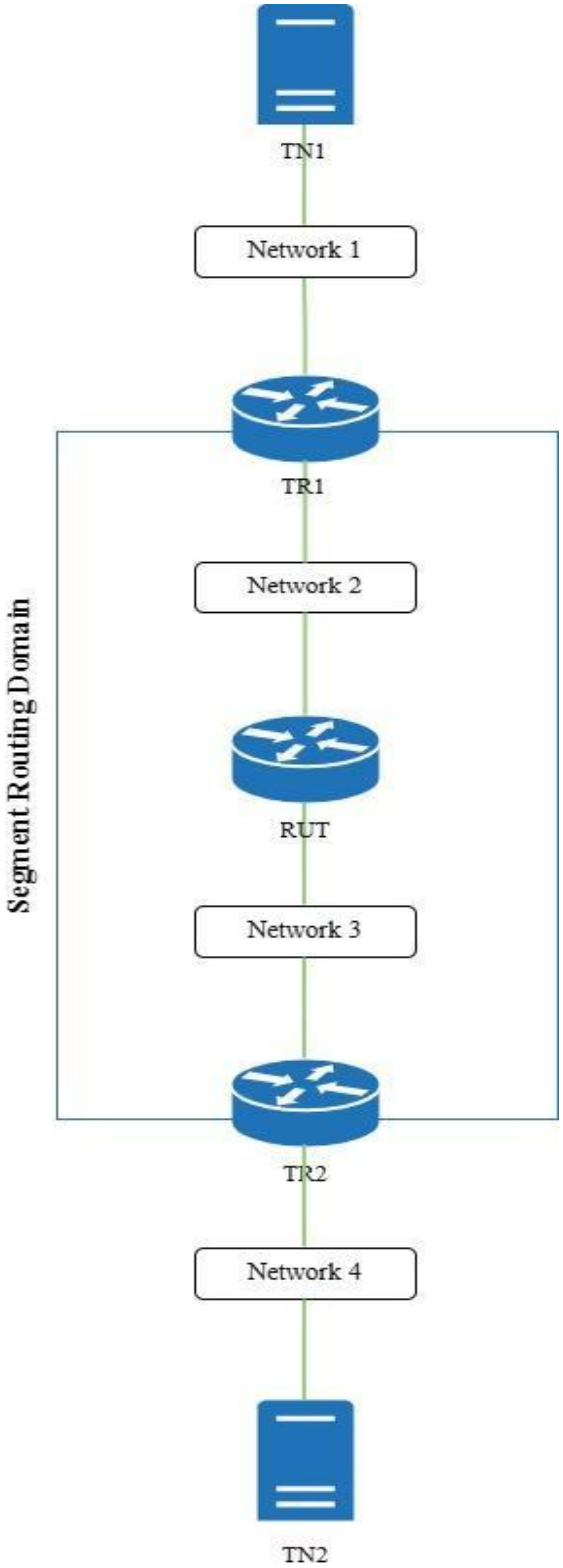
The following documents are referenced in these texts:

[SR] C. Filsfils, S. Previdi, L. Ginsberg, B. Decraene, S. Litkowski, R. Shakir, Segment Routing Architecture, RFC 8402.

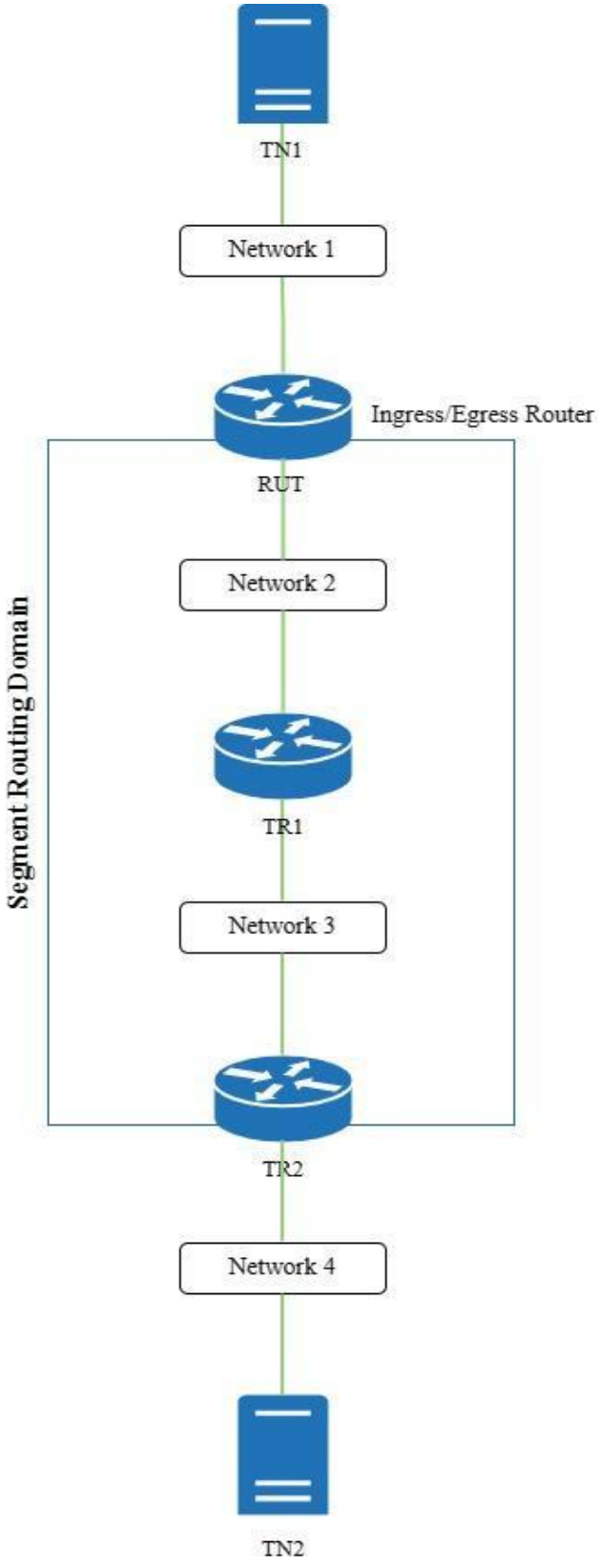
[IPV6-SRH] C. Filsfils, D. Dukes,S. Previdi, J. Leddy, S. Matsushima, D. Voyer, IPv6 Segment Routing Header (SRH), RFC 8754.

[SRv6] C. Filsfils, P. Camarillo, J. Leddy, D. Voyer, S. Matsushima, Z. Li, Segment Routing over IPv6 (SRv6) Network Programming, RFC 8986.

Common Topology A



Common Topology B



Advanced Functionality Tests

TLV:

Possible Problem Summary

The following test cases have documented possible problems that allow for altered or omitted steps in their procedures. Please see each specific test case listed for more information:

- None

Section 1: IPv6 Segment Routing

Overview
Tests in this group verify that a router properly implements the IPv6 Segment Routing Architecture. This includes basic configuration and security for the segment routing domain.

This covers IPv6 Segment Routing Header (SRH) including tests to verify concepts and describe the SRH and how it is used by nodes that are Segment Routing (SR) capable. Segment Routing over IPv6 (SRv6) Network Programming, Request for Comments 8986 has tests to verify concepts and specify the base set of SRv6 behaviors that enable the creation of interoperable overlays with underlay optimization

Test SRv6LC.1.1: SRv6 Enabled

Purpose: Verify the proper behavior of a router with SRv6 SIDs by default.

Reference:

- [SR] – Section 3.1.3

Test Setup: Test Setup is performed as per Common Topology B. The Common Test Cleanup procedure is performed after each part.

Procedure:

Step	Action	Expected Behavior
1.	RUT is not configured for SRv6.	
2.	TN1 transmits an ICMPv6 Echo Request to TN2.	A SRH header must not be appended to the packet.

Possible Problems: None.

Test SRv6LC.1.2: Outside Domain Traffic

Purpose: Verify that a router properly filters external traffic destined to an address within the domain.

Reference:

- [SR] - 8.2

Test Setup: Test Setup is performed as per Common Topology B. Common Test Setup is performed.

Procedure:

Step	Action	Expected Behavior
1.	Transmit an ICMPv6 Echo Request from TN1 to TR1 SID address.	The RUT must filter the traffic and not forward the ICMPv6 Echo Request.

Possible Problems: None.

Test SRv6LC.1.3: Leak prevention

Purpose: Verify that a router does not leak segment routing headers outside of the domain.

Reference:

- [SR] - 8.2

Test Setup: Test Setup is performed as per Common Topology B. Common Test Setup is performed.

Procedure:

Step	Action	Expected Behavior
1.	TR1 forwards an IPv6 packet with a SRH header to the RUT with an IPv6 address destination of TN1.	The RUT must not forward the SRH to TN1. The RUT must forward the IPv6 packet to TN1 after removing the SRH from the packet.

Possible Problems: None.

Test SRv6LC.1.4: Processing SRH with flag 0

Purpose: Verify the proper behavior of a router when it encounters a Segment Routing Header (SRH) with a Valid Flag.

Reference:

- [IPv6-SRH] – Section 2

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

Segment Routing Header Flag: Zero Next Header: 58
ICMPv6 Echo Request

Packet B

Segment Routing Header Flag: Non-Zero Next Header: 58
ICMPv6 Echo Request

Procedure:

Part A: RUT Sends Packet with Flag 0 in SR Header

Step	Action	Expected Behavior
1.	Configure RUT to send an echo request to TR1 with SRH.	The RUT must send an echo request with flag value of 0

Part B: RUT Receives Packet with Flag 0 in SR Header

Step	Action	Expected Behavior
2.	TR1 transmits Packet A to the RUT. Packet A has an SR Header with a Zero Flag (0x00) and is followed by the ICMPv6 echo request.	The RUT must send an echo reply in response to Packet A.

Part C: RUT Receives Packet with Non-Zero Flag in SR Header

Step	Action	Expected Behavior
3.	TR1 transmits Packet B to the RUT. Packet B has an SR Header with a Non-Zero Flag (0x08) and is followed by the ICMPv6 echo request.	The RUT must send an echo reply in response to Packet B.

Possible Problems: None.

Test SRv6LC.1.5: Packet Tagging and Tag Processing

Purpose: Verify that a router properly sets the tag value and processes the tag field.

Reference:

- [IPv6-SRH] – Section 2

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Procedure:

Part A: Tag Not Used at the Source

Step	Action	Expected Behavior
1.	TR1 sends a packet, an echo request that contains the tag field to TR2 with a first hop through the RUT.	The "Tag" field in the packet should be zero that is transmitted by RUT.

Part B: Segment Not Requiring Tag Processing

Step	Action	Expected Behavior
2.	TR1 sends a packet, an echo request to the RUT with an SRH that has the tag field.	The RUT should generate an echo reply without considering the “Tag” field.

Possible Problems: None.

Test SRv6LC.1.6: Segment Order in the Segment List

Purpose: Verify that the segments in the Segment List of the packet are correctly ordered.

Reference:

- [IPv6-SRH] – Section 2

Test Setup: Test Setup is performed as per Common Topology B. The Common Test Cleanup procedure is performed after each part.

SR Policy:

Segment 1: IPv6 Address TR1 (Action: Forward to Node TR1) Segment 2: IPv6 Address TRX (Action: Forward to Node TRX) Segment 3: IPv6 Address TRY (Action: Forward to Node TRY)

Segment List Order:

Segment List[0]: IPv6 Address TRY Segment List[1]: IPv6 Address TRX Segment List[2]: IPv6 Address TR1

Procedure:

Step	Action	Expected Behavior
1.	Configure RUT to send a packet to TR2 with a first hop through the TR1 based on the defined SR policy.	Segment List order must correspond with the Segment List order in the transmitted packet as stated above.

Possible Problems: None.

Test SRv6LC.1.7: TLV Processing

Purpose: Verify that a router properly processes the TLV in the Segment Routing Header.

Reference:
- [IPv6-SRH] – Section 2.1

Advanced Functionality:
- TLV Processing

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

Segment Routing Header Hdr Ext Len: 16 bytes TLV 1: Type (2 bytes), Length (2 bytes), Value (6 bytes) TLV 2: Type (2 bytes), Length (2 bytes), Value (6 bytes)

Packet B

Segment Routing Header Hdr Ext Len: 16 bytes TLV 1: Type (2 bytes), Length (2 bytes), Value (more than 12 bytes)

Packet C

Segment Routing Header Hdr Ext Len: 16 bytes TLV 1: Type (1 byte - unrecognized), Length (2 bytes), Value (6 bytes) TLV 2: Type (2 bytes), Length (2 bytes), Value (6 bytes)

Procedure:

Part A: TLV Boundary Check in SRH - Within the Boundary

Step	Action	Expected Behavior
1.	TR1 sends a Packet A to RUT with an SRH that contains the TLV within the boundary defined by the Hdr Ext Len field.	The RUT should generate an echo reply.

Part B: TLV Boundary Check in SRH - Exceeds the Boundary

Step	Action	Expected Behavior
2.	TR1 sends a Packet B to RUT with an SRH that contains the TLV that exceeds the boundary defined by the Hdr Ext Len field.	The RUT should discard the packet and send an ICMP Parameter Problem error message (Code 0) to the TR1. The pointer field should be offset to the Hdr Ext Len field.

Part C: TLV with Unrecognized type

Step	Action	Expected Behavior
3.	TR1 sends a Packet C to RUT with an SRH that contains the TLV with unrecognized type (i.e., 256).	The RUT should simply discard the packet and it should not send any response to it.

Possible Problems: None.

Test SRv6LC.1.8: Validation of Pad1 TLV

Purpose: Verify that a router correctly processes the packet that has a Segment Routing Header with Pad1 TLV for Single-Byte Padding and Multiple-Byte Padding requirements.

Reference:

- [IPv6-SRH] – Section 2.1.1.1

Advanced Functionality:

- TLV Processing

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

Segment Routing Header Pad1 TLV, Type: 0 Single-Byte Padding
ICMPv6 Echo Request

Packet B

Segment Routing Header Pad1 TLV, Type: 0 Multiple-Byte Padding
ICMPv6 Echo Request

Procedure:

Part A: Validation of Pad1 TLV for Single-Byte Padding

Step	Action	Expected Behavior
1.	TR1 sends a Packet A to RUT, that has a single Pad1 TLV with the type of 0 in the SRH that requires a single byte of padding.	The RUT must process the packet properly.

Part B: Validation of Pad1 TLV for Multiple-Byte Padding

Step	Action	Expected Behavior
2.	TR1 sends a Packet B to RUT, which has a single Pad1 TLV with the type of 0 in the SRH that requires multiple bytes of padding.	The RUT must discard the packet and must not send any response to it.

Possible Problems: None.

Test SRv6LC.1.9: Validation of PadN TLV

Purpose: Verify that a router properly processes the packet that has a Segment Routing Header with PadN TLV for Single-Byte Padding and Multiple-Byte Padding requirements.

Reference:
- [IPv6-SRH] – Section 2.1.1.2

Advanced Functionality:
- TLV Processing

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

Segment Routing Header PadN TLV, Type: 4 Single-Byte Padding
ICMPv6 Echo Request

Packet B

Segment Routing Header PadN TLV, Type: 4 Multiple-Byte Padding
ICMPv6 Echo Request

Procedure:

Part A: Validation of PadN TLV for Single-Byte Padding

Step	Action	Expected Behavior
1.	TR1 sends a Packet A to RUT, that has PadN TLV with the type of 4 in the SRH that requires single byte of padding.	The RUT must discard the packet and must not send any response to it.

Part B: Validation of PadN TLV for Multiple-Byte Padding

Step	Action	Expected Behavior
2.	TR1 sends a Packet B to RUT, that has PadN TLV with the type of 4 in the SRH that requires multiple bytes of padding.	The RUT must process the packet properly

Possible Problems: None.

Test SRv6LC.1.10: Processing PadN TLV with Zero and Non-Zero Padding

Purpose: Verify that a router properly processes the packet that has a Segment Routing Header with PadN TLV with Zero and Non-Zero Padding.

Reference:

- [IPv6-SRH] – Section 2.1.1.2

Advanced Functionality:

- TLV Processing

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

Segment Routing Header PadN TLV, Type: 4, Padding 0 Multiple-Byte Padding
ICMPv6 Echo Request

Packet B

Segment Routing Header PadN TLV, Type: 4, Padding 2 Multiple-Byte Padding
ICMPv6 Echo Request

Procedure:

Part A: Processing PadN TLV with Zero Padding

Step	Action	Expected Behavior
1.	TR1 sends a Packet A to RUT, that has PadN TLV with the type of 4 and the padding field set to 0 that requires variable length padding.	The RUT must process the packet properly

Part B: Processing PadN TLV with Non-Zero Padding

Step	Action	Expected Behavior
2.	TR1 sends a Packet B to RUT, that has PadN TLV with the type of 4 and the padding field set to non-zero that requires variable length padding.	The RUT must discard the packet and must not send any response to it.

Possible Problems: None.

Test SRv6LC.1.11: HMAC Verification

Purpose: Verify that a Router properly performs HMAC generation and verification process for received packets at SR Segment endpoint nodes.

Reference:

- [IPv6-SRH] – Section 2.1.2.1

Advanced Functionality:

- TLV Processing

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

Segment Routing Header HMAC TLV, Type: 5, Current Segment = Destination address (i.e, RUT address) Correct HMAC key ID
ICMPv6 Echo Request

Packet B

Segment Routing Header HMAC TLV, Type: 5, Current Segment = Destination address (i.e, RUT address) Incorrect HMAC key ID
ICMPv6 Echo Request

Procedure:

Part A: HMAC Verification Success

Step	Action	Expected Behavior
1.	Configure the RUT as SR Segment endpoint node with a valid HMAC Key ID and algorithm.	
2..	TR1 sends Packet A with a correct HMAC to the RUT.	The RUT should successfully validate the HMAC using the specified key and algorithm and should send an echo reply to TR1.

Part B: HMAC Verification Failure

Step	Action	Expected Behavior
3.	Configure the RUT as SR Segment endpoint node with a valid HMAC Key ID and algorithm.	
4.	TR1 sends Packet B with an incorrect HMAC to the RUT.	The RUT should discard the packet and should send an ICMP error message with the code field of 0, pointing to the HMAC TLV in the packet

Possible Problems: None.

Test SRv6LC.1.12: HMAC Digest Truncation

Purpose: To validate that a router correctly truncates the HMAC digest to 32 octets when the HMAC algorithm produces a digest less than 32 octets.

Reference:

- [IPv6-SRH] – Section 2.1.2.1

Advanced Functionality:

- TLV Processing

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

Segment Routing Header HMAC TLV, Type: 5, HMAC Key ID: 12345, HMAC Algorithm: SHA-256, Current Segment = Destination address (i.e, RUT address) Correct HMAC key ID
ICMPv6 Echo Request

Procedure:

Step	Action	Expected Behavior
1.	Configure the RUT as SR Segment endpoint node with a valid HMAC Key ID and algorithm that is known to produce a digest less than 32 octets.	
2.	TR1 sends Packet A to RUT for HMAC verification that has HMAC digest based on the HMAC algorithm and pre-shared key.	RUT must have 32 octets HMAC digest by adding 16 bytes of zero with the computed HMAC digest that is 16 bytes (128 bits) and verify that the HMAC verification is successful

Possible Problems: None.

Test SRv6LC.1.13: HMAC SHA-256 Implementation Verification

Purpose: To verify that the implementation correctly supports SHA-2 in its SHA-256 variant for HMAC.

Reference:
- [IPv6-SRH] – Section 2.1.2.2

Advanced Functionality:
- TLV Processing

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

Segment Routing Header HMAC TLV, Type: 5, HMAC Algorithm: SHA-256, Current Segment = RUT address
ICMPv6 Echo Request

Procedure:

Step	Action	Expected Behavior
1.	Configure RUT as a HMAC TLV verification node	
2.	TR1 sends a Packet A to RUT, that has an HMAC TLV with the SHA-256 algorithm.	RUT should use the SHA-256 variant of SHA-2 for HMAC verification and process the packet without any issues.

Possible Problems: None.

Test SRv6LC.1.14: SR Nodes Behaviour

Purpose: Verify the proper behavior of a router when it encounters a Segment Routing Header (SRH).

Reference:

- [IPv6-SRH] – Section 3, Section 4.1, 4.2, 4.3

Test Setup: Test Setup is performed as per Common Topology B for Parts A, C and Common Topology A is used for Part B. The Common Test Cleanup procedure is performed after each part.

Packet A

IPv6 Header Next Header: 58 Source Address: TN1's Global Address Destination Address: TR1's Global Address
ICMPv6 Echo Request

Packet B

IPv6 Header Source Address: TR1's Global Address Destination Address: TR2's Global Address
Segment Routing Header Next Header: 58 Segment ID
ICMPv6 Echo Request

Packet C

IPv6 Header Source Address: TR2's Global Address Destination Address: RUT's Global Address
Segment Routing Header Next Header: 58 Segment ID
ICMPv6 Echo Request

Procedure:

Part A: Source Node

Step	Action	Expected Behavior
1.	Configure the RUT as an SR domain Ingress router.	
2.	TN1 sends Packet A, an echo request to TR1's Global address with a first hop through the RUT.	RUT should configure the SID with SRH within the packet and must transmit the packet to TR1's Global Address.

Part B: Transit Node

Step	Action	Expected Behavior
3.	Configure the RUT as a transit node.	
4.	TR1 transmits Packet B, an Echo Request with a segment in SRH to TR2's Global address with a first hop through the RUT.	The RUT must forward the Echo Request from TR1 to TR2 without processing the SRH.

Part C: Segment Endpoint Node

Step	Action	Expected Behavior
5.	Configure the RUT as a segment endpoint node.	
6.	TR2 sends Packet A, an echo request to RUT's Global address with a first hop through the TR1	The RUT must generate an echo reply in response to Packet A

Possible Problems: None.

Test SRv6LC.1.15: Processing Segments Left Value

Purpose: Verify that a router properly processes a packet that contains a Segment Routing header with a Segments Left value.

Reference:

- [IPv6-SRH] – Section 4.3.1.1, 4.3.2

Test Setup: Test Setup is performed as per Common Topology A . The Common Test Cleanup procedure is performed after each part.

Packet A

IPv6 Header Source Address: TR1's Global Address Destination Address: RUT's Global Address
Segment Routing Header Next Header: 58 Segments Left: 0
ICMPv6 Echo Request

Packet B

IPv6 Header Source Address: TR1's Global Address Destination Address: RUT's Global Address
Segment Routing Header Next Header: 58 Segments Left: 1
ICMPv6 Echo Request

Packet C

IPv6 Header Source Address: TR1's Global Address Destination Address: TR2's Global Address
Segment Routing Header Next Header: 58 Segments Left: 1
ICMPv6 Echo Request

Procedure:

Part A: Segments Left Zero - End Node

Step	Action	Expected Behavior
1.	TR1 sends Packet A, an Echo Request to the RUT that has SRH with a Segments Left value of 0.	RUT should respond to the Request by sending an Echo Reply

Part B: Segments Left Non-zero - End Node

Step	Action	Expected Behavior
2.	TR1 sends Packet B, an Echo Request to the RUT that has SRH with a Segments Left value of 1.	The RUT must discard the Echo Request and send an ICMP Parameter Problem, Code 0, message to TR1's Global Address. The pointer field must be 0x2B (offset of the Routing Type field of the SRH).

Part C: Segments Left Non-zero - Intermediate Node

Step	Action	Expected Behavior
3.	TR1 sends Packet C, an Echo Request to TR2 with a first hop through the RUT. The Segments Left field is set to 1.	RUT should decrease the Segments Left field to 0 and forward the packet to TR2.

Possible Problems: None.

Test SRv6LC.1.16: Decreasing Hop Limit Value

Purpose: Verify that a router properly processes the Hop limit value and generates a valid value in transmitted packets.

Reference:

- [IPv6-SRH] – Section 4.3.1.1
- [SRv6] - Sections 4.1 and 4.1.1

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

IPv6 Header Source Address: TR1's Global Address Destination Address: TR2's Global Address Hop Limit: 64
Segment Routing Header Next Header: 58 Segments Left: 1
ICMPv6 Echo Request

Procedure:

Step	Action	Expected Behavior
1.	TR1 transmits Packet A to TR2's Global Address with a first hop through the RUT. The Hop Limit field is set to 64	The RUT should process the segment left value and forward Packet A to TR2. The Hop Limit field should be decreased to 63

Possible Problems: None.

Test SRv6LC.1.17: Invalid Packet Handling in Segment Routing

Purpose: Verify that a router generates the appropriate response to an invalid packet in segment routing.

Reference:

- [IPv6-SRH] – Section 4.3.1.1
- [SRv6] - Sections 4.1 and 4.1.1

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A	Packet B
IPv6 Header Source Address: TR1's Global Address Destination Address: TR2's Global Address	IPv6 Header Source Address: TR1's Global Address Destination Address: TR2's Global Address
Segment Routing Header Next Header: 58 Hdr Ext Len: 6 Segments Left: 2 Last Entry: 3	Segment Routing Header Next Header: 58 Hdr Ext Len: 6 Segments Left: 3 Last Entry: 2
ICMPv6 Echo Request	ICMPv6 Echo Request

Packet C	Packet D
IPv6 Header Source Address: TR1's Global Address Destination Address: TR2's Global Address Hop Limit: 0	IPv6 Header Source Address: TR1's Global Address Destination Address: TR2's Global Address Hop Limit: 1
Segment Routing Header Next Header: 58 Hdr Ext Len: 6 Segments Left: 1 Last Entry: 1	Segment Routing Header Next Header: 58 Hdr Ext Len: 6 Segments Left: 1 Last Entry: 1
ICMPv6 Echo Request	ICMPv6 Echo Request

Procedure:

Part A: Invalid Last Entry

Step	Action	Expected Behavior
1.	TR1 transmits a Packet A, an echo request to the TR2 with a first hop through the RUT. The Last entry field is set to be invalid.	The RUT must discard the Echo Request and send an ICMP Parameter Problem, Code 0, message to TR1's Global Address. The pointer field must be 0x2B (offset of the Routing Type field of the SRH).

Part B: Invalid Segments Left

Step	Action	Expected Behavior
2.	TR1 transmits a Packet B, an echo request to the TR2 with a first hop through the RUT. The Segments Left field is set to be invalid	The RUT must discard the Echo Request and send an ICMP Parameter Problem, Code 0, message to TR1's Global Address. The pointer field must be 0x2B (offset of the Routing Type field of the SRH).

Part C: Hop Limit == 0

Step	Action	Expected Behavior
3.	TR1 transmits a Packet C, an Echo Request to TR2 with a first hop of the RUT.	The RUT must discard the ICMPv6 Echo Request from TR1 and must not forward the packet to TR2. The RUT should send a Time Exceeded Message to TR1 with a code field value of 0 (Hop Limit Exceeded in transit) ● The Source Address of the Packet should be one of the RUT's unicast addresses used for packet forwarding. ● The Destination Address should be the same as TR1's Source Address. ● The invoking Echo Request packet included in the Error Message must not exceed minimum IPv6 MTU.

Part D: Hop Limit == 1

Step	Action	Expected Behavior
4.	TR1 transmits a Packet D, an Echo Request to TR2 with a first hop of the RUT.	The RUT must discard the ICMPv6 Echo Request from TR1 and must not forward the packet to TR2. The RUT should send a Time Exceeded Message to TR1 with a code field value of 0 (Hop Limit Exceeded in transit) ● The Source Address of the Packet should be one of the RUT's unicast addresses used for packet forwarding. ● The Destination Address should be the same as TR1's Source Address. ● The invoking Echo Request packet included in the Error Message must not exceed minimum IPv6 MTU.

Possible Problems: None.

Test SRv6LC.1.18: Processing Upper-Layer Header

Purpose: Verify that a router properly processes the upper-layer header of an SRH packet.

Reference:
- [IPv6-SRH] – Section 4.3.1.2
- [SRv6] - Sections 4.1 and 4.1.1

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Procedure:

Part A: Upper-Layer Header needs to be processed

Step	Action	Expected Behavior
1.	TR1 transmits an ICMPv6 Echo Request with an SRH to the RUT.	The RUT must generate an echo reply in response to Packet A.

Part B: Upper-Layer Header needs to be discarded

Step	Action	Expected Behavior
2.	TR1 transmits a UDP echo request to the RUT, which contains an SRH.	The RUT must not transmit an Echo Reply to TR1. The RUT should transmit an ICMPv6 Parameter Problem message to TR1. The Code field should be 4 (SR Upper-layer header error). The Pointer field should be offset of the SR upper-layer header.

Possible Problems: None

Test SRv6LC.1.19: Securing the SR Domain

Purpose: Verify that a router properly processes the packet from outside of the SR domain.

Reference:

- [IPv6-SRH] – Section 5.1

Test Setup: Test Setup is performed as per Common Topology B. The Common Test Cleanup procedure is performed after each part.

Packet A

IPv6 Header Source Address: TN1's Global Address Destination Address: TR1's Global Address Next Header: 58
ICMPv6 Echo Request

Packet B

IPv6 Header Source Address: TN1's Global Address Destination Address: TR1's Global Address
Segment Routing Header Next Header: 58 Segment ID
ICMPv6 Echo Request

Procedure:

Part A: Forwarding Interdomain Packet without SID

Step	Action	Expected Behavior
1.	Configure the RUT as an SR domain Ingress router.	
2.	TN1 transmits Packet A, an Echo Request to TR1's Global Address with a first hop through the RUT.	The RUT must add the SRH with TR1's SID and forward the echo request to TR1.

Part B: Forwarding Interdomain Packet with SID

Step	Action	Expected Behavior
3.	Configure the RUT as an SR domain Ingress router.	
4.	TN1 transmits Packet B to TR1's Global Address with a first hop through the RUT, an Echo Request that has the SR Header with a Segment ID.	The RUT must discard the packet and not forward the echo request to TR1.

Possible Problems: None.

Test SRv6LC.1.20: Processing PMTU in SR Domain

Purpose: Verify that a router properly reduces its estimate of the Path MTU when it receives a Packet Too Big message and to check that a router properly generates a Packet Too Big message when it receives a packet with greater MTU.

Reference:

- [IPv6-SRH] – Section 5.3

Test Setup: Test Setup is performed as per Common Topology A for Part A. The Common Topology B is used for Part B. The Common Test Cleanup procedure is performed after each part.

Procedure:

Part A: RUT Receives Packet Too Big Message

Step	Action	Expected Behavior
1.	Configure TR1 to have an MTU of 1400 on Network 1.	
1.	TR1 forwards an Echo Request from TN1 to the RUT with a packet size equal to 1500 octets.	The RUT should transmit an Echo Reply to TN1.
2.	TR1 transmits a Packet Too Big message to the RUT, which contains an MTU field with a value of 1400.	
3.	TR1 forwards an Echo Request from TN1 to the RUT with a packet size equal to 1500 octets.	The RUT should correctly fragment its response to the Echo Request using TR1 as a first hop, indicating the RUT processed the Packet Too Big message. The fragmented packets must not be larger than 1400 octets in size
4.	TR1 transmits a Packet Too Big message to the RUT, which contains an MTU field with a value of 1280	
5.	TR1 forwards an Echo Request from TN1 to the RUT with a packet size equal to 1500 octets.	The RUT should correctly fragment its response to the Echo Request using TR1 as a first hop, indicating the RUT processed the Packet Too Big message. The fragmented packets must not be larger than 1280 octets in size.

Part B: RUT Transmits Packet Too Big Message

Step	Action	Expected Behavior
6.	Configure the RUT as an SR domain Ingress Node.	
7.	Configure the RUT Network1 interface with a path MTU of 1280 bytes on the RUT.	
8.	TN1 sends an Echo Request from TR1 with a packet size equal to 1500 octets.	RUT should transmit a Packet Too Big message to the TN1, which contains an MTU field with a value of 1280.
9.	TN1 sends fragmented echo requests after processing the Packet Too Big message from the RUT.	RUT should forward the fragmented Echo Requests to TR1.

Possible Problems: None.

Test SRv6LC.1.21: SR Nodes using Flow Label

Purpose: Verify that a router properly processes and generates the Flow Label.

Reference:

- [IPv6-SRH] – Section 5.3

Test Setup: Test Setup is performed as per Common Topology B for Parts A and B. The Common Topology A is used for Parts C and D. The Common Test Cleanup procedure is performed after each part.

Packet A

IPv6 Header Source Address: TN1's Global Address Destination Address: TR1's Global Address Flow Label: 214375 Next Header: 58
ICMPv6 Echo Request

Procedure:

Part A: Imposing Flow Label for Interdomain Packet

Step	Action	Expected Behavior
1.	Configure RUT as an SR Domain Ingress Router.	
2.	TN1 sends Packet A, an Echo Request to TR1 with a first hop through RUT.	The RUT must impose a flow label computed based on the packet and forward the packet to TR1.

Part B: Imposing Flow Label for Intradomain Packet

Step	Action	Expected Behavior
3.	Configure RUT to send an Echo Request to TR1 with a Flow Label.	The RUT should generate a flow label in the transmitted packet. The flow label field must be non-zero.

Part C: Forwarding a packet with Flow Label

Step	Action	Expected Behavior
4.	Configure the RUT as a Transit Node.	
5.	TR1 sends Packet A, an Echo Request to TR2 with a first hop through RUT.	The RUT must forward the Echo Request from TR1 to TR2. The Flow Label field must be unchanged in the forwarded packet.

Part D: Receiving a packet with Flow Label

Step	Action	Expected Behavior
6.	TR1 sends Packet A, an Echo Request to RUT.	The RUT must generate an Echo Reply. The Flow Label field in the packet must be non-zero.

Possible Problems: Part A, B and D may be omitted if the device under test does not support the process of the Flow Label.

Test SRv6LC.1.22: SID Format

Purpose: Verify that a router properly formats the SID.

Reference:

- [SRv6] - Section 3.1

Test Setup: Test Setup is performed as per Common Topology B. The Common Test Cleanup procedure is performed after each part.

Packet A

IPv6 Header Source Address: TN1's Global Address Destination Address: TR1's Global Address
ICMPv6 Echo Request

Procedure:

Step	Action	Expected Behavior
1.	TN1 sends Packet A an ICMPv6 Echo Request to TR1's Global address with a first hop through the RUT.	The RUT should configure the SID with an SR Header within the packet and must transmit the packet to TR1's Global Address. The remaining bits of the SID must be zero.

Possible Problems: None.

Test SRv6LC.1.23: SID Arg Value Unchanged

Purpose: Verify that a router properly leaves the Arg value unchanged when of a routed SID.

Reference:

- [SRv6] - Section 3.1

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

IPv6 Header Source Address: TR1's Global Address Destination Address: TR2's Global Address
Segment Routing Header Next Header: 58 Segment ID LOC: TR2 Segment ID FUNCT: 0 Segment ID ARG: 0
ICMPv6 Echo Request

Procedure:

Step	Action	Expected Behavior
1.	TR1 sends Packet A an ICMPv6 echo request with an SID and an SR Header that includes an ARG value to TR2's Global address with a first hop through the RUT.	The RUT should forward the echo request. The ARG value should remain unchanged.

Possible Problems: None.

Test SRv6LC.1.24: SR Endpoint Behavior - End.X (L3 Cross-Connect)

Purpose: Verify that a router properly displays Endpoint with L3 Cross-Connect behavior. The codepoint for the SID is bound to behavior 0x0005.

Reference:

- [SRv6] - Section 4.2

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

IPv6 Header Source Address: TR1's Global Address Destination Address: TR2's Global Address
Segment Routing Header Next Header: 58 Segments Left: 2 Last Entry: 2 Segment ID LOC: DUT Segment ID FUNCT: 100 Segment ID ARG: 0
ICMPv6 Echo Request

Procedure:

Step	Action	Expected Behavior
1.	TR1 sends Packet A an ICMPv6 echo request with a SID with an SR Header to the DUTs Global address. The SIDs list indicates <DUT, TR2>.	The RUT should process the SRH, decrement the IPv6 Hop Limit by 1, decrement Segments Left by 1, update IPv6 DA with Segment List[Segments Left], Submit the packet to the IPv6 module for transmission to TR2

Possible Problems: None.

Test SRv6LC.1.25: SR Endpoint Behavior - End.T (Specific IPv6 Table Lookup)

Purpose: Verify that a router properly displays Endpoint with specific IPv6 table lookup behavior. The codepoint for the SID is bound to behavior 0x0009.

Reference:

- [SRv6] - Section 4.3

Test Setup: Test Setup is performed as per Common Topology A. The Common Test Cleanup procedure is performed after each part.

Packet A

IPv6 Header Source Address: TR1's Global Address Destination Address: TR2's Global Address
Segment Routing Header Next Header: 58 Segments Left: 2 Last Entry: 2 Segment ID LOC: DUT Segment ID FUNCT: 100 Segment ID ARG: 0
ICMPv6 Echo Request

Procedure:

Step	Action	Expected Behavior
1.	TR1 sends Packet A an ICMPv6 echo request with a SID with an SR Header to the DUTs Global address. The SIDs list indicates <DUT, TR2>.	The RUT should process the SRH, decrement IPv6 Hop Limit by 1, decrement Segments Left by 1, update IPv6 DA with Segment List[Segments Left], Set the packet's associated FIB table to T, Submit the packet to the egress IPv6 FIB lookup for transmission to the new destination

Possible Problems: None.

Modification Record

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