IP CONSORTIUM TEST SUITE

Internet Protocol,
Version 6

Technical Document

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INTRODUCTION

Overview
The University of New Hampshire's InterOperability Laboratory (IOL) is an institution designed to improve the interoperability of standards based products by providing an environment where a product can be tested against other implementations of a standard. This suite of tests has been developed to help implementers evaluate the functioning of their Internet Protocol, version 6 products. The tests do not determine if a product conforms to the IPv6 Specifications, nor are they purely interoperability tests. Rather, they provide one method to isolate problems within a device. Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other IPv6 devices. However, combined with satisfactory operation in the IOL's semi-production environment, these tests provide a reasonable level of confidence that the Node Under Test will function well in most multi-vendor IPv6 environments.

Test Software
The UNH IOL Testing Software is not a full IPv6 implementation; it is simply a packet generator that can transmit and receive packets. This allows the Testing Node to generate invalid packets and to simulate both an IPv6 Router and an IPv6 Host. The Testing Software is not currently available to the public.

Organization of Tests
The tests contained in this document are organized to simplify the identification of information related to a test and to facilitate in the actual testing process. Each test contains an identification section that describes the test and provides cross-reference information. A detailed section discusses the background information and specifies how the test is to be performed. Each test contains the following information:

Test Label
The Test Label associated with each test follows that of hierarchical domain names, with subgroups being separated by periods. In domain name format, the more specified identifiers are on the left; the higher level entries are on the right. For example, the "no_next_header" test, which is one of the Base Specification tests, is identified using the following label:

no_next_header.base.v6.ip

Purpose
The Purpose is a short statement describing that which the test attempts to achieve. The test is written at the functional level. An example of the purpose statement follows:

Verify proper behavior of a node when it encounters a Next Header value of 59 (no next header).

References
The References section lists cross references to the IPv6 Specifications and other documentation that might be helpful in understanding and evaluating the test and results.

Resource Requirements
The Resource Requirements section specifies the software, hardware, and test equipment that will be needed to perform the test. The items contained in this section are special test devices, software that must reside on the NUT, or other facilities that may not be available on all devices.

Last Modification
This specifies the date of the last modification of this test.

Discussion
The Discussion covers the assumptions made in the design or implementation of the test as well as known limitations. Other items specific to the test are covered here.

Test Packets/Setup
The Test Packets/Setup section describes in detail the description of the test packets and may include a block diagram for clarification as well as information such as the interconnection of devices, Small changes in the configuration and/or packets may be included in the test procedure.

Procedure
The procedure section of the test description contains the step-by-step instructions for carrying out the test, i.e., what monitoring equipment should capture, what the generation equipment should transmit, and any other configuration information vital to carrying out the test. It also includes observations that can be examined by the tester to verify that the NUT is operating properly. When multiple values are possible for an observation, a short discussion on how to interpret them is included.

Possible Problems
This section provides some clues for evaluating a test that does not yield reasonable results.

DEFINITIONS

Overview:
This section defines conventions of this test suite.

Packets:
The most common field values used in packets are specified in this section. When necessary, modified values are specified the Test Packets/Setup section of the tests.

IPv6 Header

Version: 6
Priority: 0
Flow Label: 0
Next Header: 59 (None)
Hop Limit: 255
Source Address: TN
Destination Address: NUT

Acronyms:
Common acronyms are defined in this section.

TN: **T**esting **N**ode
TR: **T**esting **R**outer
NUT: **N**ode **U**nder **T**est
RUT: **R**outer **U**nder **T**est
HUT: **H**ost **U**nder **T**est
DAD: **D**uplicate **A**ddress **D**etection

REFERENCES

The following documents are referenced in this text:

[IPv6-SPEC] Hinden, R., S. Deering, Internet Protocol, Version 6 (IPv6) Specification, RFC 2460, December 1998.

[ND] Narten, T., Nordmark, E., and W. Simpson, Neighbor Discovery for IP Version 6 (IPv6), RFC 2461, December 1998.

[ADDRCONF] Thomson, S., T. Narten, IPv6 Stateless Address Autoconfiguration, RFC 2462, December 1998.

[ICMPv6] Conta, A., S. Deering, Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification, RFC 2463, December 1998.

[PMTU] McCann, J., S. Deering, and J. Mogul, Path MTU Discovery for IPv6, RFC 1981, August 1996.

[JUMBO] Hinden, R., S. Deering, The IPv6 Jumbo Payload Option, Internet Draft, August 1998. (expires February 6, 1999)

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BASE SPECIFICATION

Scope
The following tests cover the Base Specification for Internet Protocol version 6. IP version 6 (IPv6) is a new version of the Internet Protocol, designed as the successor to IP version 4 (IPv4). The Base Specification specifies the basic IPv6 header and the initially defined IPv6 extension headers and Options. It also discusses packet size issues, the semantics of flow labels and traffic classes, and the effects of IPv6 on upper-layer protocols.

Overview
These tests are designed to verify conformance with the Base IPv6 Specification.

Default Packets

IPv6 Header

Version: 6
Priority: 0
Flow Label: 0
Next Header: 59 (None)
Hop Limit: 255
Source Address: TN
Destination Address: NUT

Echo Request

IPv6 Header
Payload Length: 1400 bytes
Next Header: 58
ICMPv6 Header
Type: 128
Code: 0

Test Label: **unrecognized_next_header.base.v6.ip** (1.4.0.0.1a)

Purpose: Verify that a node discards a packet with an unknown next header and transmits an ICMPv6 Parameter Problem message to the source of the packet.

References:

- [IPv6-SPEC] – Section 4
- [ICMPv6] – Section 3.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 11, 1999

Discussion: If, as a result of processing a header, a node is required to proceed to the next header, but the Next Header value in the current header is unrecognized by the node, it should discard the packet and transmit an ICMPv6 Parameter Problem message to the source of the packet, with an ICMPv6 Code value of 1 ("unrecognized Next Header type encountered") and the ICMPv6 Pointer field containing the offset of the unrecognized value within the original packet.

Test Packets/Setup:

Packet A

IPv6 Header Next Header: 138 (unknown)

Procedure: (1.4.0.01a)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A	Unknown Next Header value of 138
The NUT should send an ICMPv6 Parameter Problem message to TR-1.	ICMPv6 Code Field equal to 1 (unrecognized Next Header type encountered) ICMPv6 Pointer Field equal to 0x06 / 6_d (offset of the Next Header Field)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **next_header_zero.base.v6.ip** (1.4.0.0.2)

Purpose: Verify that a node discards a packet which has a Next Header field of zero in a header other than an IPv6 Header and generates an ICMPv6 Parameter Problem message to the source of the packet.

References:

- [IPv6-SPEC] – Section 4
- [ICMPv6] – Section 3.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 11, 1999

Discussion: The value of zero in the Next Header field of the IPv6 header indicates the presence of the Hop-by-Hop Options Header. When present, the Hop-by-Hop Options header must immediately follow the IPv6 header. The Hop-by-Hop Options header contains information that must be examined by every node along a packet's delivery path, including the source and destination nodes. As a result of processing a Header, if a node encounters a Next Header value of zero in any header other than an IPv6 header, it should discard the packet and transmit an ICMPv6 Parameter Problem message to the source of the packet. The ICMPv6 Code field should be equal to1 ("unrecognized Next Header type encountered") and the ICMPv6 Pointer field contains the offset of the unrecognized value within the original packet.

Test Packets/Setup:

Packet A

IPv6 Header Next Header: 0
Hop By Hop Header Next Header: 0 Header Ext. Length: 0 PadN Option
Hop By Hop Header Next Header: 59 Header Ext. Length: 0 PadN Option

Procedure: (1.4.0.0.2)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A.	Next Header field equal to zero in Hop-by-Hop Options Header
The NUT should send an ICMPv6 Parameter Problem message to TR-1.	Code value field equal to 1 (unrecognized Next Header type) Pointer field equal to 0x28 / 40_d (offset of Next Header field of Hop-by-Hop options header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **payload_length_zero.base.v6.ip** (1.4.0.0.3)

Purpose: Verify that a node does not generate any packets when it receives a packet with a Payload Length of zero and a Next Header Value of 59.

References:

- [IPv6-SPEC] – Sections 3, 4 and 4.7

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 11, 1999

Discussion: An IPv6 packet may carry zero, one, or more extension headers, each identified by the Next Header field of the preceding header. The Payload Length indicates the length of the IPv6 payload, i.e., the rest of the packet following this header, in octets. The value 59 in the Next Header field of an IPv6 header or any extension header indicates that there is nothing following that header.

Test Packets/Setup:

Packet A

IPv6 Header Payload Length: 0 Next Header: 59

Procedure: (1.4.0.0.3a)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A.	Payload length equal to zero (no payload following this header) Next Header equal field to 59 (nothing following the header)
The NUT should not generate any packets.	Indicates successful processing of this packet
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **header_option_processing_order.base.v6.ip** (1.4.2.0.1)

Purpose: Verify that a node properly processes the headers and options of an IPv6 packet in the correct order.

References:

- [IPv6-SPEC] – Sections 4, 4.1 and 4.2
- [ICMPv6] – Sections 3.4 and 4.1

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 11, 1999

Discussion: IPv6 nodes must accept and attempt to process extension headers in any order and occurring any number of times in the same packet, except for the Hop-By-Hop Options Header which is restricted to appear immediately after an IPv6 Header only. The sequence of options within a header must be processed strictly in the order they appear in the header. The Option Type identifiers are internally encoded such that their highest-order two bits specify the action that must be taken if the processing IPv6 node does not recognize the Option Type. Each extension header is an integer multiple of 8 octets long, in order to retain 8-octet alignment for subsequent headers. Option Type Identifiers (highest order two bits):

- 00_b: skip over this option and continue processing the header

- 01_b: discard the packet

- 10_b: discard the packet and, regardless of whether or not the packet's Destination Address was a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and an ICMPv6 Pointer field pointing to the unrecognized Option Type.

- 11_b: discard the packet and, only if the packet's Destination Address was not a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and an ICMPv6 Pointer field pointing to the unrecognized Option Type.

Test Packets/Setup:

Packet A	Packet B
IPv6 Header Next Header: 60 Payload Length: 37	IPv6 Header Next Header: 60 Payload Length: 37
Destination Options Header Next Header: 60 Header Ext. Length: 0 PadN Option	Destination Options Header Header Ext. Length: 0 Option: 135 (unknown, msb:10_b) Next Header: 44
Destination Options Header Header Ext. Length: 0 Option: 135 (unknown, msb 10_b) Next Header: 44	Fragment Header Fragment Offset: 0 More Fragments flag: 1 Next Header: 60
Fragment Header Next Header: 58 Fragment Offset: 0 More Fragments flag: 1	ICMPv6 Echo Request Data Length: 5
ICMPv6 Echo Request Data Length: 5	

Packet C	Packet D
IPv6 Header Next Header: 44 Payload Length: 29	IPv6 Header Next Header: 60
Fragment Header Fragment Offset: 0 More Fragments flag: 1 Next Header: 60	Destination Options Header Next Header: 43 Header Ext. Length: 0 Option: 135 (unknown, msb: 10_b)
Destination Options Header Next Header: 58 Header Ext. Length: 0 Option: 135 (unknown, msb: 10_b)	Routing Header Next Header: 58 Address: P1:x
ICMPv6 Echo Request Data Length: 5	ICMPv6 Echo Request Data Length: 5

Packet E
IPv6 Header Next Header: 43
Routing Header Next Header: 60 Address: P1:x
Destination Options Header Option: 135 (Unknown) Next Header: 58
ICMPv6 Echo Request Data Length: 5

Procedure: (1.4.2.0.1a)

- Option Type Identifier (highest order two bits) :
  10_b: discard the packet and, regardless of whether or not the packet's Destination Address was a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and an ICMPv6 Pointer field pointing to the unrecognized Option Type

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A.	Option Type of second Destination Options header equal to 135 (unknown, msb: 10_b)
The NUT should send an ICMPv6 Parameter Problem message to TR-1.	Code value field equal to 2 (unrecognized IPv6 Option encountered) Pointer field equal to 0x32 / 50_d (offset of Option type field of the second Destination Options Header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.1b)

- An unknown option type should cause the generation of an ICMP Parameter Problem message. The NUT should encounter this error before it processes the fragment header (which would cause an error due to the odd payload length of the IPv6 packet).

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet B.	Payload length is not a multiple of 8 octets
The NUT should send an ICMPv6 Parameter Problem message to TR-1	Code value field equal to 0 (erroneous header field encountered) Pointer field equal to 0x04 / 4_d (offset of the Payload Length field of the IPv6 header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.1c)

- Fragment must be a multiple of 8 octets. Hence, an odd valued Payload Length in the IPv6 header is invalid. The NUT should encounter this error before it processes the unknown Option in the Destination Options Header.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet C.	Payload length is not a multiple of 8 octets
The NUT should send an ICMPv6 Parameter Problem message to TR-1.	Code value field equal to 0 (erroneous header field encountered) Pointer field equal to 0x04 / 4_d (offset of the Payload Length field of the IPv6 header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.1d)

- Option Type Identifier (highest order two bits):
  10_b: discard the packet and, regardless of whether or not the packet's Destination Address was a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and an ICMPv6 Pointer field pointing to the unrecognized Option Type

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet D.	Option Type of second Destination Options header equal to 135 (unknown, msb: 10_b)
The NUT should send an ICMPv6 Parameter Problem message to TR-1. No other packets should be sent.	Code value field equal to 2 (unrecognized IPv6 Option encountered) Pointer field equal to 0x2A / 42_d (offset of Option type field of the second Destination Options Header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.1e)

- Unknown option in Destination Options header occurs after the Routing Header
- Applicable to routers only

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet E.	Contains Routing Header before unknown option
The NUT should send an ICMPv6 Echo Request Packet with the source IPv6 address of the TN and the source hardware address of the NUT. No ICMPv6 Parameter Problem message should be sent.	This test is applicable to routers only. Hosts will not forward the packet.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **option_processing_single_option.base.v6.ip** (1.4.2.0.2)

Purpose: Verify that a node properly processes unknown options and acts in accordance with the highest order two bits of the option.

References:

- [IPv6-SPEC] – Section 4.2
- [ICMPv6] – Sections 3 and 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 16, 1999

Discussion: Option Type identifiers are internally encoded such that their highest order two bits specify the action that must be taken if the processing IPv6 node does not recognize the Option Type:

- 00_b: Skip over this option and continue processing the header.

- 01_b: Discard the packet.

- 10_b: Discard the packet and, regardless of whether or not the packet's Destination Address was a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.

- 11_b: Discard the packet and, only if the packet's Destination Address was not a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.

Test Packets/Setup:

Packet A	Packet B
IPv6 Header Next Header: 60	IPv6 Header Next Header: 60
Destination Options Header Next Header: 58 Header Ext. Length: 0 Option: 7 (unknown, msb: 00_b)	Destination Options Header Next Header: 58 Header Ext. Length: 0 Option: 71 (unknown, msb: 01_b)
ICMPv6 Echo Request	ICMPv6 Echo Request

Packet C	Packet D
IPv6 Header Next Header: 60	IPv6 Header Next Header: 60
Destination Options Header Next Header: 58 Header Ext. Length: 0 Option: 135 (unknown, msb: 10_b)	Destination Options Header Next Header: 58 Header Ext. Length: 0 Option: 199 (unknown, msb: 11_b)
ICMPv6 Echo Request	ICMPv6 Echo Request

Packet E	Packet F
IPv6 Header Destination: All Nodes Link Local Multicast Next Header: 60	IPv6 Header Destination: All Nodes Link Local Multicast Next Header: 60
Destination Options Header Next Header: 58 Header Ext. Length: 0 Option: 135 (unknown, msb: 10_b)	Destination Options Header Next Header: 58 Header Ext. Length: 0 Option: 199 (unknown, msb: 11_b)
ICMPv6 Echo Request	ICMPv6 Echo Request

Procedure: (1.4.2.0.2a)

- Option Type Identifier (highest order two bits):
  00_b: Skip over this option and continue processing the header.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A.	Option Type of Destination Options header equal to 7 (unknown , msb: 00_b)
The NUT should send an ICMPv6 Echo Reply from the NUT to TR-1.	The unknown option is skipped and the header is processed.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.2b)

- Option Type Identifier (highest order two bits):
  01_b: Discard the packet.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet B.	Option Type of Destination Options header equal to 71 (unknown , msb: 01_b)
The NUT should not generate any packets to be sent to TR-1.	The ICMPv6 Echo request is discarded.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.2c)

- Option Type Identifier (highest order two bits):
  10_b: Discard the packet and, regardless of whether or not the packet's Destination Address was a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet C.	Option Type of Destination Options header equal to 135 (unknown , msb: 10_b)
The NUT should send an ICMPv6 Parameter Problem message to TR-1	Code value field equal to 2 (unrecognized IPv6 Option encountered) Pointer field equal to 0x2A / 42_d (offset of the option field of Destination Options Header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.2d)

- Option Type Identifier (highest order two bits):
  11_b: Discard the packet and, only if the packet's Destination Address was not a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet D.	Option Type of Destination Options header equal to 199 (unknown , msb: 11_b)
The NUT should send an ICMPv6 Parameter Problem message to TR-1.	Code value field equal to 2 (unrecognized IPv6 Option encountered) Pointer field equal to 0x2A / 42_d (offset of the option field of Destination Options Header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.2e)

- Option Type Identifier (highest order two bits):
  10_b: Discard the packet and, regardless of whether or not the packet's Destination Address was a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet E.	Option Type of Destination Options header equal to 135 (unknown , msb: 10_b) Destination Address local multicast
The NUT should send an ICMPv6 Parameter Problem message to TR-1	Code value field equal to 2 (unrecognized IPv6 Option encountered) Pointer field equal to 0x2A / 42_d (offset of the option field of Destination Options Header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.2f)

- Option Type Identifier (highest order two bits):
  11_b: Discard the packet and, only if the packet's Destination Address was not a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet F.	Option Type of Destination Options header equal to 199 (unknown , msb: 11_b) Destination Address: local multicast
The NUT should not generate any packets to be sent to TR-1.	The ICMPv6 Echo Request is discarded and the address is local multicast.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **option_processing_many_options.base.v6.ip** (1.4.2.0.3)

Purpose: Verify that a node properly processes the options in a single header in the order of occurrence.

References:

- [IPv6-SPEC] – Section 4.2
- [ICMPv6] – Sections 3.4 and 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 16, 1999

Discussion: The sequence of options within a header must be processed strictly in the order they appear in the header; a receiver must not, for example, scan through the header looking for a particular kind of option and process that option prior to processing all preceding ones. The Option Type identifiers are internally encoded such that their highest-order two bits specify the action that must be taken if the processing IPv6 node does not recognize the Option Type:

- 00_b: Skip over this option and continue processing the header.
- 01_b: Discard the packet.
- 10_b: Discard the packet and, regardless of whether or not the packet's Destination Address was a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.
- 11_b: Discard the packet and, only if the packet's Destination Address was not a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.

Test Packets/Setup:

Packet A	Packet B
IPv6 Header Next Header: 60	IPv6 Header Next Header: 60
Destination Options Header Next Header: 58 Header Ext. Length: 3 Option: 7 (unknown, msb:00_b) Option: 71 (unknown, msb:01_b) Option: 135 (unknown, msb:10_b) Option: 199 (unknown, msb:11_b)	Destination Options Header Next Header: 58 Header Ext. Length: 3 Option: 7 (unknown, msb:00_b) Option: 135 (unknown, msb:10_b) Option: 199 (unknown, msb:11_b) Option: 71 (unknown, msb:01_b)
ICMPv6 Echo Request	ICMPv6 Echo Request

Packet C

IPv6 Header Next Header: 60
Destination Options Header Next Header: 58 Header Ext. Length: 3 Option: 7 (unknown, msb:00_b) Option: 199 (unknown, msb:11_b) Option: 135 (unknown, msb:10_b) Option: 71 (unknown, msb:01_b)
ICMPv6 Echo Request

Packet D	Packet E
IPv6 Header Next Header: 60	IPv6 Header Next Header: 60
Destination Options Header Next Header: 58 Header Ext. Length: 19 Option: 7 (unknown, msb:00_b, Length: 22) Option: 12 (unknown, msb:00_b, Length: 40) Option: 16 (unknown, msb:00_b Length: 29) Option: 31 (unknown, msb:00_b Length: 25) Option: 16 (unknown, msb:00_b Length: 29) PadN Option	Destination Options Header Next Header: 58 Header Ext. Length: 131 Option: 7 (unknown, msb:00_b Length: 22) Option: 12 (unknown, msb:00_b Length: 254) Option: 16 (unknown, msb:00_b Length: 255) Option: 31 (unknown, msb:00_b Length: 255) Option: 16 (unknown, msb:00_b Length: 255) PadN Option
ICMPv6 Echo Request	ICMPv6 Echo Request

Procedure: (1.4.2.0.3a)

- Option Type Identifier (highest order two bits):
  $01_{b:}$ Discard the packet.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A.	Option Type of Destination Options Header has the following order: 7, 71, 135, 199
The NUT should silently discard the ICMPv6 Echo Request and not send any packets to TR-1.	Option 71 causes the NUT to discard the packet.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.3b)

- Option Type Identifier (highest order two bits):
  10_b: Discard the packet and, regardless of whether or not the packet's Destination Address was a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet B.	Option Type of Destination Options Header has the following order: 7, 135, 199, 71
The NUT should send an ICMPv6 Parameter Problem message to TR-1	Code value field equal to 2 (unrecognized IPv6 Option encountered) Pointer field equal to 0x30 / 48_d (offset of the Option Type field of the second option)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.3c)

- Option Type Identifier (highest order two bits):
  11_b: Discard the packet and, only if the packet's Destination Address was not a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet C.	Option Type of Destination Options Header has the following order: 7, 199, 135, 71
The NUT should send an ICMPv6 Parameter Problem message to TR-1	Code value field equal to 2 (unrecognized IPv6 Option encountered) Pointer field equal to 0x30 / 48_d (offset of the Option Type field of the second option)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.3d)

- Option Type Identifier (highest order two bits):
  00_b: Skip over this option and continue processing the header.
- Short Option Lengths

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet D.	All Option Types of Destination Options Header have the following value: 00_b
The NUT should send an ICMPv6 Echo Reply from the NUT.	The NUT should skip all options and process the ICMPv6 Echo Request.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.2.0.3e)

- Option Type Identifier (highest order two bits):
  00_b: Skip over this option and continue processing the header.
- Long Option Lengths

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet E.	All Option Types of Destination Options Header have the following value: 00_b
The NUT should send an ICMPv6 Echo Reply from the NUT.	The NUT should skip all options and process the ICMPv6 Echo Request.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **routing_header.base.v6.ip** (1.4.4.0.1)

Purpose: Verify that a node properly handles Routing Headers within an IPv6 packet.

References:

- [IPv6-SPEC] – Section 4.4
- [ICMPv6] – Sections 3 and 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 16, 1999

Discussion: If, while processing a received packet, a node encounters a Routing Header with an unrecognized Routing Type value, the required behavior of the node depends on the value of the Segments Left field, as follows:

- If Segments Left is zero, the node must ignore the Routing Header and proceed to process the next header in the packet, whose type is identified by the Next Header field in the Routing Header.

- If Segments Left is non-zero, the node must discard the packet and transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 0 and an ICMPv6 Pointer field pointing to the unrecognized Routing Type.

A Routing header is not examined or processed until it reaches the node identified in the Destination Address field of the IPv6 header. In that node, dispatching on the Next Header field of the immediately preceding header causes the Routing header module to be invoked, which, in the case of Routing Type 0, performs the following algorithm:

```
if Segments Left = 0 {
     proceed to process the next header in the packet, whose type is
     identified by the Next Header field in the Routing header
  }
  else if Hdr Ext Len is odd {
       send an ICMP Parameter Problem, Code 0, message to the Source
       Address, pointing to the Hdr Ext Len field, and discard the
       packet
  }
  else {
     compute n, the number of addresses in the Routing header, by
     dividing Hdr Ext Len by 2

     if Segments Left is greater than n {
       send an ICMP Parameter Problem, Code 0, message to the Source
       Address, pointing to the Segments Left field, and discard the
       packet
     }
     else {
       decrement Segments Left by 1;
       compute i, the index of the next address to be visited in
       the address vector, by subtracting Segments Left from n
```

```
    if Address [i] or the IPv6 Destination Address is multicast {
      discard the packet
    }
    else {
      swap the IPv6 Destination Address and Address[i]

      if the IPv6 Hop Limit is less than or equal to 1 {
        send an ICMP Time Exceeded -- Hop Limit Exceeded in
       Transit message to the Source Address and discard the
        packet
      }
      else {
        decrement the Hop Limit by 1

        resubmit the packet to the IPv6 module for transmission
        to the new destination
      }
    }
  }
}
```

Test Packets/Setup:

Packet A	Packet B
IPv6 Header Next Header: 43	IPv6 Header Next Header: 43
Routing Header Next Header: 58 Routing Type: 1(Undefined) Segments Left: 1	Routing Header Next Header: 58 Routing Type: 1(Undefined) Segments Left: 0
ICMPv6 Echo Request	ICMPv6 Echo Request

Packet C	Packet D
IPv6 Header Next Header: 43	IPv6 Header Next Header: 43
Routing Header Next Header: 58 Header Ext. Length: 46 Routing Type: 0 Segments Left: 9 Address[1-23]: TN's Global Address	Routing Header Next Header: 58 Header Ext. Length: 46 Routing Type: 0 Segments Left: 2 Address[1-23]: NUT's Global Address
ICMPv6 Echo Request	ICMPv6 Echo Request

Packet E	Packet F
IPv6 Header Next Header: 43	IPv6 Header Next Header: 43
Routing Header Next Header: 58 Header Ext. Length: 0 Routing Type: 0 Segments Left: 0	Routing Header Next Header: 58 Header Ext. Length: 2 Routing Type: 0 Segments Left: 5
ICMPv6 Echo Request	ICMPv6 Echo Request

Procedure: (1.4.4.0.1a)

- If a node encounters a Routing Header with an unrecognized Routing Type value, the required behavior of the node depends on the value of the Segments Left field
- If Segments Left is non-zero, the node must discard the packet and transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 0 and an ICMPv6 Pointer field pointing to the unrecognized Routing Type.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A.	Routing Type:1 (undefined), Segments left: 1
The NUT should send an ICMPv6 Parameter Problem message to TR-1	Code value field equal to 0 (erroneous Header field encountered) Pointer field equal to 0x2A / 42_d (offset of the Routing Type field of the Routing Header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.4.0.1b)

- If a node encounters a Routing Header with an unrecognized Routing Type value, the required behavior of the node depends on the value of the Segments Left field.
- If Segments Left is zero, the node must ignore the Routing Header and proceed to process the next header in the packet, whose type is identified by the Next Header field in the Routing Header.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet B.	Routing Type:1 (undefined) Segments left: 0
The NUT should send an ICMPv6 Echo Reply from the NUT to TR-1.	The NUT should ignore the Routing Header and proceed to process the Next Header.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.4.0.1c)

- Applies to routers only
- Invoke Routing header algorithm

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet C.	Routing Type:0 Segments left: 9 Header Ext. Length: 46 Address [1-23] : TN's Global Address
Capture the packet forwarded by the NUT to TR-1's Global Address.	Based on Routing header module the NUT resubmits the packet to the IPv6 module for transmission to the new destination which in this case is the Global Address of the TN. Packet should be seen only once.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.4.0.1d)

- Applies to routers only
- Invoke Routing header algorithm

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet D.	Routing Type:0 Segments left: 2 Header Ext. Length: 46 Address [1-23] : NUT's Global Address
The NUT should send an ICMPv6 Echo Reply to TR-1.	Based on Routing header module the NUT processes the Routing header with the packet looped back to itself. Since the final destination is also the NUT, it should process the ICMPv6 Echo Request.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.4.0.1e)

- In the Routing header algorithm:
  if Segments Left = 0 {
  proceed to process the next header in the packet, whose type is identified by the Next Header field in the Routing header
  }

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet E.	Routing Type:0 Segments left: 0
The NUT should send an ICMPv6 Echo Reply to TR-1.	Based on Routing header module the NUT processes the the ICMPv6 Echo Request.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.4.0.1f)

- In the Routing header algorithm:
  if Segments Left is greater than (Header Ext. Length / 2) {
  send an ICMP Parameter Problem, Code 0, message to the Source Address, pointing to the Segments Left field, and discard the packet
  }

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet F.	Routing Type:0 Segments left: 5 Header Ext. Length: 2
The NUT should send an ICMPv6 Parameter Problem message to TR-1.	Code value field equal to 0 (erroneous Header field encountered) Pointer field equal to 0x2B / 43_d (offset of Segments Left field of the Routing Header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **routing_header2.base.v6.ip** (1.4.4.0.2)

Purpose: Verify that a node properly handles Routing Headers within an IPv6 packet.

References:

- [IPv6-SPEC] – Section 4.4.
- [ICMPv6] – Sections 3 and 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 16, 1999

Discussion: A Routing header is not examined or processed until it reaches the node identified in the Destination Address field of the IPv6 header. In that node, dispatching on the Next Header field of the immediately preceding header causes the Routing header module to be invoked, which, in the case of Routing Type 0, performs the following algorithm:

```
if Segments Left = 0 {
     proceed to process the next header in the packet, whose type is
     identified by the Next Header field in the Routing header
  }
  else if Hdr Ext Len is odd {
       send an ICMP Parameter Problem, Code 0, message to the Source
       Address, pointing to the Hdr Ext Len field, and discard the
       packet
  }
  else {
     compute n, the number of addresses in the Routing header, by
     dividing Hdr Ext Len by 2

     if Segments Left is greater than n {
       send an ICMP Parameter Problem, Code 0, message to the Source
       Address, pointing to the Segments Left field, and discard the
       packet
     }
     else {
       decrement Segments Left by 1;
       compute i, the index of the next address to be visited in
       the address vector, by subtracting Segments Left from n

       if Address [i] or the IPv6 Destination Address is multicast {
         discard the packet
       }
       else {
         swap the IPv6 Destination Address and Address[i]

         if the IPv6 Hop Limit is less than or equal to 1 {
           send an ICMP Time Exceeded -- Hop Limit Exceeded in
          Transit message to the Source Address and discard the
```

```
            packet
          }
          else {
            decrement the Hop Limit by 1

            resubmit the packet to the IPv6 module for transmission
            to the new destination
          }
        }
      }
    }
```

Test Packets/Setup:

Packet A	Packet B	Packet C
IPv6 Header Next Header: 43	IPv6 Header Next Header: 43	IPv6 Header Next Header: 43 Hop Limit: 1
Routing Header Next Header: 41 Header Ext. Length: 3(odd) Routing Type: 0 Segments Left: 1	Routing Header Next Header: 58 Header Ext. Length: 2 Routing Type: 0 Segments Left: 1 Address[1]: Multicast	Routing Header Next Header: 58 Header Ext. Length: 8 Routing Type: 0 Segments Left: 2
ICMPv6 Echo Request	ICMPv6 Echo Request	ICMPv6 Echo Request

Procedure: (1.4.4.0.2a)

- In the Routing header algorithm:
  if Hdr Ext Len is odd {
    send an ICMP Parameter Problem, Code 0, message to the Source Address, pointing to the Hdr Ext Len field, and discard the packet
  }

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A.	Routing Type:0 Header Ext. Length: 3
The NUT should send an ICMPv6 Parameter Problem message to TR-1.	Code value field equal to 0 (erroneous Header field encountered) Pointer field equal to 0x29 / 41_d (offset of Header Ext. Length field of the Routing Header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.4.0.2b)

- In the Routing header algorithm:
  if Address [i] or the IPv6 Destination Address is multicast {
  discard the packet
  }

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet B.	Routing Type:0 Address [1]: Multicast
The NUT should discard the packet.	No packets should be sent to TR-1.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.4.0.2c)

- In the Routing header algorithm:
  if the IPv6 Hop Limit is less than or equal to 1 {
  send an ICMP Time Exceeded -- Hop Limit Exceeded in Transit message to the Source Address and discard the packet
  }

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet C.	Routing Type:0 Header Ext. Length: 8
The NUT should send an ICMPv6 Time Exceeded – Hop Limit Exceeded in Transit message to TR-1.	None.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **reassembly_frag_entry.base.v6.ip** (1.4.5.0.1)

Purpose: Verify that a node distinguishes between packet fragments using the Source Address, Destination Address, and Fragment Identification of the fragments.

References:

- [IPv6-SPEC] – Section 4.5
- [ICMPv6] – Sections 3 and 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 17, 1999

Discussion: The Fragment header is used by an IPv6 source to send a packet larger than would fit in the Path MTU to its destination. An original packet is reassembled only from fragment packets that have the same Source Address, Destination Address and Fragment Identification.

Test Packets/Setup:

Packet A
IPv6 packet with an ICMPv6 Echo Request with 80 bytes of data fragmented into three packets, the maximum of which contains 32 bytes of payload.

Fragment A.1	Fragment A.2	Fragment A.3
IPv6 Header Next Header: 44 Source Address: Specified Below	IPv6 Header Next Header: 44 Source Address: Specified Below	IPv6 Header Next Header: 44 Source Address: Specified Below
Fragment Header Next Header: 58 Fragment Offset: 0 More Fragments flag: 1 ID: Specified Below	Fragment Header Next Header: 58 Fragment Offset: 32 More Fragments flag: 1 ID: Specified Below	Fragment Header Next Header: 58 Fragment Offset: 64 More Fragments flag: 0 ID: Specified Below
ICMPv6 Echo Request	Fragment Data: 32 Bytes	Fragment Data: 32 Bytes

Procedure: (1.4.5.0.1a)

- All fragments are valid

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Fragments A.1, A.2 and A.3 in order.	All fragments have the same value for Fragment ID.
The NUT should transmit an Echo Reply to TR-1.	In response to the reassembled Echo Request.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.5.0.1b)

- Fragment IDs differ between fragments

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Fragments A.1, A.2 and A.3 in order.	Fragments A.1 and A.3 have ID equal to 2999. Fragment A.2 has ID equal to 3000.
The NUT should not generate an Echo Reply.	The Echo Request could not be reassembled due to differences in the Fragment ID.
The NUT should transmit an ICMPv6 Time Exceeded Message to TR-1 60 seconds after reception of Fragment A.1	None.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.5.0.1c)

- Source Addresses differ between fragments.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
Transmit Fragments A.1, A.2 and A.3 in order.	Fragments A.1 and A.3 have source address equal to TR-1's link-local address. Fragment A.2 has a different link-local source address.
The NUT should not generate an Echo Reply.	The Echo Request was not reassembled due to differences in the source addresses of the fragments.
The NUT should transmit an ICMPv6 Time Exceeded Message to TR-1 60 seconds after reception of Fragment A.1	None.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.5.0.1d)

- Destination Addresses differ between fragments.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Contains a Prefix Option for the link's prefix. Cause the NUT to autoconfigure its global address from the link's prefix.
TR-1 transmits Fragments A.1, A.2 and A.3 in order.	Fragments A.1 and A.3 have destination address equal to the NUT's link-local address. Fragment A.2 has destination address equal to the autoconfigured global address of the NUT.
The NUT should not generate an Echo Reply.	The Echo Request was not reassembled due to differences in the destination addresses of the fragments.
The NUT should transmit an ICMPv6 Time Exceeded Message to TR-1 60 seconds after reception of Fragment A.1	None.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: The monitor may have to wait longer than 60 seconds for the ICMPv6 Time Exceeded message.

Test Label: **reassembly_time_exceeded.base.v6.ip** (1.4.5.0.2)

Purpose: Verify that a node takes the proper actions when the reassembly time has been exceeded for a packet.

References:

- [IPv6-SPEC] – Section 4.5
- [ICMPv6] – Sections 3 and 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: May 13, 1996

Discussion: If insufficient fragments are received to complete reassembly of a packet within 60 seconds of the reception of the first-arriving fragment of the packet, reassembly of that packet must be abandoned and all the fragments that have been received for that packet must be discarded. If the first fragment (i.e., the one with a Fragment Offset of zero) has been received, an ICMPv6 Time Exceeded – Fragment Reassembly Time Exceeded message should be sent to the source of that fragment.

Test Packets/Setup:

Packet A
IPv6 packet with an ICMPv6 Echo Request with 80 bytes of data fragmented into three packets, the maximum of which contains 32 bytes of payload.

Fragment A.1	Fragment A.2	Fragment A.3
IPv6 Header Next Header: 44	IPv6 Header Next Header: 44	IPv6 Header Next Header: 44
Fragment Header Next Header: 58 Fragment Offset: 0 More Fragments flag: 1	Fragment Header Next Header: 58 Fragment Offset: 32 More Fragments flag: 1 Fragment Data: 32 Bytes	Fragment Header Next Header: 58 Fragment Offset: 64 More Fragments flag: 0 Fragment Data: 32 Bytes
ICMPv6 Echo Request		

Procedure: (1.4.5.0.2a)

- Long wait between fragments.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Fragments A.1, A.2 and A.3 in order to the NUT. There is a 58-second delay between the transmission of Fragment A.1 and Fragment A.2.	Fragments A.2 and A.3 should arrive just before the NUT's reassembly timer expires for Fragment A.1.
The NUT should transmit an Echo Reply to TR-1.	In response to the reassembled Echo Request.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.5.0.2b)

- Reassembly time is exceeded before the second and third fragments arrive.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Fragments A.1, A.2 and A.3 in order to the NUT. There is a 79-second delay between the transmission of Fragment A.1 and Fragment A.2.	Fragments A.2 and A.3 should arrive after the NUT's reassembly timer expires for Fragment A.1.
The NUT should not transmit an Echo Reply.	The Echo Request was not reassembled.
The NUT should transmit an ICMPv6 Time Exceeded Message to TR-1 60 seconds after reception of Fragment A.1	None.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.5.0.2c)

- Reassembly time is exceeded before the last fragments arrive. All individual packets arrive within 60 seconds of each other.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Fragments A.1, A.2 and A.3 in order to the NUT. There is a 40 second delay between the transmission of Fragment A.1 and Fragment A.2, and a 40 second delay between the transmission of Fragment A.2 and Fragment A.3.	Fragment A.3 should arrive after the NUT's reassembly timer expires for Fragment A.1.
The NUT should not transmit an Echo Reply.	The Echo Request was not reassembled.
The NUT should transmit an ICMPv6 Time Exceeded Message to TR-1 60 seconds after reception of Fragment A.1	None.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.5.0.2d)

Reassembly time is exceeded after the middle fragment arrives, but before the offset zero fragments arrives. The offset 0 fragment arrives last.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Fragments A.2, A.3 and A.1 in that order to the NUT. There is a 70 second delay between the transmission of Fragment A.2 and Fragment A.3, and a 20 second delay between the transmission of Fragment A.3 and Fragment A.1.	Fragment A.3 should arrive after the NUT's reassembly timer expires for Fragment A.2.
The NUT should not transmit an Echo Reply.	The Echo Request was not reassembled.
The NUT should not transmit an ICMPv6 Time Exceeded message due to fragment A.2.	Fragment A.2 has a non-zero Fragment Offset. When the reassembly timer expires for Fragment A.2, the Fragment with Fragment Offset zero has not yet been received.
The NUT should transmit an ICMPv6 Time Exceeded Message to TR-1 40 seconds after reception of Fragment A.1	None.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **fragment_header_m_bit.base.v6.ip** (1.4.5.0.3)

Purpose: Verify that a node takes the proper actions when it receives an IPv6 fragment with the M-bit set (more fragments), but which has a payload length which is not a multiple of 8 bytes.

References:

- [IPv6-SPEC] – Section 4.5
- [ICMPv6] – Section 3.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 18, 1999

Discussion: If the length of a fragment, as derived from the fragment packet's Payload Length field, is not a multiple of 8 octets and the M flag of that fragment is set, then that fragment must be discarded and an ICMPv6 Parameter Problem message should be sent to the packet's source with an ICMPv6 Code field of 0 and an ICMPv6 Pointer field containing the offset of the Payload Length field of the fragment packet.

Test Packets/Setup:

Packet A

IPv6 Header Payload Length: 21 bytes Next Header: 44
Fragment Header Next Header: 58 Fragment Offset: 0 More Fragments flag: 1
ICMPv6 Echo Request Data Length: 5 bytes

Procedure:

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A	Packet A contains a Payload Length of 21, which is not a multiple of 8 octets.
The NUT should transmit an ICMPv6 Parameter Problem message to TR-1.	Code value field equal to 0 (erroneous Header field encountered) Pointer field equal to 0x4 / 4_d (offset of Payload Length field of the IPv6 Header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **max_reassembly_size_exceeded.base.v6.ip** (1.4.5.0.4)

Purpose: Verify the response of a node to a fragment packet which would cause the reassembled packet's payload length to exceed 65,535 bytes.

References:

- [IPv6-SPEC] – Section 4.5
- [ICMPv6] – Section 3.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 18, 1999

Discussion: If the length and offset of a fragment are such that the Payload Length of the packet reassembled from that fragment would exceed 65,535 octets, then that fragment must be discarded and an ICMPv6 Parameter Problem message should be sent to the packet's source with an ICMPv6 Code field of 0 and an ICMPv6 Pointer field containing the offset of the Fragment Offset field of the fragment packet

Test Packets/Setup:

Packet A

IPv6 Header Payload Length: 272 bytes Next Header: 44
Fragment Header Next Header: 58 Fragment Offset: 65528 More Fragments flag: 1
ICMPv6 Echo Request Data Length: 256 bytes

Procedure:

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A.	Packet A contains a Payload Length of 272, and a Fragment Offset of 65528. The Payload Length of the reassembled packet would exceed 65535 octets.
The NUT should transmit an ICMPv6 Parameter Problem message to TR-1.	Code value field equal to 0 (erroneous Header field encountered) Pointer field equal to 0x2A/ 42_d (offset of Fragment Offset field of the Fragment Header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **stub_frag_header.base.v6.ip** (1.4.5.0.5)

Purpose: Verify that a node accepts the offset zero fragment with the More Fragments flag clear.

References:

- [IPv6-SPEC] – Section 4.5
- [ICMPv6] – Section 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 18, 1999

Discussion: The Fragment Offset of the first fragment is 0. An M flag value of 0 indicates the fragment is the last fragment. It is acceptable for a fragmented packet to consist of only a single fragment.

Test Packets/Setup:

Packet A

IPv6 Header Next Header: 44
Fragment Header Next Header: 58 Fragment Offset: 0 More Fragments flag: 0
ICMPv6 Echo Request

Procedure:

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A	Packet A contains the Fragment Header set to 0 and the M Flag set to 0.
The NUT should transmit an ICMPv6 Parameter Echo Reply to TR-1.	None.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **frag_multiple_m_bit_zero.base.v6.ip** (1.4.5.0.6)

Purpose: Verify that a node takes the proper actions when two different fragments of the same packet have the More Fragments flag clear.

References:

- [IPv6-SPEC] – Section 4.5

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 18, 1999

Discussion: The More Fragments flag indicates whether there are more fragments to follow (set to 1) or if the fragment is the last fragment (clear). The action taken by a node for receiving multiple fragments with More Fragments flag clear is not defined, however, adverse affects should not occur as a result.

Test Packets/Setup:

Packet A
ICMPv6 Echo Request fragmented into four fragments.

Fragment A.1

IPv6 Header Next Header: 44
Fragment Header Next Header: 58 Fragment Offset: 0 More Fragments flag: 1
ICMPv6 Echo Request

Fragment A.2

IPv6 Header Next Header: 44
Fragment Header Next Header: 58 Fragment Offset: 40 More Fragments flag: 1

Fragment A.3

IPv6 Header Next Header: 44
Fragment Header Next Header: 58 Fragment Offset: 80 More Fragments flag: 0

Fragment A.4

IPv6 Header Next Header: 44
Fragment Header Next Header: 58 Fragment Offset: 120 More Fragments flag: 0

Packet B
ICMPv6 Echo Request fragmented into two fragments.

Fragment B.1	Fragment B.2
IPv6 Header Next Header: 44	IPv6 Header Next Header: 44
Fragment Header Next Header: 58 Fragment Offset: 0 More Fragments flag: 0	Fragment Header Next Header: 58 Fragment Offset: 80 More Fragments flag: 0
ICMPv6 Echo Request	

Procedure: (1.4.5.0.6a)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Fragments A.3, A.4, A.1 and A.2 in that order to the NUT.	Fragment A.3 and A.4 contain the M flag clear. Fragment A.1 has Fragment Offset clear.
The NUT should not generate invalid packets or crash.	No problems should arise as a result of the M flag being clear in multiple fragments.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.5.0.6b)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Fragments B.2 and B.1 in that order to the NUT.	Fragment B.2 and B.1 contain the M flag clear. Fragment B.1 has Fragment Offset clear.
The NUT should not generate invalid packets or crash.	No problems should arise as a result of the M flag being clear in multiple fragments.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **reassembly_unfragmentable_header.base.v6.ip** (1.4.5.0.7)

Purpose: Verify that a node properly processes the unfragmentable portion of a packet fragment and creates the correct headers in the reassembled packet.

References:

- [IPv6-SPEC] – Section 4.5
- [ICMPv6] – Sections 3 and 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 18, 1999

Discussion: The Unfragmentable Part of the reassembled packet consists of all headers up to, but not including, the Fragment Header of the first fragment packet (that is, the packet whose Fragment Offset is zero), with the following two changes:

- The Next Header field of the last header of the Unfragmentable Part is obtained from the Next Header field of the first fragment's Fragment Header.

- The Payload Length of the reassembled packet is computed from the length of the Unfragmentable Part and the length and offset of the last fragment.

Option Type identifiers are internally encoded such that their highest order two bits specify the action that must be taken if the processing IPv6 node does not recognize the Option Type:

- 10_b: Discard the packet and, regardless of whether or not the packet's Destination Address was a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.

Test Packets/Setup:

Packet A
IPv6 packet with a Hop-By-Hop Header and an ICMPv6 Echo Request with 80 bytes of data fragmented into three packets, the maximum of which contains 32 bytes of payload.

Fragment A.1	Fragment A.2	Fragment A.3
IPv6 Header Next Header: 60	IPv6 Header Next Header: 48	IPv6 Header Next Header: 44
Destination Options Header Next Header: 44 Header Ext. Length: 0 PadN Option	Hop-By-Hop Header Next Header: 44 Header Ext. Length: 0 PadN Option	Fragment Header Next Header: 58 Fragment Offset: 64 More Fragments flag: 0 Fragment Data: 32 Bytes
Fragment Header Next Header: 58 Fragment Offset: 0 More Fragments flag: 1	Fragment Header Next Header: 58 Fragment Offset: 32 More Fragments flag: 1 Fragment Data: 32 Bytes	
ICMPv6 Echo Request		

Packet B
IPv6 packet with a Destination Options Header and an ICMPv6 Echo Request with 80 bytes of data fragmented into three packets, the maximum of which contains 32 bytes of payload.

Fragment B.1	Fragment B.2	Fragment B.3
IPv6 Header Next Header: 60	IPv6 Header Next Header: 48	IPv6 Header Next Header: 44
Destination Options Header Next Header: 44 Header Ext. Length: 0 PadN Option	Destination Options Header Next Header: 44 Header Ext. Length: 0 Option: 135 (unknown, msb: 10_b)	Fragment Header Next Header: 58 Fragment Offset: 64 More Fragments flag: 0 Fragment Data: 32 Bytes
Fragment Header Next Header: 58 Fragment Offset: 0 More Fragments flag: 1	Fragment Header Next Header: 58 Fragment Offset: 32 More Fragments flag: 1 Fragment Data: 32 Bytes	
ICMPv6 Echo Request		

Packet C
ICMPv6 Echo Request fragmented into four fragments.

Fragment C.1

IPv6 Header Next Header: 60 Payload Length: 48
Destination Options Header Next Header: 44 Header Ext. Length: 0 PadN Option
Fragment Header Next Header: 43 Fragment Offset: 0 More Fragments flag: 1
Routing Header Next Header: 58 Routing Type: 0 Header Ext. Length: 2 Segments Left: 1
ICMPv6 Echo Request

Fragment C.2

IPv6 Header Next Header: 60 Payload Length: 48
Destination Options Header Next Header: 44 Header Ext. Length: 0 PadN Option
Fragment Header Next Header: 138 Fragment Offset: 32 More Fragments flag: 1 Fragment Data: 32 Bytes

Fragment C.3

IPv6 Header Next Header: 44 Payload Length: 40
Fragment Header Next Header: 43 Fragment Offset: 64 More Fragments flag: 1

Fragment C.4

IPv6 Header Next Header: 60 Payload Length: 32
Destination Options Header Next Header: 44 Header Ext. Length: 0 PadN Option
Fragment Header Next Header: 43 Fragment Offset: 96 More Fragments flag: 0

Procedure: (1.4.5.0.7a)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A.	Packet A contains a Hop-By-Hop Header and an ICMPv6 Echo Request in three fragments.
The NUT should send an ICMPv6 Echo Reply to TR-1.	No problems should arise as a result of the differences in the unfragmentable parts.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.5.0.7b)

- Option Type 135 (unknown, msb:10_b)
  10_b: Discard the packet and, regardless of whether or not the packet's Destination Address was a multicast address, transmit an ICMPv6 Parameter Problem message to the packet's Source Address with an ICMPv6 Code field of 2 and the ICMPv6 Pointer field containing the offset of the unrecognized Option Type.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet B.	Packet B contains a Destination Options Header and an ICMPv6 Echo Request in three fragments. Fragment B.2 contains Option Type: 135 (unknown, msb:10_b) in the Destination Options Header.
The NUT should send an ICMPv6 Parameter Problem message to TR-1.	Code value field equal to 2 (unrecognized IPv6 Option encountered) Pointer field equal to 0x2A / 42_d (offset of the option field of Destination Options Header)
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.5.0.7c)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet C.	Packet C contains an ICMPv6 Echo Request in four fragments. Fragment C.1 contains a Routing Header.
The NUT should forward the ICMPv6 Echo Request.	The presence of the Routing Header causes the NUT to forward the packet. The unfragmentable part of the packet should correspond to that of the first fragment.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **no_next_header.base.v6.ip** (1.4.7.0.1)

Purpose: Verify proper behavior of a node when it encounters a Next Header value of 59 (no next header).

References:

- [IPv6-SPEC] – Section 4.7

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 18, 1999

Discussion: The value 59 in the Next Header field of an IPv6 Header or any extension header indicates that there is nothing following that header. If the Payload Length field of the IPv6 Header indicates the presence of octets past the end of a header whose Next Header field contains 59, those octets must be ignored, and passed on unchanged if the packet is forwarded.

Test Packets/Setup:

Packet A

IPv6 Header Next Header: 43
Routing Header Next Header: 60 Header Ext. Length: 2 Segments Left: 1
Destination Options Header Next Header: 59 (None) Header Ext. Length: 0 PadN Option

Packet B

IPv6 Header Next Header: 60
Destination Options Header Next Header: 59 (None) Header Ext. Length: 0 PadN Option

Procedure: (1.4.7.0.1a)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet A.	Packet A contains a Routing Header and a Destination Options Header with a Next Header Value of 59.
The NUT should send a packet to the next hop in the Routing Header.	The data portion of the packet should remain unchanged.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (1.4.7.0.1b)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Packet B.	Packet B contains a Destination Options Header with a Next Header value of 59.
The NUT should not send any packets.	
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

NEIGHBOR DISCOVERY

Scope
The following tests cover the Neighbor Discovery Specification for Internet Protocol version 6. The Neighbor Discovery protocol is used by nodes (hosts and routers) to determine the link-layer address for neighbors known to reside on attached links as well as to quickly purge cached values that become invalid. Hosts also use Neighbor Discovery to find neighboring routers that are willing to forward packets on their behalf. Finally, nodes use the protocol to actively keep track of neighbors that are reachable and those that are not. When a router or the path to a router fails, a host actively searches for functioning alternates.

Overview
These tests are designed to verify conformance with the Neighbor Discovery Specification.

Test Label: **on-link_determination.nd.v6.ip** (2.5.2.0.1)

Purpose: Verify that a node correctly determines that a destination is on-link.

References:

- [ND] – Section 5.2

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: April 20, 1999

Discussion: Next-hop determination for a given unicast destination operates as follows. The sender performs a longest prefix match against the Prefix List to determine whether the packet's destination is on- or off-link. If the destination is on-link, the next-hop address is the same as the packet's Destination Address. Otherwise, the sender selects a router from the Default Router List. If the Default Router List is empty, the sender assumes that the destination is on-link.

Test Packets/Setup:

If these tests are being performed on a router, configure the router with a static route for all global addresses to the TR. Also configure the router to advertise the global prefix advertised by the TR.

Packet A

IPv6 Header Next Header: 58 Source Address: TN's Link Local Address
ICMPv6 Echo Request

Packet B, C

IPv6 Header Next Header: 58 Source Address: TN's Global Address
ICMPv6 Echo Request

Router Advertisement

IPv6 Header Next Header: 58
Router Advertisement Prefix Length: 64 L Bit: 1 (on-link) Prefix: TN's Global Prefix

Packet D

IPv6 Header Next Header: 58 Source Address: TN's Global Address Destination Address: NUT's Global Address
ICMPv6 Echo Request

Procedure: (2.5.2.0.1a)

Steps	Notes
TN-1 transmits the Router Advertisement.	Cause the NUT to add, if necessary, the source address to the Default Router list and compute Reachable Time. The prefix covers TN-1's Global address.
TN-1 transmits Packet A.	Packet A contains TN-1's Link Local Source Address.
The NUT should send a Neighbor Solicitation.	Target Address equal to TN-1's Link Local Address indicating that the NUT has successfully determined that TN-1 was on-link.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.5.2.0.1b)

Steps	Notes
TN-1 transmits the Router Advertisement.	Cause the NUT add, if necessary, the source address to the Default Router list and compute Reachable Time. The prefix covers TN-1's Global address.
TN-1 transmits Packet B.	Packet B contains TN-1's Global Source Address.
The NUT should send a Neighbor Solicitation.	There are no routers on the link and NUT considers all global addresses as on-link. Target Address equal to TN-1's Global Address indicating that the NUT has successfully determined that TN-1 was on-link.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.5.2.0.1c)

Steps	Notes
TN-1 transmits the Router Advertisement.	Cause the NUT to add, if necessary, the source address to the Default Router list and compute Reachable Time. The prefix covers TN-1's Global address.
TN-1 transmits Packet C.	Packet C contains TN-1's Global Source Address.
The NUT should send a Neighbor Solicitation.	TN-1's Global Address is covered by the prefix (TN's Global)/64. Hence, the NUT should consider the TN's Global Address as on-link. Target Address equal to TN-1's Global Address indicating that the NUT has successfully determined that TN-1 was on-link.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.5.2.0.1d)

Steps	Notes
TN-1 transmits the Router Advertisement.	Cause the NUT to add, if necessary, the router to the Default Router list and compute Reachable Time. The prefix does not cover TN-1's Global Address.
TN-1 transmits Packet D.	Packet D contains TN-1's Global Source Address.
The NUT should send a Neighbor Solicitation.	TN-1's Global Address is not covered by the prefix (TN's Global)/64. Hence, the NUT should consider the TN's Global Address as off-link. Target Address equal to the router's address indicating that the NUT has successfully determined that TN-1 was off-link.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **resolution_wait_queue.nd.v6.ip** (2.5.2.0.2)

Purpose: Verify that a node properly queues packets while waiting for address resolution of the next hop.

References:

- [ND] – Section 3, Section 7.2.2
- [ICMPv6] – Section 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: April 27, 1999

Discussion: Nodes accomplish address resolution by multicasting a Neighbor Solicitation that asks the target node to return its link-layer address. Neighbor Solicitation messages are multicast to the solicited-node multicast address of the target address. The target returns its link-layer address in a unicast Neighbor Advertisement message. A single request-response pair of packets is sufficient for both the initiator and the target to resolve each other's link-layer addresses; the initiator includes its link-layer address in the Neighbor Solicitation.

While waiting for address resolution to complete, the sender MUST, for each neighbor, retain a small queue of packets waiting for address resolution to complete. The queue MUST hold at least one packet, and MAY contain more. However, the number of queued packets per neighbor SHOULD be limited to some small value. When a queue overflows, the new arrival SHOULD replace the oldest entry. Once address resolution completes, the node transmits any queued packets.

Test Packets/Setup:

Packet A

IPv6 Header Next Header: 58 Source Address: TN's Link Local Address
ICMPv6 Echo Request ID: I

Neighbor Advertisement

IPv6 Header Next Header: 58 Source Address: TN's Link Local Address Destination Address: NUT's Link Local Address
Neighbor Advertisement Router flag: 0 Solicited flag: 1 Override flag: 1 Target Address: TN's Link Local Address

Procedure: (2.5.2.0.2a)

Steps	Notes
TN-1 transmits the Router Advertisement.	Cause the NUT to add, if necessary, the router to the Default Router list and compute Reachable Time. The prefix does not cover TN-1's Global Address.
TN-1 transmits Packet A N times.	Packet A is an ICMPv6 Echo Request. Each time the identifier is incremented.
The NUT should send a Neighbor Solicitation.	The NUT initiates address resolution in order to determine the link-layer address of the TN.
TN-1 transmits the Neighbor Advertisement.	In response to the Neighbor Solicitation
The NUT should send Echo Replies to the NUT.	The Echo Replies should correspond to the last N Echo Requests sent by the TN to the NUT indicating successful queuing of packets while waiting for address resolution to complete.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **add_default_router.nd.v6.ip** (2.5.3.0.1)

Purpose: Verify that the receipt of a valid Router Advertisement with nonzero Router Lifetime field causes a node to add that router to its Default Router List.

References:

- [ND] – Section 6.3.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: April 27, 1999

Discussion: On receipt of a valid Router Advertisement, a host extracts the source address of the packet and does the following:

- If the address is not already present in the host's Default Router List, and the advertisement's Router Lifetime is non-zero, create a new entry in the list, and initialize its invalidation timer value from the advertisement's Router Lifetime field. This test applies only to hosts.

Test Packets/Setup:

Router Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address
Router Advertisement Prefix Length: 64 L Bit: 1 (on-link) Prefix: TR's Global Prefix

Packet A

IPv6 Header Next Header: 58 Source Address: TR's Global Address
ICMPv6 Echo Request

Neighbor Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: NUT's Link Local Address
Neighbor Advertisement Router flag: 1 Solicited flag: 1 Override flag: 1 Target Address: TR's Link Local Address

Procedure: (2.5.3.0.1a)

Steps	Notes
TR-1 transmits a Router Advertisement.	Cause the NUT to add the router to the Default Router List and compute Reachable Time.
The NUT should send a Neighbor Solicitation to the TR's on-link address.	The NUT initiates address resolution in order to determine the link-layer address of the TN.
TR-1 transmits Packet A.	Packet A is an ICMPv6 Echo Request.
TR-1 transmits the Neighbor Advertisement.	In response to the Neighbor Solicitations.
The NUT should send an ICMPv6 Echo Reply to the TR.	The Echo Reply should correspond to the previously sent Echo Request. The Destination Address should be the address advertised in the Neighbor Advertisement.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **default_router_switch.nd.v6.ip** (2.5.3.0.2)

Purpose: Verify that a host maintains at least two routers in its Default Router List and will switch routers when the router in use fails.

References:

- [ND] – Sections 5.2, 5.3

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: May 4, 1999

Discussion: A host should retain entries in the Default Router List and the Prefix List until their lifetimes expire. However, a host may delete old entries prematurely if it is low on memory. If not all routers are kept on the Default Router list, a host should retain at least two entries in the Default Router List (preferably more) in order to maintain robust connectivity for off-link destinations.

For efficiency reasons, next-hop determination is not performed on every packet that is sent. Instead, the results of next-hop determination computations are saved in the Destination Cache. When the sending host has a packet to send, it first examines the Destination Cache. If no entry exists for the destination, next-hop determination is invoked to create a Destination Cache entry.

Next-hop determination is done the first time traffic is sent to a destination. As long as subsequent communication to that destination proceeds successfully, the Destination Cache entry continues to be used. If at some point communication ceases to proceed, as determined by the Neighbor Unreachability Detection algorithm, next-hop determination may need to be performed again. For example, traffic through a failed router should be switched to a working router. This test applies only to Hosts.

Test Packets/Setup:

Router Advertisement A	Router Advertisement B
IPv6 Header Next Header: 58 Source Address: TR1's Link Local Address	IPv6 Header Next Header: 58 Source Address: TR2's Link Local Address
Router Advertisement Router Lifetime: 45 seconds Reachable Time: 10 seconds Retransmit Interval: 1 second Prefix Length: 64 L Bit: 1 (on-link) Prefix: TN's Global Prefix	Router Advertisement Router Lifetime: 45 seconds Reachable Time: 10 seconds Retransmit Interval: 1 second Prefix Length: 64 L Bit: 1 (on-link) Prefix: TN's Global Prefix

Packet A	Packet B
IPv6 Header Next Header: 58 Source Address: TR1's Link Local Address Destination Address: NUT's Link Local Address	IPv6 Header Next Header: 58 Source Address: TN's Global Address Destination Address: NUT's Global Address
ICMPv6 Echo Request	ICMPv6 Echo Request

Procedure: (2.5.3.0.2a)

Steps	Notes
TR-1 transmits Router Advertisement A.	Cause the NUT to compute Reachable Time.
TR-1 transmits Packet A.	Packet A is an ICMPv6 Echo Request.
The NUT should send a Neighbor Solicitation.	Target address equal to TR-1's Link local Address.
TR-1 transmits the Neighbor Advertisement.	In response to the Neighbor Solicitation received.
The NUT should send an Echo Reply to the TR-1.	In response to the Echo Request received.
TR-2 transmits Router Advertisement B.	Cause the NUT to compute Reachable Time.
TN transmits Packet B every 3 seconds for 30 seconds.	Packet B is an ICMPv6 Echo Request that has an off-link source address.
The NUT should send Echo Replies to TR-1's Link Local Address until Reachable Time expires.	The NUT retains entries in the Default Router List and Prefix List until their lifetimes expire.
The NUT should send 3 Neighbor Solicitations to TR-1's Link Local Address when Reachable Time expires.	The NUT probes TR-1 to verify reachability. TR-1 does not respond to these solicitations.
The NUT sends Echo Replies to TR-2's Link-Local address.	The NUT selects TR-2 from its Default Router list.
The NUT sends Neighbor Solicitations to TR-2's Link Local Address.	After sending the packets to TR-2, the NUT probes TR-2 as a side effect.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **router_solicitation_handling_by_router.nd.v6.ip** (2.6.2.6.1)

Purpose: Verify that a router properly processes a Router Solicitation.

References:

- [ND] – Section 6.2.6

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: May 4, 1999

Discussion: In addition to transmitting periodic, unsolicited advertisements, a router transmits advertisements in response to valid solicitations received on an advertising interface. A router MAY choose to unicast the response directly to the soliciting host's address (if the solicitation's source address is not the unspecified address), but the usual case is to multicast the response is multicast to the all-nodes group. In the latter case, the interface's interval timer is reset to a new random value, as if an unsolicited advertisement had just been sent.

In all cases, Router Advertisements sent in response to a Router Solicitation MUST be delayed by a random time between 0 and MAX_RA_DELAY_TIME (0.5 seconds). If a single advertisement is sent in response to multiple solicitations, the delay is relative to the first solicitation. In addition, consecutive Router Advertisements sent to the all-nodes multicast address MUST be rate limited to no more than one advertisement every MIN_DELAY_BETWEEN_RAS (3.0 seconds). This test applies only to Routers.

Test Packets/Setup:

Router Solicitation A	Router Solicitation B
IPv6 Header Next Header: 58 Source Address: TN's Link Local Address	IPv6 Header Next Header: 58 Source Address: Unspecified Address
Router Solicitation	Router Solicitation

Procedure: (2.6.2.6.1a)

Steps	Notes
TR-1 transmits an Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for an Echo Reply from the RUT.	Cause the RUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Router Solicitation A.	The IPv6 Source Address is equal to the TR-1's Link Local Address. The IPv6 Destination Address is equal to the All-Routers Multicast Address.
The RUT should respond to the to the Router Solicitation by transmitting a Router Advertisement.	The IPv6 Destination Address is equal to the All-Nodes Multicast Address.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.6.2.6.1b)

- Configure the RUT to be advertising with a MinRtrAdvInterval of 3 seconds and a MaxRtrAdvInterval of 4 seconds.

Steps	Notes
TR-1 transmits an Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for an Echo Reply from the RUT.	Cause the RUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits Router Solicitation A.	The IPv6 Destination Address is equal to the All-Routers Multicast Address.
The RUT should respond to the Router Solicitation by transmitting a Router Advertisement.	The IPv6 Destination Address is equal to the All-Nodes Multicast Address.
Transmit Router Solicitation B twice, 3 seconds apart.	The monitor should capture exactly one Router Advertisement from the RUT in the interval of 0 to 1 second after the receipt of each Router Solicitation.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.6.2.6.1c)

- Configure the RUT to be advertising with a MinRtrAdvInterval of 30 seconds and a MaxRtrAdvInterval of 40 seconds.

Steps	Notes
TR-1 transmits an Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for an Echo Reply from the RUT.	Cause the RUT to resolve the address of the TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits a Router Solicitation A.	The IPv6 Destination Address is equal to the All-Routers Multicast Address.
The RUT should transmit a mulitcast Router Advertisement.	Response to the Router Solicitation.
Transmit Router Solicitation B twice, 25 seconds apart.	The monitor should capture a Router Advertisement every 25 seconds once the RUT starts transmitting Router Solicitations.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.6.2.6.1d)

- Configure the RUT to be Advertising with a MinRtrAdvInterval of 30 seconds and a MaxRtrAdvInterval of 40 seconds.

Steps	Notes
TR-1 transmits an Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for and Echo Reply from the RUT.	Cause the RUT to resolve the address of the TR-1 and create a Neighbor Cache entry for the TR-1 in state REACHABLE.
TR-1 transmits a Router Solicitation A.	The IPv6 Destination Address is equal to the All-Routers Multicast Address.
The RUT should transmit a multicast Router Advertisement.	Response to the Router Solicitation.
Transmit Router Solicitation B twice, 10 seconds apart.	The monitor should capture a Router Advertisement no sooner than MIN_DELAY_BETWEEN_RAS.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.6.2.6.1e)

Steps	Notes
TR-1 transmits an Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for and Echo Reply from the RUT.	Cause the RUT to resolve the address of the TR-1 and create a Neighbor Cache entry for the TR-1 in state REACHABLE.
TR-1 transmits Router Solicitation B.	Wait 1 second. The monitor should capture a multicast Router Advertisement within 0.5 seconds of the receipt of the Router Solicitations.
Transmit Router Solicitation A and Router Solicitation B in immediate succession.	Wait 5 seconds. If a unicast Router Advertisement is not sent by the RUT after the Router Solicitation A and before the Router Solicitation B, a multicast Router Advertisement should be sent by the RUT sometimes between 3 seconds and 3.5 seconds after the previous multicast Router Advertisement.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **neighbor_cache_rs.nd.v6.ip** (2.6.2.6.2)

Purpose: Verify that a router properly updates its Neighbor Cache upon receipt of a Router Solicitation.

References:

- [ND] – Section 6.2.6

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: October 30, 1997

Discussion: Router Solicitations in which the source address is the unspecified address MUST NOT update the router's Neighbor Cache; solicitations with a proper source address update the Neighbor Cache as follows. If the router already has a Neighbor Cache entry for the solicitation's sender, the solicitation contains a Source Link-Layer Address option, and the received link-layer address differs from that already in the cache, the link-layer address SHOULD be updated in the Neighbor Cache and its reachability state MUST be set to STALE. If there is no existing Neighbor Cache entry for the solicitation's sender, the router creates one, installs the link-layer address and sets the reachability to state STALE as specified in Section 7.3.3. Whether or not a Source Link-Layer Address option is provided, if a Neighbor Cache entry for the solicitation's sender exists (or is created) the entry's IsRouter flag MUST be set to FLASE. This test is applies only to Routers.

Test Packets/Setup:

Router Solicitation A	Router Solicitation B
IPv6 Header Next Header: 58 Source Address: TN's Link Local Address	IPv6 Header Next Header: 58 Source Address: Unspecified Address
Router Solicitation (No Source Link-layer Option)	Router Solicitation Source Link-layer Option

Packet A

IPv6 Header Next Header: 58 Source Address: TN's Link Local Address
ICMPv6 Echo Request

Procedure: (2.6.2.6.2a)

Steps	Notes
TR-1 transmits an Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN. Note that the Source Address used to verify reachability is not that of the TN.
Transmit Router Solicitation A.	No Source Link-layer Option.
Transmit Packet A.	The monitor should capture Neighbor Solicitations from the RUT with a Target Address equal to the TN's Link-Local Address, since the RUT does not have a Neighbor Cache entry for the TN.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.6.2.6.2b)

Steps	Notes
TR-1 transmits and Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN. Note that the source address used to verify reachability is not that of the TN.
Transmit Router Solicitation B.	With Source Link-layer Option.
Transmit Packet A.	The monitor should capture an ICMPv6 Echo Reply from the RUT to the TN's Link-Local Address with a Destination Link-Layer Address equal to the TN's Link-Layer Address.
Wait 5 seconds.	The monitor should capture a Neighbor Solicitation from the RUT with a Target Address equal to the TN's Link-Local Address.
Perform test cleanup procedure.	Force the NUT to delete the address from its Neighbor Cache.

Procedure: (2.6.2.6.2c)

Steps	Notes
TR-1 transmits an Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN. No Router Advertisement is sent during the Preparation Sequence. After the Preparation Sequence, the RUT should have a Neighbor Cache entry for the TN in state REACHABLE.
Transmit Router Solicitation B.	Note: The source Link-layer Address is the same as was used in the Preparation Sequence.
Transmit Packet A.	The monitor should capture an ICMPv6 Echo Reply from the RUT to the TN's Link-Local Address with a Destination Link-Layer Address equal to the Source Link-layer Address of the Router Advertisement.
Wait 5 seconds.	The monitor should not capture any Neighbor Solicitations from the RUT for the TN, since the Router Solicitation should not have triggered the RUT's Neighbor Cache entry for the TN to transition from state REACHABLE.
Perform test cleanup procedure.	Force the NUT to delete the address from its Neighbor Cache.

Procedure: (2.6.2.6.2d)

Steps	Notes
TR-1 transmits and Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN. No Router Advertisement is sent during the Preparation Sequence. After the Preparation Sequence, the RUT should have a Neighbor Cache entry for the TN in state REACHABLE.
Transmit Router Solicitation B.	Note: The Source Link-layer Address is different from the one used in the Preparation Sequence.
Transmit Packet A.	The monitor should capture an ICMPv6 Echo Reply from the RUT to the TN's Link-Local Address with a Destination Link-Layer Address equal to the Source Link-layer Address of the Router Solicitation.
Wait 5 seconds.	The monitor should capture Neighbor Solicitations from the RUT as the Router Solicitation should have triggered the RUT's Neighbor Cache entry for the TN to transition from state REACHABLE to state STALE.
Perform test cleanup procedure.	Force the NUT to delete the address from its Neighbor Cache.

Possible Problems: None.

Test Label: **host_ra_processing_lifetime.nd.v6.ip** (2.6.3.4.1)

Purpose: Verify that a host properly processes a Router Advertisement and the Router Lifetime field within it.

References:

- [ND] – Section 6.3.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: October 30, 1997

Discussion: On receipt of a valid Router Advertisement, a host extracts the source address of the packet and does the following:

- If the address is not already present in the host's Default Router List, and the advertisement's Router Lifetime is non-zero, create a new entry in the list, and initialize its invalidation timer value from the advertisement's Router Lifetime field.
- If the address is already present in the host's Default Router List as a result of a previously received advertisement, reset its invalidation timer to the Router Lifetime value in the newly-received advertisement.
- If the address is already present in the host's Default Router List and the received Router Lifetime value is zero, immediately timeout the entry as specified in Section 6.3.5.

This test applies only to Hosts.

Test Packets/Setup:

Packet A	Packet B	Packet C
IPv6 Header Next Header: 58 Source Address: TN's Global Address Destination Address: NUT's Link Local Address	IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: NUT's Link Local Address	IPv6 Header Next Header: 58 Source Address: TR's Global Address Destination Address: NUT's Global Address
ICMPv6 Echo Request	ICMPv6 Echo Request	ICMPv6 Echo Request

Router Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: Multicast Address
Router Advertisement Router Lifetime: 20 seconds Reachable Time: 600 seconds Retransmit Interval: 1 second
Prefix Option Valid Lifetime: 100 seconds Preferred Lifetime: 20 seconds Prefix: TR's Global Prefix

Procedure: (2.6.3.4.1a)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN.
Transmit Packet A every 5 seconds for 30 seconds.	For each ICMPv6 Echo Request there should be a corresponding ICMPv6 Echo Reply to the Link-layer Address of the advertised router until Router Lifetime expires. At which point the NUT should transmit a Neighbor Solicitation with a Target Address equal to the TN's Global Address since there is no longer a default router.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.6.3.4.1b)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement.	The Source Address is equal to the TR's Link Local Address. The Destination Address is equal to the multicast address.
Transmit Packet B.	The monitor should capture a Neighbor Solicitation from the NUT with a Target Address equal to the TR's Link Local Address.
Respond to the Neighbor Solicitation from the NUT with the Neighbor Advertisement.	The monitor should capture an ICMPv6 Echo Response from the NUT.
Transmit Packet C every second until near the end of Router Lifetime.	The monitor should capture ICMPv6 Replies from the NUT to the TR.
Transmit the Router Advertisement again. Wait 10 seconds.	No packets should be received during this time.

Transmit Packet C.	The monitor should capture an ICMPv6 Echo Reply from the NUT.
Transmit the Router Advertisement with a lifetime of 0.	The monitor should capture a Neighbor Solicitation from the NUT with a target Address equal to the TR's Global Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: **reachable_time.nd.v6.ip** (2.6.3.4.2)

Purpose: Verify that a host updates its BaseReachableTime variable and re-computes its ReachableTime variable upon receipt of a Router Advertisement with a specified Reachable Time.

References:

- [ND] – Section 6.3.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: October 30, 1997

Discussion: If the received Reachable Time value is non-zero, the host SHOULD set its BaseReachableTime variable to the received value. If the new value differs from the previous value, the host SHOULD re-compute a new random ReachableTime value. ReachableTime is computed as a uniformly distributed random value between MIN_RANDOM_FACTOR and MAX_RANDOM_FACTOR times the BaseReachableTime. Using a random component eliminates the possibility of Neighbor Unreachability Detection messages synchronizing with each other. This test applies only to Hosts.

Test Packets/Setup:

Router Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address
Router Advertisement Router Lifetime: 0 seconds Reachable Time: 10 seconds Retransmit Interval: 1 second

Neighbor Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: NUT's Link Local Address
Neighbor Advertisement Router flag: 0 Solicited flag: 1 Override flag: 1 Target Address: TR's Link Local Address

Packet A

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: NUT's Link Local Address
ICMPv6 Echo Request

Procedure:

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement A.	The Source Address is equal to the TR's Link Local Address.
Transmit Packet A.	The monitor should capture a Neighbor Solicitation from the NUT with a Target Address equal to the TR's Link Local Address.
Respond to the Neighbor Solicitation from the NUT with the Neighbor Advertisement.	The monitor should capture an ICMPv6 Echo Response from the NUT.
Transmit Packet A every second for 40 seconds.	A Neighbor Solicitation should be seen from the NUT with a Target Address equal to the TR's Link Local Address at an interval of between 5 and 15 seconds. Respond to Neighbor Solicitations as needed.
Transmit the Router Advertisement with a Reachable Time of 40 seconds.	
Transmit Packet A every second for 140 seconds.	A Neighbor Solicitation should be seen from the NUT with a Target Address equal to the TR's Link Local Address at an interval between 20 and 60 seconds. Respond to Neighbor Solicitations as necessary.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: **neighbor_cache_ra.nd.v6.ip** (2.6.3.4.3)

Purpose: Verify that a host properly updates its Neighbor Cache upon receipt of a Router Advertisement.

References:

- [ND] – Sections 6.3.4 and 7.3.3

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: November 6, 1997

Discussion: After extracting information from the fixed part of the Router Advertisement message, the advertisement is scanned for valid options. If the advertisement contains a Source Link-Layer Address option, the link-layer address SHOULD be recorded in the Neighbor Cache entry for the router (creating an entry if necessary) and the IsRouter flag in the Neighbor Cache entry MUST be set to TRUE. If no Source Link-Layer option is included, but a corresponding Neighbor Cache entry exists, its IsRouter flag MUST be set to TRUE. The IsRouter flag is used by Neighbor Unreachability Detection to determine when a router changes to being a host (i.e., no longer capable of forwarding packets). If a Neighbor Cache entry is created for the router, its reachability state MUST be set to STALE as specified in Section 7.3.3. If a cache entry already exists and is updated with a different link-layer address, its reachability state MUST also be set to STALE. This test applies only to Hosts.

Test Packets/Setup:

Router Advertisement A	Router Advertisement B
IPv6 Header Next Header: 58 Source Address: TR's Link Local Address	IPv6 Header Next Header: 58 Source Address: TR's Link Local Address
Router Advertisement Router Lifetime: 0 seconds Reachable Time: 10 seconds Retransmit Interval: 1 second Source Link-layer Option	Router Advertisement Router Lifetime: 0 seconds Reachable Time: 10 seconds Retransmit Interval: 1 second (No Source Link-layer Option)

Neighbor Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: NUT's Link Local Address
Neighbor Advertisement Router flag: 1 Solicited flag: 1 Override flag: 1 Target Address: TR's Link Local Address

Packet A

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: NUT's Link Local Address
ICMPv6 Echo Request

Procedure: (2.6.3.4.3a)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement A.	The Source Address is the TR's Link Local Address.
Transmit Packet A.	The monitor should capture an ICMPv6 Echo Reply from the NUT's Link Local Address destined for the TR, followed by Neighbor Solicitations from the NUT with a Target Address equal to the TR's Link-Local Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.6.3.4.3b)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement B.	The Source Address is equal to the TR's Link Local Address.
Transmit Packet A.	The monitor should capture a Neighbor Solicitation from the NUT with a Target Address equal to the TR's Link-Local Address.
Transmit the Neighbor Advertisement in response to the Neighbor Solicitation.	The monitor should capture an ICMPv6 Echo Reply from the NUT to the TR's Link-Local Address.
Transmit the Router Advertisement A.	The Source Link-layer Address is the same as the Target Address in the Neighbor Advertisement sent by the TR.
Transmit Packet A.	The monitor should capture an ICMPv6 Echo Reply from the NUT to the TR's Link Local Address.
Wait 5 seconds.	No Neighbor Solicitations should be seen from the NUT to the TR during this time.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.6.3.4.3c)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement B.	The Source Address is equal to the TR's Link Local Address.
Transmit Packet A.	The monitor should capture a Neighbor Solicitation from the NUT with a Target Address equal to the TR's Link-Local Address.
Transmit the Neighbor Advertisement in response to the Neighbor Solicitation.	The monitor should capture an ICMPv6 Echo Reply from the NUT to the TR's Link-Local Address.
Transmit the Router Advertisement A.	The Source Link-layer Address is the same as the Target Address in the Neighbor Advertisement sent by the TR.
Transmit Packet A.	The monitor should capture an ICMPv6 Echo Reply from the NUT to the TR's Link-Local Address. The monitor should capture Neighbor Solicitations from the NUT with a Target Address equal to the TR's Link-Local Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: **prefix_on-link_bit.nd.v6.ip** (2.6.3.4.4)

Purpose: Verify that a host properly processes the On-Link bit of a Prefix Information Option.

References:

- [ND] – Section 6.3.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: November 6, 1997

Discussion: Prefix Information options that have the "on-link" (L) flag set indicate a prefix identifying a range of addresses that should be considered on-link. Note, however, that a Prefix Information option with the on-link flag clear conveys no information concerning on-link determination and MUST NOT be interpreted to mean that addresses covered by the prefix are off-link. This test applies only to hosts.

Test Packets/Setup:

Router Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: Multicast Address
Router Advertisement Router Lifetime: 0 seconds Reachable Time: 10 seconds Retransmit Interval: 1 second
Prefix Option "on-link" (L) flag: 1 Valid Lifetime: 20 seconds Preferred Lifetime: 20 seconds Prefix: TR's Global Prefix

Packet A

IPv6 Header Next Header: 58 Source Address: TR's Global Address Destination Address: NUT's Link Local Address
ICMPv6 Echo Request

Procedure:

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement	
Transmit Packet A.	The monitor should capture 3 Neighbor Solicitations from the NUT with the Target Address equal to the TR's Global Address.
Transmit the Router Advertisement with the "on-link" (L) flag clear.	
Transmit Packet A.	The monitor should capture 3 Neighbor Solicitations from the NUT with the Target Address equal to the TR's Global Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: host_prefix_list.nd.v6.ip (2.6.3.4.5)

Purpose: Verify that a host properly updates its Prefix List upon receipt of Prefix Information Options, which have the on-link flag set.

References:

- [ND] – Sections 6.3.4 and 6.3.5

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: March 17, 1998

Discussion: For each Prefix Information option with the on-link flag set, a host does the following:

- If the prefix is not already present in the Prefix List, and the Prefix Information option's Valid Lifetime field is non-zero, create a new entry for the prefix and initialize its invalidation timer to the Valid Lifetime value in the Prefix Information option.
- If the prefix is already present in the host's Prefix List as the result of a previously received advertisement, reset its invalidation timer to the Valid Lifetime value in the Prefix Information option. If the new Lifetime value is zero, timeout the prefix immediately (see Section 6.3.5).
- If the Prefix Information option's Valid Lifetime field is zero, and the prefix is not present in the host's Prefix List, silently ignore the option.

This test applies only to Hosts.

Test Packets/Setup:

Router Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: Multicast Address
Router Advertisement Router Lifetime: 20 seconds Reachable Time: 600 seconds Retransmit Interval: 1 second
Prefix Option "on-link" (L) flag: 1 Valid Lifetime: 10 seconds Preferred Lifetime:120 seconds Prefix: TR's Global Prefix

Packet A

IPv6 Header Next Header: 58 Source Address: TR's Global Address Destination Address: NUT's Link Local Address
ICMPv6 Echo Request

Procedure: (2.6.3.4.5a)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement. Wait 8 seconds.	The Source Address is equal to the TR's Link Local Address. The Destination Address is equal to the multicast address. The on-link flag is set.
Transmit Packet A.	The monitor should capture Neighbor Solicitations from the NUT with a Target Address equal to the TR's Global Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.6.3.4.5b)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement. Wait 8 seconds.	The Source Address is equal to the TR's Link Local Address. The Destination Address is equal to the multicast address. The on-link flag is set.
Transmit the Router Advertisement. Wait 8 seconds.	The Source Address is equal to the TR's Link Local Address. The Destination Address is equal to the multicast address. The on-link flag is set.
Transmit Packet A.	The monitor should capture Neighbor Solicitations from the NUT with a Target Address equal to the TR's Global Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.6.3.4.5c)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement. Wait 11 seconds.	The Source Address is equal to the TR's Link Local Address. The Destination Address is equal to the multicast address. The on-link flag is set.
Transmit Packet A.	The monitor should capture Neighbor Solicitations from the NUT with a Target Address equal to the TR's Link Local Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.6.3.4.5d)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement. Wait 3 seconds.	The Source Address is equal to the TR's Link Local Address. The Destination Address is equal to the multicast address. The on-link flag is set.
Transmit the Router Advertisement with Valid and Preferred lifetimes of 0 seconds.	
Transmit Packet A.	The monitor should capture Neighbor Solicitations from the NUT with a Target Address equal to the TR's Link Local Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: **prefix_invalidation.nd.v6.ip** (2.6.3.5.1)

Purpose: Verify that a host takes the appropriate actions when the Invalidation Timer expires for a Prefix List entry.

References:

- [ND] – Section 6.3.5

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: March 17, 1998

Discussion: Whenever the invalidation timer expires for a Prefix List entry, that entry is discarded. No existing Destination Cache entries need be updated, however. Should a reachability problem arise with an existing Neighbor Cache entry, Neighbor Unreachability Detection will perform any needed recovery. This test applies only to Hosts.

Test Packets/Setup:

Router Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: Multicast Address
Router Advertisement Router Lifetime: 100 seconds Reachable Time: 10 seconds Retransmit Interval: 1 second
Prefix Option "on-link" (L) flag: 1 Valid Lifetime: 10 seconds Preferred Lifetime: 10 seconds Prefix: TR's Global Prefix

Neighbor Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Global Address Destination Address: NUT's Link Local Address
Neighbor Advertisement Router flag: 0 Solicited flag: 1 Override flag: 1 Target Address: TR's Global Address

Packet A

IPv6 Header Next Header: 58 Source Address: TR's Global Address Destination Address: NUT's Link Local Address
ICMPv6 Echo Request

Procedure:

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement.	The Source Address is equal to the TR's Link Local Address. The Destination Address is equal to the multicast address. The on-link flag is set
Transmit Packet A.	The monitor should capture a Neighbor Solicitation from the NUT with a Target Address equal to the TR's Global Address.
Respond to the Neighbor Solicitation from the NUT with the Neighbor Advertisement.	The monitor should capture an ICMPv6 Echo Response from the NUT.
Transmit Packet A every 8 seconds for 6 iterations.	The monitor should capture Neighbor Solicitations from the NUT with Target Address equal to the TR's Global Address as well as ICMPv6 Echo Replies from the NUT to the TR. Respond to Neighbor Solicitations from the NUT as necessary.
After the sixth iteration, stop responding to the Neighbor Solicitations and transmit Packet A.	The monitor should capture a Neighbor Solicitation from the NUT with a Target Address equal to the TR's Global Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: **default_router_selection.nd.v6.ip** (2.6.3.6.1)

Purpose: Verify that a host chooses properly from its Default Router List.

References:

- [ND] – Section 6.3.6

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: March 17, 1998

Discussion: The policy for selecting routers from the Default Router List is as follows:

- Routers that are reachable or probably reachable (i.e., in any state other than INCOMPLETE) SHOULD be preferred over routers whose reachability is unknown or suspect (i.e., in the INCOMPLETE state, or for which no Neighbor Cache entry exists). An implementation may choose to always return the same router or cycle through the router list in a round-robin fashion as long as it always returns a reachable or a probably reachable router when one is available.
- When no routers on the list are known to be reachable or probably reachable, routers SHOULD be selected in a round-robin fashion, so that subsequent requests for a default router do not return the same router until all other routers have been selected. Cycling through the router list in this case ensures that all available routers are actively probed by the Neighbor Unreachability Detection algorithm. A request for a default router is made in conjunction with the sending of a packet to a router, and the selected router will be probed for reachability as a side effect.
- If the Default Router List is empty, assume that all destinations are on-link as specified in Section 5.2.

This test applies only to Hosts.

Test Packets/Setup:

Router Advertisement A	Router Advertisement B
IPv6 Header Next Header: 58 Source Address: TR1's Link Local Address Destination Address: Multicast Address	IPv6 Header Next Header: 58 Source Address: TR2's Link Local Address Destination Address: Multicast Address
Router Advertisement Router Lifetime: 100 seconds Reachable Time: 10 seconds Retransmit Interval: 1 second	Router Advertisement Router Lifetime: 100 seconds Reachable Time: 10 seconds Retransmit Interval: 1 second
Prefix Option "on-link" (L) flag: 1 "autonomous" (A) flag: 1 Valid Lifetime: 40 seconds Preferred Lifetime: 40 seconds Prefix: TR1's Global Prefix	Prefix Option "on-link" (L) flag: 1 "autonomous" (A) flag: 1 Valid Lifetime: 40 seconds Preferred Lifetime: 40 seconds Prefix: TR2's Global Prefix

Packet A

IPv6 Header Next Header: 58 Source Address: TN's Global Address Destination Address: NUT's Global Address
ICMPv6 Echo Request

Procedure:

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit Router Advertisements A and B.	
Transmit Packet A from an off-link source.	The monitor should capture Neighbor Solicitations from the NUT with Target Address equal to TR1's Link Local Address.
Transmit Packet A.	The monitor should capture Neighbor Solicitations from the NUT with Target Address equal to TR2's Link Local Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: **neighbor_solicitation_origination.nd.v6.ip** (2.7.2.2.1)

Purpose: Verify that a node properly originates Neighbor Solicitations when trying to resolve the address of a neighbor.

References:

- [ND] – Section 7.2.2

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: March 17, 1998

Discussion: When a node has a unicast packet to send to a neighbor, but does not know the neighbor's link-layer address, it performs address resolution. For multicast-capable interfaces this entails creating a Neighbor Cache entry in the INCOMPLETE state and transmitting a Neighbor Solicitation message targeted at the neighbor. The solicitation is sent to the solicited-node multicast address corresponding to the target address.
If the source address of the packet prompting the solicitation is the same as one of the addresses assigned to the outgoing interface, that address SHOULD be placed in the IP Source Address of the outgoing solicitation. Otherwise, any one of the addresses assigned to the interface should be used. Using the prompting packet's source address when possible insures that the recipient of the Neighbor Solicitation installs in its Neighbor Cache the IP address that is highly likely to be used in subsequent return traffic belonging to the prompting packet's "connection".
If the solicitation is being sent to a solicited-node multicast address, the sender MUST include its link-layer address (if it has one) as a Source Link-Layer Address option. Including the source link-layer address in a multicast solicitation is required to give the target an address to which it can send the Neighbor Advertisement. On unicast solicitations, an implementation MAY omit the Source Link-Layer Address option. The assumption here is that if the sender has a peer's link-layer address in its cache, there is a high probability that the peer will also have an entry in its cache for the sender. Consequently, it need not be sent.
While awaiting a response, the sender SHOULD retransmit Neighbor Solicitation messages approximately every RetransTimer milliseconds, even in the absence of additional traffic to the neighbor. Retransmissions MUST be rate-limited to at most one solicitation per neighbor every RetransTimer milliseconds. Test case A applies only to hosts.

Test Packets/Setup:

If this test is performed on a router, all test cases besides A require the router to be configured with a retransmit interval of 1 second, and to be configured to advertise the global prefix advertised by the TR.

Router Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: Multicast Address
Router Advertisement Router Lifetime: 0 seconds Reachable Time: 100 seconds Retransmit Interval: 1 second

Packet A	Packet B
IPv6 Header Next Header: 58 Source Address: TN's Link Local Address Destination Address: NUT's Link Local Address	IPv6 Header Next Header: 58 Source Address: TN's Global Address Destination Address: NUT's Global Address
ICMPv6 Echo Request	ICMPv6 Echo Request

Neighbor Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: NUT's Link Local Address
Neighbor Advertisement Router flag: 0 Solicited flag: 0 Override flag: 1 Target Link-layer Option

Procedure: (2.7.2.2.1a) **(applies only to hosts)**

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement.	The source address is equal to the TR's Link Local address and the destination address is equal to the multicast address.
Transmit Packet A.	The source address is equal to the TN's Link Local address and the destination address is equal to the NUT's Link Local address. The monitor should capture Neighbor Solicitations from the NUT's Link Local Address with a Target Address equal to the TN's Link Local Address at intervals of 1 second. Each Neighbor Solicitation should have a Source Link-Layer Option.
Repeat the process with the Retransmit Interval of the Router Advertisement set to 5 seconds.	The monitor should capture the same Neighbor Solicitations at intervals of 5 seconds.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.2.2.1b)

Steps	Notes
Perform Test Preparation Sequence with a Retransmit Interval equal to 1 second.	Force the NUT to resolve the address of the TR.
Transmit Packet B.	The source address is equal to the TN's Global address. The destination address is equal to the NUT's Global address. The monitor should capture Neighbor Solicitations from the NUT's Link Local Address with a Target Address equal to the TN's Global Address at intervals of 1 second. Each Neighbor Solicitation should have a Source Link-Layer Option.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.2.2.1c)

Steps	Notes
Perform Test Preparation Sequence with Retransmit Interval equal to 1 second.	Force the NUT to resolve the address of the TR.
Transmit the Neighbor Advertisement.	The Source Address is equal to the TR's Link Local Address. The Destination Address is equal to the NUT's Link Local Address.
Transmit Packet A.	The source address is equal to the TN's Link Local Address. The destination address is equal to the NUT's Link Local Address. The monitor should capture an ICMPv6 Echo Reply and then Neighbor Solicitations from the NUT's Link Local Address with a Target Address equal to the TN's Link Local Address at intervals of 1 second. Each Neighbor Solicitation should have a Source Link-Layer Option.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: **neighbor_solicitation_handling.nd.v6.ip** (2.7.2.3.1)

Purpose: Verify that a node takes the proper actions upon receipt of a valid Neighbor Solicitation.

References:

- [ND] – Sections 7.2.3 and 7.2.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: March 17, 1998

Discussion:

XXX- this part of the spec was changed extensively- so we may need to modify this test!!!

A valid Neighbor Solicitation that does not meet any of the following requirements must be silently discarded:

- The Target Address is a "valid" unicast or anycast address assigned to the receiving interface [ADDRCONF],
- The Target Address is a unicast address for which the node is offering proxy service, or
- The Target Address is a "tentative" address on which Duplicate Address Detection is being performed [ADDRCONF].

If the Target Address is tentative, the Neighbor Solicitation should be processed as described in [ADDRCONF]. Otherwise, the following description applies. If the Source Address is not the unspecified address and, on link layers that have addresses, the solicitation includes a Source Link-Layer Address option, then the recipient SHOULD create or update the Neighbor Cache entry for the IP Source Address of the solicitation. If an entry does not already exist, the node SHOULD create a new one and set its reachability state to STALE as specified in Section 7.3.3. If an entry exists, and the cached link-layer address differs from the one in the received Source Link-Layer Address option, the cached address should be replaced by the received address and the entry's reachability state MUST be set to STALE.

A node sends a Neighbor Advertisement in response to a valid Neighbor Solicitation targeting one of the node's assigned addresses. The Target Address of the advertisement is copied from the Target Address of the solicitation. If the solicitation's IP Destination Address is not a multicast address, the Target Link-Layer Address option MAY be omitted; the neighboring node's cached value must already be current in order for the solicitation to have been received. If the solicitation's IP Destination Address is a multicast address, the Target Link-Layer option MUST be included in the advertisement. Furthermore, if the node is a router, it MUST set the Router flag to one; otherwise it MUST set the flag to zero.

If the Target Address is either an anycast or a unicast address for which the node is providing proxy service, or the Target Link-Layer Address option is not included, the Override flag SHOULD be set to zero. Otherwise, the Override flag SHOULD be set to one. Proper setting of the Override flag ensures that nodes give preference to non-proxy advertisements, even when received after proxy advertisements, and also ensures that the first advertisement for an anycast address "wins".

If the source of the solicitation is the Unspecified Address, the node MUST reset the Solicited flag and transmit the advertisement to the all-nodes multicast address.

Test Packets/Setup:

Neighbor Sol. A	Neighbor Sol. B	Neighbor Sol. C	Neighbor Sol. D
IPv6 Header Next Header: 58 Destination Address: NUT's Link Local Address	IPv6 Header Next Header: 58 Source Address: Unspecified Address	IPv6 Header Next Header: 58 Destination Address: NUT's Link Local Address	IPv6 Header Next Header: 58 Destination Address: Solicited-Node Multicast Address
Neighbor Sol. Target Address: All Nodes Multicast	Neighbor Sol. Target Address: NUT's Link Local Address	Neighbor Sol. Target Address: NUT's Link Local Address	Neighbor Sol. Target Address: NUT's Link Local Address

Procedure: (2.7.2.3.1a)

Steps	Notes
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN.
Transmit Neighbor Solicitation A.	The Destination Address is equal to the NUT's Link Local Address. There should be no Neighbor Advertisements from the NUT.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.2.3.1b)

Steps	Notes
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN.
Transmit Neighbor Solicitation B.	The Source Address is an unspecified address. The monitor should capture a Neighbor Advertisement from the NUT to the All-Nodes Multicast Address with the Solicited flag clear.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.2.3.1c)

Steps	Notes
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN.
Transmit Neighbor Solicitation C.	The Destination Address is equal to the NUT's Link Local Address. The monitor should capture a Neighbor Advertisement from the NUT to the TR with the Solicited flag set and the Router flag set if the NUT is a router.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.2.3.1d)

Steps	Notes
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN.
Transmit Neighbor Solicitation D.	The Destination Address is a Solicited Node Multicast Address. The monitor should capture a Neighbor Advertisement from the NUT to the TR with the Solicited flag set and the Router flag set if the NUT is a router. The Neighbor Advertisement should include a Target Link-Layer Option.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: **neighbor_solicitation_cache_updates.nd.v6.ip** (2.7.2.3.2)

Purpose: Verify that a node properly updates its neighbor cache upon receipt of neighbor solicitations.

References:

- [ND] – Sections 7.2.3 and 7.2.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: March 17, 1998

Discussion:

A valid Neighbor Solicitation that does not meet any of the following requirements must be silently discarded:

- The Target Address is a "valid" unicast or anycast address assigned to the receiving interface [ADDRCONF],
- The Target Address is a unicast address for which the node is offering proxy service, or
- The Target Address is a "tentative" address on which Duplicate Address Detection is being performed [ADDRCONF].

If the Target Address is tentative, the Neighbor Solicitation should be processed as described in [ADDRCONF]. Otherwise, the following description applies. If the Source Address is not the unspecified address and, on link layers that have addresses, the solicitation includes a Source Link-Layer Address option, then the recipient SHOULD create or update the Neighbor Cache entry for the IP Source Address of the solicitation. If an entry does not already exist, the node SHOULD create a new one and set its reachability state to STALE as specified in Section 7.3.3. If an entry exists, and the cached link-layer address differs from the one in the received Source Link-Layer Address option, the cached address should be replaced by the received address and the entry's reachability state MUST be set to STALE.

Test Packets/Setup:

Neighbor Sol. A	Neighbor Sol. B
IPv6 Header Next Header: 58 Destination Address: NUT's Link Local Address Source Address: TN-1's Link Local Address	IPv6 Header Next Header: 58 Destination Address: NUT's Link Local Address Source Address: TN-1's Link Local Address
Neighbor Sol. Target Address: NUT's Link Local Address Source Link-Layer Address: TN-1's ethernet address	Neighbor Sol. Target Address: NUT's Link Local Address Source Link-Layer Address: new ethernet address

Procedure: (2.7.2.3.2a)

Steps	Notes
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN.
Transmit Neighbor Solicitation A.	The Destination Address is equal to the NUT's Link Local Address. The NUT should add an entry in state STALE to its neighbor cache.
The NUT should send a neighbor advertisement to TN-1.	
TN-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	The NUT should update its neighbor cache entry for TN-1 to state DELAY.
After 5 seconds, the NUT should send a neighbor solicitation to TN-1.	The NUT enters state PROBE after 5 seconds.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.2.3.2b)

Steps	Notes
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of TR-1.
TN-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of TN.
Transmit Neighbor Solicitation B.	The Destination Address is equal to the NUT's Link Local Address. The NUT should change the link-layer address of its neighbor cache entry for TN-1, and update the state to STALE.
The NUT should send a neighbor advertisement to TN-1.	
TN-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	The NUT should update its neighbor cache entry for TN-1 to state DELAY.
After 5 seconds, the NUT should send a neighbor solicitation to TN-1 with an ethernet destination address equal to the newly advertised ethernet address.	The NUT should update its neighbor cache entry for TN-1 to state PROBE after 5 seconds.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Test Label: **no_neighbor_cache_na.nd.v6.ip** (2.7.2.5.1)

Purpose: Verify that a node silently discards a Neighbor Advertisement if the target does not have a Neighbor Cache entry.

References:

- [ND] – Section 7.2.5

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: March 17, 1998

Discussion: When a valid Neighbor Advertisement is received (either solicited or unsolicited), the Neighbor Cache is searched for the target's entry. If no entry exists, the advertisement SHOULD be silently discarded. There is no need to create an entry if none exists, since the recipient has apparently not initiated any communication with the target.

Test Packets/Setup:

Neighbor Advertisement

IPv6 Header Next Header: 58
Neighbor Advertisement Solicited flag: 1 Override flag: 1 Target Link-layer Option

Packet A

IPv6 Header Next Header: 58
ICMPv6 Echo Request

Procedure:

Steps	Notes
TR-1 transmits an Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN.
Transmit the Neighbor Advertisement.	
Transmit Packet A.	The monitor should only capture Neighbor Solicitations from the NUT.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: **neighbor_cache_incomplete.nd.v6.ip** (2.7.3.3.1)

Purpose: Verify that a node properly updates its Neighbor Cache from the INCOMPLETE state upon receipt of a Neighbor Advertisement.

References:

- [ND] – Section 7.3.3

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: January 13, 2000

Discussion: When a Neighbor Cache entry is in the INCOMPLETE state the receipt of a Neighbor Advertisement causes the state of the entry to change as follows, based upon the Solicited and Override flags of the advertisement:

Solicited flag	Override flag	New State	Update Link Local Address
set	Set	REACHABLE	yes
set	Clear	REACHABLE	yes
clear	Set	STALE	yes
clear	Clear	STALE	yes

Test Packets/Setup:

If performed on a router, the RUT must be configured with a retransmit interval of 1 second. For test cases B-E, the router must be configured with a reachable time of 100 seconds.

Packet A

IPv6 Header Next Header: 58
ICMPv6 Echo Request

Router Advertisement A	Router Advertisement B
IPv6 Header Next Header: 58	IPv6 Header Next Header: 58
Router Advertisement Retransmit Interval: 1 second	Router Advertisement Reachable Time: 100 seconds

Neighbor Adv. B	Neighbor Adv. C	Neighbor Adv. D	Neighbor Adv. E
IPv6 Header Next Header: 58	IPv6 Header Next Header: 58	IPv6 Header Next Header: 58	IPv6 Header Next Header: 58
Neighbor Adv. Solicited flag: 1 Override flag: 1	Neighbor Adv. Solicited flag: 1 Override flag: 0	Neighbor Adv. Solicited flag: 0 Override flag: 1	Neighbor Adv. Solicited flag: 0 Override flag: 0

Procedure: (2.7.3.3.1a)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN.
Transmit the Router Advertisement A.	Set the Retransmit Interval to 1 second.
Transmit Packet A.	The monitor should capture 3 Neighbor Solicitations, 1 second apart, with a Target Address equal to the TR's Link Local Address. There should be no ICMPv6 Echo Reply.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.3.3.1b)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement B.	Set the Reachable Time to 100 seconds.
Transmit Packet A.	The monitor should capture a Neighbor Solicitation from the NUT with a Target Address equal to the TR's Link Local Address.
Respond to the Neighbor Solicitation from the NUT with the Neighbor Advertisement B.	The monitor should capture an ICMPv6 Echo Response from the NUT. The monitor should NOT capture Neighbor Solicitations from the NUT.
Transmit Packet A 3 times, 5 seconds apart.	The NUT should reply to each of the ICMPv6 Echo Requests.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.3.3.1c)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement B.	Set the Reachable Time to 100 seconds.
Transmit Packet A.	The monitor should capture a Neighbor Solicitation from the NUT with a Target Address equal to the TR's Link Local Address.
Respond to the Neighbor Solicitation from the NUT with the Neighbor Advertisement C.	The monitor should capture an ICMPv6 Echo Response from the NUT. The monitor should not capture Neighbor Solicitations from the NUT.
Transmit Packet A 3 times, 5 seconds apart.	The NUT should reply to each of the ICMPv6 Echo Requests.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.3.3.1d)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement B.	Set the Reachable Time to 100 seconds.
Transmit Packet A.	The monitor should capture a Neighbor Solicitation from the NUT with a Target Address equal to the TR's Link Local Address.
Respond to the Neighbor Solicitation from the NUT with the Neighbor Advertisement D.	The monitor should capture an ICMPv6 Echo Response from the NUT. The monitor should capture an ICMPv6 Echo Response from the NUT followed by Neighbor Solicitations with a Target Address equal to the TR's Link Local Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.3.3.1e)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TR.
Transmit the Router Advertisement B.	Set the Reachable Time to 100 seconds.
Transmit Packet A.	The monitor should capture a Neighbor Solicitation from the NUT with a Target Address equal to the TR's Link Local Address.
Respond to the Neighbor Solicitation from the NUT with the Neighbor Advertisement E.	The monitor should capture an ICMPv6 Echo Response from the NUT. The monitor should capture an ICMPv6 Echo Reply from the NUT followed by Neighbor Solicitations with a Target Address equal to the TR's Link Local Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: **neighbor_cache_stale.nd.v6.ip** (2.7.3.3.2)

Purpose: Verify that a node properly updates its Neighbor Cache from the STALE state upon receipt of a Neighbor Advertisement.

References:

- [ND] – Section 7.3.3

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: January 13, 2000

Discussion: When a Neighbor Cache entry is in the STALE state, the receipt of a Neighbor Advertisement causes the state of the entry to change as follows, based upon the Solicited and Override flags of the advertisement and whether the new link-layer address is equal to the previously cached value:

Solicited flag	Override flag	LLA equal to Cached	New State	Update Link-Local Address	Test
clear	clear	no	STALE	no	D
clear	clear	yes	STALE		E
set	clear	no	STALE	no	B
set	clear	yes	REACHABLE		G
clear	set	no	STALE	yes	C
clear	set	yes	STALE		F
set	set	no	REACHABLE	yes	A
set	set	yes	REACHABLE		H

Test Packets/Setup:

If this test is being run on a router, configure Base Reachable Time for the router to 5 seconds.

Echo Request A	Router Advertisement	Neighbor Adv. (A-H)
IPv6 Header Next Header: 58	IPv6 Header Next Header: 58	IPv6 Header Next Header: 58
ICMPv6 Echo Request	Router Advertisement Reachable Time: 5 seconds	Neighbor Adv. Solicited flag: see table Override flag: see table
		Target LLA Option Link-layer Address: see table

Procedure: (2.7.3.3.2a-h)

This description applies to multiple procedures.
Tests 2.7.3.3.2a though 2.7.3.3.2h have similar procedures. The differences in the test packets and the expected results for each section are summarized in the table in the test discussion section above. The notes here describe the differences as they apply to each step in each test procedure.

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to learn a Reachable Time of 5 seconds.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of TR-1. TR-1 replies normally to neighbor solicitations from the NUT until the Echo Reply is received.
Wait 8 seconds.	The NUT's neighbor cache entry for TR-1 should transition to state STALE during this time.
Transmit the Neighbor Advertisement A.	The Solicited and Override flags are set according to the table. Similarly, the address in the TLLA option is different from the address previously supplied by TR-1 if 'LLA different from cached' is indicated in the table.
Transmit Echo Request A.	In all cases, the monitor should capture an ICMPv6 Echo Reply from the NUT. • (Procedures A and C) Otherwise, the destination link-layer address of the Echo Reply should be the new address supplied in the TLLA option of Neighbor Advertisement A. • (Procedures B, D, E, F, G and H) If 'Update Link-Local Address' is not indicated in the table, the destination link-layer address should be the same address as was used by the NUT to reply to the first Echo-Request.
Wait up to 6 seconds for the NUT to begin sending Neighbor Solicitations for the address of TR-1.	• (Procedures A, G and H) If the new state in the table is REACHABLE, the entry should stay REACHABLE and the NUT should not transmit neighbor solicitations. • (Procedures B, C, D, E, and F) If the new state given in the table is STALE, then the NUT should have transitioned its cache entry for TR-1 through state DELAY and into PROBE, and should generate neighbor solicitations at this point.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: If the NUT does not process Router Advertisements, or does not properly set its base reachable time from values supplied in a Router Advertisement, then this test will fail. This problem can be avoided by manually configuring the NUT's base reachable time to 5 seconds.

Test Label: **neighbor_cache_delay.nd.v6.ip** (2.7.3.3.3)

Purpose: Verify that a node properly updates its Neighbor Cache from the DELAY state upon receipt of a Neighbor Advertisement.

References:

- [ND] – Section 7.3.3

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: January 13, 2000

Discussion: When a Neighbor Cache entry is in the DELAY state, the receipt of a Neighbor Advertisement causes the state of the entry to change as follows, based upon the Solicited and Override flags of the advertisement and whether the new link-layer address is equal to the previously cached value.

Solicited flag	Override flag	LLA equal to Cached	New State	Update Link-Local Address	Test
clear	clear	no	DELAY	no	D
clear	clear	yes	DELAY		E
set	clear	no	DELAY	no	B
set	clear	yes	REACHABLE		G
clear	set	no	STALE	yes	C
clear	set	yes	DELAY		F
set	set	no	REACHABLE	yes	A
set	set	yes	REACHABLE		H

Test Packets/Setup:

If this test is being run on a router, configure Base Reachable Time for the router to 5 seconds.

Echo Request A	Router Advertisement	Neighbor Adv. (A-H)
IPv6 Header Next Header: 58	IPv6 Header Next Header: 58	IPv6 Header Next Header: 58
ICMPv6 Echo Request	Router Advertisement Reachable Time: 5 seconds	Neighbor Adv. Solicited flag: see table Override flag: see table
		Target LLA Option Link-layer Address: see table

Procedure: (2.7.3.3.3a-h)

This description applies to multiple procedures.
Tests 2.7.3.3.3a though 2.7.3.3.3h have similar procedures. The differences in the test packets and the expected results for each section are summarized in the table in the test discussion section above. The notes here describe the differences as they apply to each step in each test procedure.

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to learn a Base Reachable Time of 5 seconds.
TR-1 transmits an Echo Request to the NUT. Wait for an Echo Reply.	Force the NUT to resolve the address of TR-1. TR-1 responds normally to any neighbor solicitations sent by the NUT until the echo reply is received.
Wait 8 seconds.	During this time the NUT should transition its neighbor cache entry for TR-1 to state STALE.
TR-1 Transmits Echo Request A to the NUT.	The NUT should send an Echo Reply. The NUT's neighbor cache entry for TR-1 should transition to state DELAY.
Transmit the Neighbor Advertisement (A-H).	The Solicited and Override flags are set according to the table. Similarly, the address in the TLLA option is different from the address previously supplied by TR-1 if 'LLA different from cached' is indicated in the table.
Wait up to 6 seconds for neighbor solicitations from the NUT.	• (Procedures A, G and H) If the new state given in the table is REACHABLE, this step is not performed. • (Procedures B, D, E and F) If the new state given in the table is DELAY, the NUT should transition the Neighbor Cache entry to state PROBE within this time and Neighbor Solicitations should be seen. • (Procedure C) If the new state given in the table is STALE, no Neighbor Solicitations should be seen.
TR-1 transmits Echo Request A to the NUT.	In all cases the NUT should generate an Echo Reply. • (Procedures A and C) If 'Update Link-Layer Address' is indicated in the table, the NUT should send the Echo Reply to the new link-layer address supplied by the TR-1 in its most recent Neighbor Advertisement. • (Procedures B, D, E, F, G and H) Otherwise, the NUT should send the Echo Reply to the same link-layer address that was the destination for the previous Echo Reply.
Wait up to 6 seconds for neighbor solicitations from the NUT.	• (Procedures A, G and H) If the new state given in the table is REACHABLE, no Neighbor Solicitations should be generated by the NUT. • (Procedure C) If the new state given in the table is STALE, the NUT should generate Neighbor Solicitations because the cache entry will have entered the PROBE state after 5 seconds. • (Procedures B, D, E and F) If the new state in the table is DELAY, this check is not done.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: If the NUT does not process Router Advertisements, or does not properly set its base reachable time from values supplied in a Router Advertisement, then this test will fail. This problem can be avoided by manually configuring the NUT's base reachable time to 5 seconds.

Test Label: **neighbor_cache_probe.nd.v6.ip** (2.7.3.3.4)

Purpose: Verify that a node properly updates its Neighbor Cache from the PROBE state upon receipt of a Neighbor Advertisement.

References:

- [ND] – Section 7.3.3

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: January 14, 2000

Discussion: When a Neighbor Cache entry is in the PROBE state, the receipt of a Neighbor Advertisement causes the state of the entry to change as follows, based upon the Solicited and Override flags of the advertisement and whether the new link-layer address is equal to the previously cached value:

Solicited flag	Override flag	LLA equal to Cached	New State	Update Link-Local Address	Test
clear	clear	no	PROBE	no	D
clear	clear	yes	PROBE		E
set	clear	no	PROBE	no	B
set	clear	yes	REACHABLE		G
clear	set	no	STALE	yes	C
clear	set	yes	PROBE		F
set	set	no	REACHABLE	yes	A
set	set	yes	REACHABLE		H

Test Packets/Setup:

If this test is being run on a router, configure Base Reachable Time for the router to 5 seconds.

Echo Request A	Router Advertisement	Neighbor Adv. (A-H)
IPv6 Header Next Header: 58	IPv6 Header Next Header: 58	IPv6 Header Next Header: 58
ICMPv6 Echo Request	Router Advertisement Reachable Time: 5 seconds	Neighbor Adv. Solicited flag: see table Override flag: see table
		Target LLA Option Link-layer Address: see table

Procedure: (2.7.3.3.4a-h)

This description applies to multiple procedures.
Tests 2.7.3.3.4a though 2.7.3.3.4h have similar procedures. The differences in the test packets and the expected results for each section are summarized in the table in the test discussion section above. The notes here describe the differences as they apply to each step in each test procedure.

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to learn a Base Reachable Time of 5 seconds.
TR-1 transmits an Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of TR-1. TR-1 responds normally to any neighbor solicitations sent by the NUT until the echo reply is received.
Wait 8 seconds.	During this time the NUT should transition its neighbor cache entry for TR-1 to state STALE.
TR-1 Transmits Echo Request A to the NUT.	The NUT should send an Echo Reply. The NUT's neighbor cache entry for TR-1 should transition to state DELAY.
Wait up to 6 seconds for the NUT to begin sending Neighbor Solicitations for TR-1's address, then transmit the Neighbor Advertisement (A-H).	The Solicited and Override flags are set according to the table. Similarly, the address in the TLLA option is different from the address previously supplied by TR-1 if 'LLA different from cached' is indicated in the table.
Wait up to 2 seconds for neighbor solicitations from the NUT.	• (Procedures A, G and H) If the new state given in the table is REACHABLE, this step is not performed. • (Procedures B, D, E and F) If the new state given in the table is PROBE, the NUT should continue transmission of Neighbor Solicitations. • (Procedure C) If the new state given in the table is STALE, no Neighbor Solicitations should be seen.
TR-1 transmits Echo Request A to the NUT.	In all cases the NUT should generate an Echo Reply. • (Procedures A and C) If 'Update Link-Layer Address' is indicated in the table, the NUT should send the Echo Reply to the new link-layer address supplied by the TR-1 in its most recent Neighbor Advertisement. • (Procedures B, D, E, F, G and H) Otherwise, the NUT should send the Echo Reply to the same link-layer address that was the destination for the previous Echo Reply.
Wait up to 6 seconds for neighbor solicitations from the NUT.	• (Procedures A, G and H) If the new state given in the table is REACHABLE, no Neighbor Solicitations should be generated by the NUT. • (Procedure C) If the new state given in the table is STALE, the NUT should generate Neighbor Solicitations because the cache entry will have entered the PROBE state after 5 seconds. • (Procedures B, D, E and F) If the new state in the table is PROBE, this check is not done.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: If the NUT does not process Router Advertisements, or does not properly set its base reachable time from values supplied in a Router Advertisement, then this test will fail. This problem can be avoided by manually configuring the NUT's base reachable time to 5 seconds.

Test Label: **neighbor_cache_reachable.nd.v6.ip** (2.7.3.3.5)

Purpose: Verify that a node properly updates its Neighbor Cache from the REACHABLE state upon receipt of a Neighbor Advertisement.

References:

- [ND] – Section 7.3.3

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: January 14, 2000

Discussion:

When a Neighbor Cache entry is in the REACHABLE state, the receipt of a Neighbor Advertisement causes the state of the entry to change as follows, based upon the Solicited and Override flags of the advertisement, and whether the link-layer address is equal to the previously cached value.

Solicited flag	Override flag	LLA equal to Cached	New State	Update Link-Local Address	Test
clear	clear	no	STALE	no	D
clear	clear	yes	REACHABLE		E
set	clear	no	STALE	no	B
set	clear	yes	REACHABLE		G
clear	set	no	STALE	yes	C
clear	set	yes	REACHABLE		F
set	set	no	REACHABLE	yes	A
set	set	yes	REACHABLE		H

Test Packets/Setup:

If performed on a router, the RUT must be configured with a base reachable time of 5 seconds.

Echo Request A	Router Advertisement	Neighbor Adv. (A-H)
IPv6 Header Next Header: 58	IPv6 Header Next Header: 58	IPv6 Header Next Header: 58
ICMPv6 Echo Request	Router Advertisement Reachable Time: 5 seconds	Neighbor Adv. Solicited flag: see table Override flag: see table
		Target LLA Option Link-layer Address: see table

Procedure: (2.7.3.3.5a-h)

This description applies to multiple procedures.
Tests 2.7.3.3.5a though 2.7.3.3.5h have similar procedures. The differences in the test packets and the expected results for each section are summarized in the table in the test discussion section above. The notes here describe the differences as they apply to each step in each test procedure.

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to learn a Base Reachable Time of 100,000 seconds.
TR-1 transmits an Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of TR-1. TR-1 responds normally to any neighbor solicitations sent by the NUT until the echo reply is received. After this step the NUT's Neighbor Cache entry for TR-1 should be in state REACHABLE.
TR-1 transmits the Neighbor Advertisement (A-H).	The Solicited and Override flags are set according to the table. Similarly, the address in the TLLA option is different from the address previously supplied by TR-1 if 'LLA different from cached' is indicated in the table.
TR-1 transmits Echo Request A to the NUT.	In all cases the NUT should generate an Echo Reply. • (Procedures A and C) If 'Update Link-Layer Address' is indicated in the table, the NUT should send the Echo Reply to the new link-layer address supplied by the TR-1 in its most recent Neighbor Advertisement. • (Procedures B, D, E, F, G and H) Otherwise, the NUT should send the Echo Reply to the same link-layer address that was the destination for the previous Echo Reply.
Wait up to 6 seconds for neighbor solicitations from the NUT.	• (Procedures A, E, F, G and H) If the new state given in the table is REACHABLE, no neighbor solicitations should be received. • (Procedures B, C and D) If the new state given in the table is STALE, the NUT should transmit neighbor solicitations for the address of TR-1
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

Test Label: **na_r_bit_change.nd.v6.ip** (2.7.3.3.6)

Purpose: Verify that a host takes appropriate actions when a neighbor which was a router starts transmitting Neighbor Advertisements with the Router flag clear.

References:

- [ND] – Section 7.2.5

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: March 17, 1998

Discussion: The IsRouter flag in the cache entry MUST be set based on the Router flag in the received advertisement. In those cases where the IsRouter flag changes from TRUE to FALSE as a result of this update, the host MUST remove that router from the Default Router List and update the Destination Cache entries for all destinations using that neighbor as a router as specified in Section 7.3.3. This is needed to detect when a node that is configured as a router stops forwarding packets due to being configured as a host. This test applies only to Hosts.

Test Packets/Setup:

Router Advertisement

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address
Router Advertisement Router Lifetime: 20 seconds Reachable Time: 100 seconds Retransmit Interval: 1 second Prefix: TR's Global Prefix

Packet A

IPv6 Header Next Header: 58 Source Address: TN's Global Address Destination Address: NUT's Global Address
ICMPv6 Echo Request

Neighbor Advertisement A	Neighbor Advertisement B
IPv6 Header Next Header: 58 Source Address: TR's Link Local Address	IPv6 Header Next Header: 58 Source Address: TR's Link Local Address
Neighbor Advertisement Router flag: 0 Solicited flag: 1 Override flag: 1	Neighbor Advertisement Router flag: 0 Solicited flag: 0 Override flag: 0

Procedure: (2.7.3.3.6a)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits and Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN.
Transmit Packet A.	The ICMPv6 Echo Request should cause the NUT to transmit Neighbor Solicitations with a Target Address equal to the TR's Link Local Address. The NUT should then transmit an ICMPv6 Echo Reply to Packet A using the TR as the first hop.
Respond as needed to Neighbor Solicitations from the NUT for the TR with the Router, Solicited, and Override flags set.	
Transmit the Neighbor Advertisement.	
Transmit Packet A.	The monitor should capture Neighbor Solicitations from the NUT with a Target Address equal to the Global Address of the TN.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.3.3.6b)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits and Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN.
Transmit the Router Advertisement without Source Link-Layer Option.	The Source Address is equal to the TR's Link Local Address.
Transmit Packet A.	The ICMPv6 Echo Request should cause the NUT to transmit Neighbor Solicitations with a Target Address equal to the TR's Link Local Address. The NUT should then transmit an ICMPv6 Echo Reply to Packet A using the TR as the first hop.
Respond as needed to Neighbor Solicitations from the NUT for the TR with the Router, Solicited, and Override flags set.	
Transmit Neighbor Advertisement B.	The Source Address is equal to the TR's Link Local Address.
Transmit Packet A.	The monitor should capture Neighbor Solicitations from

	the NUT with a Target Address equal to the Global Address of the TN.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Procedure: (2.7.3.3.6c)

Steps	Notes
TR-1 transmits Router Advertisement.	Cause the NUT to compute Reachable Time.
TR-1 transmits and Echo Request to the RUT. Wait for an Echo Reply.	Force the NUT to resolve the address of the TN.
Transmit the Router Advertisement without Source Link-Layer Option.	The Source Address is equal to the TR's Link Local Address.
Transmit Packet A.	The Source Address is equal to the TN's Global Address and the Destination Address is equal to the NUT's Global Address.
Respond as needed to Neighbor Solicitations from the NUT for the TR with the Router flag clear and the Solicited and Override flags set.	The monitor should capture Neighbor Solicitations from the NUT with a Target Address equal to the TN's Global Address.
Transmit Packet A.	The monitor should capture Neighbor Solicitations from the NUT with a Target Address equal to the TN's Global Address.
Perform test cleanup procedure.	Force the NUT to delete the addresses from its Neighbor Cache.

Possible Problems: None.

REDIRECT FUNCTION

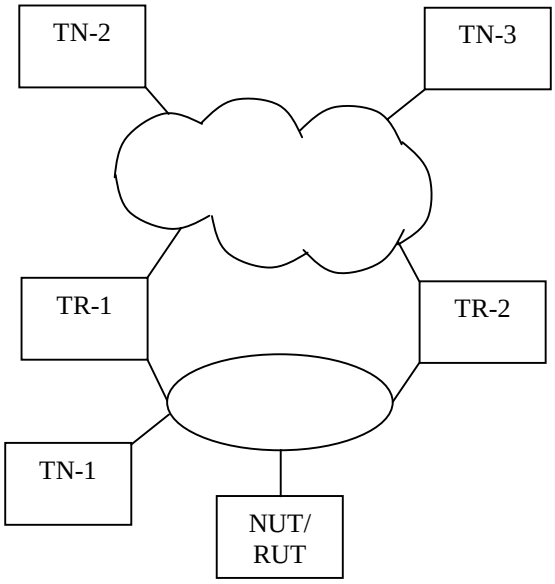
Scope
The following tests cover the Redirect Function of the Neighbor Discovery Specification for Internet Protocol version 6. Redirect messages are sent by routers to redirect a host to a better first-hop router for a specific destination or to inform hosts that a destination is in fact a neighbor (i.e., on-link).

Overview
These tests are designed to verify conformance of the Redirect function with the Neighbor Discovery Specification.

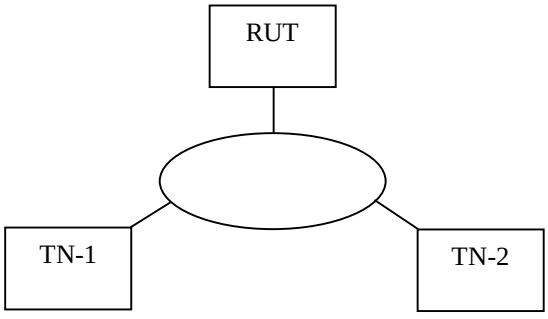
Default Setups

TR: Test Router
TN: Test Node
NUT: Node Under Test
RUT: Router Under Test

Default Setup 1:



Default Setup 2:



Default Packets

Echo Request

IPv6 Header Payload Length: 136 bytes Next Header: 58
ICMPv6 Header Type: 128 Code: 0

Router Advertisement

IPv6 Header Source Address: TR's Link-Local Address Destination Address: all-nodes multicast address Next Header: 58
ICMPv6 Header Type: 134 Code: 0 M Bit (managed): 0 O Bit (other): 0 Router Lifetime: 20 seconds Reachable Time: 10 seconds Retrans Timer: 1 second
Prefix Option Type: 3 L Bit (on-link flag): 1 A Bit (addr conf): 1 Valid Lifetime: 20 seconds Preferred Lifetime: 20 seconds Prefix: link's prefix

Redirect message

IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: NUT's Link Local Address
ICMPv6 Header Type: 137 Code: 0
Redirected Header Option Type: 4 Length: Length of Invoking Packet in 8 octet units
Invoking Packet

Test Label: **redirect_handling.redirect.nd.v6.ip** (2.8.0.0.1)

Purpose: Verify that a host properly processes valid Redirect messages.

References:

- [ND] – Sections 4.5, 4.6.3, and 8

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: November 24, 1998

Discussion: A host receiving a valid redirect SHOULD update its Destination Cache accordingly so that subsequent traffic goes to the specified target. If no Destination Cache entry exists for he destination, an implementation SHOULD create such an entry. Hosts can be redirected to a better first-hop but can also be informed by a redirect that the destination is in fact a neighbor. The latter is accomplished by setting the ICMPv6 Target Address equal to the ICMPv6 Destination Address. If the ICMPv6 Target and Destination Addresses are both the same, the host MUST treat the Target as on-link. The Redirected Header option is used in Redirect messages and contains all or part of the packet that is being redirected. This test applies only to Hosts.

Test Setup: Default Setup 1.

Procedure: (2.8.0.0.1a)

- Different next-hop for a destination.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-2 as the first-hop.	The NUT should have processed the Redirect message indicating TR-2 as the next-hop for TN-2.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.0.0.1b)

- Same ICMPv6 Target and Destination Address (destination on-link).

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TN-1 transmits an Echo Request to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-1. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-1. The ICMPv6 Target Address is equal to the global address of TN-1.
TN-1 transmits an Echo Request to the NUT. TN-1 Responds to Neighbor Solicitations for its global address.	The IPv6 Source Address is equal to the off-link global address of TN-1. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request by sending directly to TN-1.	The NUT should have processed the Redirect message indicating that TR-1 is reachable on-link.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.0.0.1c)

- ICMPv6 Target Address equal to link-local address of a router on the NUT's default router list.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-2 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-2 to its Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-2 as the first-hop.	The NUT should have processed the Redirect message indicating TR-2 as the next-hop for TN-2.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.0.0.1d)

- The new next-hop issues a Redirect to a third router.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-2 as the first-hop.	The NUT should have processed the Redirect message indicating TR-2 as the next-hop for TN-2.
TR-2 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-3.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-3 as the first-hop.	The NUT should have processed the Redirect message indicating TR-3 as the next-hop for TN-2.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.0.0.1e)

- The invoking packet is not included in the Redirect message.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. The invoking packet is not included.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-2 as the first-hop.	The NUT should have processed the Redirect message indicating TR-2 as the next-hop for TN-2.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **redirect_validation_1.redirect.nd.v6.ip** (2.8.1.0.1)

Purpose: Verify that a host properly ignores Redirect messages that contain invalid fields.

References:

- [ND] – Sections 4.5 and 8.1

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 2, 1999

Discussion: A host MUST silently discard any received Redirect message that does not satisfy all of the following validity checks:

- IP Source Address is a link-local address. Routers must use their link-local address as the source for Router Advertisement and Redirect messages so that hosts can uniquely identify routers.
- The IP Hop limit field has a value of 255 (indicating the packet was sent from a router on the same physical network).
- If the message includes an IP Authentication Header, the message authenticates correctly.
- ICMPv6 Checksum is valid.
- ICMPv6 Code is 0.
- ICMPv6 length (derived from the IP length) is 40 or more octets.
- The IP Source Address of the Redirect message is the same as the current first-hop router for the specified ICMPv6 Destination Address.
- The ICMPv6 Destination Address field in the Redirect message does not contain a multicast address.
- The ICMPv6 Target Address is either a link-local address (when redirected to a router) or the same as the ICMPv6 Destination Address (when redirected to the on-link destination).
- All included options have a length that is greater than zero.

In addition:

- The contents of the Reserved field, and any unrecognized options MUST be ignored.
- A host MUST NOT consider a redirect invalid just because the Target Address of the redirect is not covered under one of the link's prefixes. Part of the semantics of the Redirect message is that the Target Address is on-link.

<u>This test applies only to Hosts.</u>

Test Setup: Default Setup 1.

Procedure: (2.8.1.0.1a)

- ICMPv6 Code is 0.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Contains an incorrect ICMPv6 Code equal to 1.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	The NUT should not have processed the Redirect message, so the first-hop remains unchanged.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.1b)

- The IP Hop limit field has a value of 255 (indicating the packet was sent from a router on the same physical network).

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Contains an incorrect IPv6 Hop Limit equal to 254.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	The NUT should not have processed the Redirect message, so the first-hop remains unchanged.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.1c)

- The IP Source Address of the Redirect message is the same as the current first-hop router for the specified ICMPv6 Destination Address.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-2 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Contains an incorrect IPv6 Source Address that is not equal to the current first-hop router (TR-1) for that destination.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	The NUT should not have processed the Redirect message, so the first-hop remains unchanged.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.1d)

- IP Source Address is a link-local address. Routers must use their link-local address as the source for Router Advertisement and Redirect messages so that hosts can uniquely identify routers.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TN-2 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Contains an incorrect IPv6 Source Address (the off-link global address of TN-2).
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	The NUT should not have processed the Redirect message, so the first-hop remains unchanged.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.1e)

The ICMPv6 Target Address is either a link-local address (when redirected to a router) or the same as the ICMPv6 Destination Address (when redirected to the on-link destination).

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Target Address is not equal to the ICMPv6 Destination Address. The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the global address of TN-3.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	The NUT should not have processed the Redirect message, so the first-hop remains unchanged.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.1f)

- The ICMPv6 Target Address is either a link-local address (when redirected to a router) or the same as the ICMPv6 Destination Address (when redirected to the on-link destination).

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. ICMPv6 Target Address equal to the all nodes on link multicast address. (FF02::1)
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	The NUT should not have processed the Redirect message, so the first-hop remains unchanged.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **redirect_validation_2.redirect.nd.v6.ip** (2.8.1.0.2)

Purpose: Verify that a host properly ignores Redirect messages that contain invalid fields.

References:

- [ND] – Sections 4.5 and 8.1

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 2, 1999

Discussion: A host MUST silently discard any received Redirect message that does not satisfy all of the following validity checks:

- IP Source Address is a link-local address. Routers must use their link-local address as the source for Router Advertisement and Redirect messages so that hosts can uniquely identify routers.
- The IP Hop limit field has a value of 255 (indicating the packet was sent from a router on the same physical network).
- If the message includes an IP Authentication Header, the message authenticates correctly.
- ICMPv6 Checksum is valid.
- ICMPv6 Code is 0.
- ICMPv6 length (derived from the IP length) is 40 or more octets.
- The IP Source Address of the Redirect message is the same as the current first-hop router for the specified ICMPv6 Destination Address.
- The ICMPv6 Destination Address field in the Redirect message does not contain a multicast address.
- The ICMPv6 Target Address is either a link-local address (when redirected to a router) or the same as the ICMPv6 Destination Address (when redirected to the on-link destination).
- All included options have a length that is greater than zero.

In addition:

- The contents of the Reserved field, and any unrecognized options MUST be ignored.
- A host MUST NOT consider a redirect invalid just because the Target Address of the redirect is not covered under one of the link's prefixes. Part of the semantics of the Redirect message is that the Target Address is on-link.

This test applies only to Hosts.

Test Setup: Default Setup 1.

Procedure: (2.8.1.0.2a)

- ICMPv6 Checksum is valid.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. IPv6 Destination Address equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Contains an incorrect ICMPv6 Checksum.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. IPv6 Destination Address equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	The NUT should not have processed the Redirect message, so the first-hop remains unchanged.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.2b)

- ICMPv6 length (derived from the IP length) is 40 or more octets.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Contains an invalid IPv6 Length of 39 bytes.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. IPv6 Destination Address equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	The NUT should not have processed the Redirect message, so the first-hop remains unchanged.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.2c)

- All included options have a length that is greater than zero.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. An Option with length equal to 0 is included.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. IPv6 Destination Address equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	The NUT should not have processed the Redirect message, so the first-hop remains unchanged.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.2d)

- The contents of the Reserved field, and any unrecognized options MUST be ignored.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Contains a non-zero Reserved field.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	The NUT should not have processed the Redirect message, so the first-hop remains unchanged.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **unexpected_option.redirect.nd.v6.ip** (2.8.1.0.3)

Purpose: Verify that a host ignores invalid options in Redirect messages and processes the remainder of Redirect normally.

References:

- [ND] – Section 4.5

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: February 2, 1999

Discussion: Possible options for a Redirect message includes:
- Target Link-Layer Address
- Redirected Header

The Path MTU option is used in Router Advertisements and MUST be silently ignored for other Neighbor Discovery messages. The Prefix Information option is used in Router Advertisements and MUST be silently ignored for other Neighbor Discovery messages. The Source Link-Layer Address option is used in Neighbor Solicitations, Router Solicitations, and Router Advertisements and MUST be silently ignored for other Neighbor Discovery messages. This test applies only to Hosts.

Test Setup: Default Setup 1.

Procedure: (2.8.1.0.3a)

- Path MTU option.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Contains an invalid Path MTU option.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-2 as the first-hop.	The NUT should ignore the invalid option and process the Redirect message normally.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.3b)

- Prefix Information option.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Contains an invalid Prefix Information option.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-2 as the first-hop.	The NUT should ignore the invalid option and process the Redirect message normally.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.3c)

- Source Link-Layer Address option.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Contains an invalid Source Link-Layer option.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-2 as the first-hop.	The NUT should ignore the invalid option and process the Redirect message normally.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.3d)

- Unknown option.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Contains an invalid Unknown option.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-2 as the first-hop.	The NUT should ignore the invalid option and process the Redirect message normally.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **no_dce.redirect.nd.v6.ip** (2.8.1.0.4)

Purpose: Verify that a host properly validates a Redirect message when there is no entry for the destination in the host's Destination Cache.

References:

- [ND] – Section 5.2

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: January 20, 1999

Discussion: For efficiency reasons, next-hop determination is not performed on every packet that is sent. Instead, the results of next-hop determination computations are saved in the Destination Cache (which also contains updates learned from Redirect messages). This test applies only to Hosts.

Test Setup: Default Setup 1.

Procedure: (2.8.1.0.4a)

- Redirect from current next-hop

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Target Link-Layer option with the link-layer address of TR-2.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should transmit Neighbor Solicitations to TR-2. TR-2 responds to the Neighbor Solicitations.	The NUT should have process the Redirect message normally.
The NUT should respond to the Request using TR-2 as the first-hop.	Since address resolution for TR-2 was successful the NUT should now use TR-2 as the next-hop for the destination.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.1.0.4b)

- Redirect not from current next-hop

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-2 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Target Link-Layer option with the link-layer address of TR-2.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	Since the Source Address of the Redirect message was not the current next-hop for the destination the NUT should ignore the Redirect and continue to use TR-1 as the next-hop for the destination.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **redirect_generation.redirect.nd.v6.ip** (2.8.2.0.1)

Purpose: Verify that a router properly transmits an ICMP Redirect Message when it forwards a packet out the interface on which it was received. A router should not generate ICMP messages bigger than the IPv6 minimum MTU.

References:

- [ND] – Sections 4.5 and 8

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: July 20, 1998

Discussion: A router SHOULD send a Redirect message whenever it forwards a packet that is not explicitly addressed to itself in which the router determines that a better first-hop node resides on the same link as the sending node for the Destination Address of the packet being forwarded.
The transmitted Redirect message contains:

- In the Target Address field: the address to which subsequent packets for the destination SHOULD be sent. If the target is a router, that router's link-local address MUST be used. If the target is a host the target address field MUST be set to the same value as the Destination Address field.
- In the Destination Address field: the destination address of the invoking IP packet.

Possible options:

- Redirected Header: As much as possible of the IP packet that triggered the sending of the Redirect without making the Redirect message exceed 1280 (IPv6 minimum link MTU) octets.

This test applies only to routers.

Test Setup: Default Setup 2.

Procedure: (2.8.2.0.1a)

- Forwards a packet to host.

Steps	Notes
TN-1 transmits an ICMPv6 Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for an Echo Reply from the RUT.	Cause the RUT to resolve the on-link, global address of TN-1 and create a Neighbor Cache entry in state REACHABLE.
TN-2 transmits an Echo Request to TN-1 using the RUT as the first-hop. TN-2 responds to Neighbor Solicitations from the RUT.	The IPv6 Source Address is equal to the global address of TN-2. The IPv6 Destination Address is equal to the on-link global address of TN-1.
The RUT should forward the Echo Request from TN-2 to TN-1.	Since TN-1's global address is on link.
The RUT should transmit a Redirect message to TN-2.	The ICMPv6 Destination Address is equal to the global address of TN-1. The ICMPv6 Target Address is equal to the global address of TN-1.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.2.0.1b) Configure the RUT to have a static route to network 2f02:3000:84b1:7601 through TR-1. This test uses Default Setup 1.

- Forwards a packet to router

Steps	Notes
TR-1 transmits an ICMPv6 Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for an Echo Reply from the RUT.	Cause the RUT to resolve the link-local address of TR-1 and create a Neighbor Cache entry in state REACHABLE.
TN-1 transmits an Echo Request to TN-2 using the RUT as the first-hop. TN-1 responds to Neighbor Solicitations from the RUT.	The IPv6 Source Address is equal to the on-link global address of TN-1. The IPv6 Destination Address is equal to the global address of TN-2. TN2 is a host on network 2f02:3000:84b1:7601::/64.
The RUT should forward the Echo Request from TN-1 to TR-1.	The RUT has been configured with a static router for the 2f02:3000:84b1:7601::/64 net through TR-1.
The RUT should transmit a Redirect message to TN-1.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-1. If a TLLA option is included in the Redirect message, It must be the correct link-layer address for TR-1.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.2.0.1c)

- Limit the size of the Redirect message to 1280 (IPv6 minimum link MTU) octets.

Steps	Notes
TN-1 transmits an ICMPv6 Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for an Echo Reply from the RUT.	Cause the RUT to resolve the on-link, global address of TN-1 and create a Neighbor Cache entry in state REACHABLE.
TN-2 transmits an Echo Request to TN-1 using the RUT as the first-hop. TN-2 responds to Neighbor Solicitations from the RUT.	The IPv6 Source Address is equal to the global address of TN-2. The IPv6 Destination Address is equal to the on-link global address of TN-1. The Echo Request contains a large amount of data.
The RUT should forward the Echo Request from TN-2 to TN-1.	Since TN-1's global address is on-link.
The RUT should transmit a Redirect message to TN-2.	The ICMPv6 Destination Address is equal to the global address of TN-1. The ICMPv6 Target Address is equal to the global address of TN-1. The invoking packet, if included, should be truncated so that the entire packet is no larger than the IPv6 minimum MTU (1280 octets).
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **no_redirect_generation.redirect.nd.v6.ip** (2.8.2.0.2)

Purpose: Verify that a router does not generate an ICMP Redirect message when the source of the invoking packet is not a neighbor.

References:

- [ND] – Section 8.2

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: January 20, 1999

Discussion: A router SHOULD send a Redirect message, subject to rate limiting, whenever it forwards a packet that is not explicitly addressed to itself (i.e., a packet that is not source routed through the router) in which:

- the Source Address field of the packet identifies a neighbor, and
- the Destination Address of the packet is not a multicast address

This test only applies to routers.

Test Setup: Default Setup 1.

Procedure: (2.8.2.0.2a)

- Source Address field of the packet identifies a neighbor

Steps	Notes
TN-1 transmits an ICMPv6 Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for an Echo Reply from the RUT.	Cause the RUT to resolve the on-link, global address of TN-1 and create a Neighbor Cache entry in state REACHABLE.
TN-2 transmits an Echo Request to TN-1 using the RUT as the first-hop.	Default ICMPv6 Echo Request. IPv6 Source address equal to the off-link global address of TN-2
The RUT should forward the Echo Request directly to TN-1's hardware address.	Since TN-1's global address is on-link.
The RUT should not transmit a Redirect message to TN-2.	Since the Source Address of the Echo Request is not a neighbor the RUT must not transmit a Redirect message.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.2.0.2b)

- Destination Address of the packet is not a multicast address

Steps	Notes
TN-1 transmits an ICMPv6 Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for an Echo Reply from the RUT.	Cause the RUT to resolve the on-link, global address of TN-1 and create a Neighbor Cache entry in state REACHABLE.
TN-1 transmits an Echo Request to a solicited-node's multicast address.	IPv6 Destination address is an unknown solicited-node's multicast address. Transmitted to the unicast hardware address of the RUT.
The RUT should not transmit a Redirect message to TN-1.	Since the Destination Address of the Echo Request is a multicast address the RUT must not transmit a Redirect message.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **redirect_rate_limit.redirect.nd.v6.ip** (2.8.2.0.3)

Purpose: Verify that a router properly limits the rate at which Redirect messages are transmitted.

References:

- [ND] – Section 8.2
- [ICMPv6] – Section 2.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: November 2, 1998

Discussion: A router MUST limit the rate at which Redirect messages are sent, in order to limit the bandwidth and processing costs incurred by the Redirect messages when the source does not correctly respond to the Redirects, or the source chooses to ignore unauthenticated Redirect messages.
In order to limit the bandwidth and forwarding costs incurred sending ICMPv6 error messages, an IPv6 node MUST limit the rate of ICMPv6 error messages it sends. There are a variety of ways of implementing the rate-limiting function:

- Timer-based: limiting the rate of transmission of error messages to a given source, or to any source, to at most once every T milliseconds.
- Bandwidth-based: limiting the rate at which error messages are sent from a particular interface to some fraction F of the attached link's bandwidth.

The limit parameters in the above examples MUST be configurable for a node, with a conservative default value (e.g., T = 1 second, or F = 2 percent). This test applies only to routers.

Test Setup: Default Setup 2. Configure the RUT to limit the rate at which Redirect messages are sent to T = 1 second.

Procedure: (2.8.2.0.3a)

Steps	Notes
TN-1 transmits an ICMPv6 Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for an Echo Reply from the RUT.	Cause the RUT to resolve the global, on-link address of TN-1 and create a Neighbor Cache entry in state REACHABLE.
TN-2 transmits an Echo Request to TN-1 using the RUT as the first-hop.	Default ICMPv6 Echo Request.
As soon an ICMP redirect is received from the RUT, TN-2 transmits an Echo Request to TN-1 using the RUT as the first-hop. This step is repeated 29 times.	Default ICMPv6 Echo Request.
The RUT should transmit a Redirect message to TN-2 no more than once every second.	The RUT should limit the rate at which it transmits Redirect messages to the configured value.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **router_ignores_redirects.redirect.nd.v6.ip** (2.8.2.0.4)

Purpose: Verify that a router does not update its routing tables upon receipt of a Redirect message.

References:

- [ND] – Section 8.2

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: November 2, 1998

Discussion: A router MUST NOT update its routing tables upon receipt of a Redirect message. This test applies only to routers.

Test Setup: Default Setup 1.

Procedure: (2.8.2.0.4a) Configure the RUT to have a route to network 2f02:3000:2820:4a01 through TR-1.

- Update Routing Table

Steps	Notes
TR-1 transmits an Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for an Echo Reply from the RUT.	Cause the RUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the RUT.	The IPv6 Destination Address is equal to the global address of the RUT.
The RUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the first-hop for TN-2's network because of the configured static route.
TR-1 transmits a Redirect message to the RUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2.
TR-1 forwards an Echo Request from TN-2 to the RUT.	The IPv6 Destination Address is equal to the global address of the RUT.
The RUT should respond to the Request using TR-1 as the first-hop.	The RUT should not have processed the redirect, so the first-hop for TN-2 is unchanged.
Perform test cleanup procedure.	Cause the RUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.2.0.4b) Configure the RUT to have a route to network 2f02:3000:2820:4b01 through TR-1.

- Update Neighbor Cache

Steps	Notes
TR-1 transmits an Echo Request to the RUT and responds to Neighbor Solicitations from the RUT. Wait for an Echo Reply from the RUT.	Cause the RUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the RUT.	The IPv6 Destination Address is equal to the global address of the RUT.
The RUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the first-hop for TN-2's network because of the configured static route.
TR-1 transmits a Redirect message to the RUT.	The ICMPv6 Destination Address is equal to the global address of TN-2 The ICMPv6 Target Address is equal to the link-local address of TR-2. A Target Link Layer Address option is included giving a new address for TR-2.
TR-2 transmits an Echo Request to the RUT.	Default Echo Request.
The RUT should send an ICMPv6 Neighbor Solicitation message to the solicited-node's multicast address of TR-2. No Echo Reply should be sent.	The RUT should not have a neighbor cache entry for TR-2, because it did not update its neighbor cache with information from the TLLA option in the Redirect message sent by TR-1.
Perform test cleanup procedure.	Cause the RUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **neighbor_cache_redirect.redirect.nd.v6.ip** (2.8.3.0.1)

Purpose: Verify that a host properly updates its Neighbor Cache entry upon receipt of a valid ICMP Redirect Message that includes a Target Link-Layer Option.

References:

- [ND] – Section 8.3

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: November 24, 1998

Discussion: If a host receives a Redirect message containing a Target Link-Layer Address option the host either creates or updates the Neighbor Cache entry for the target. In both cases the cached link-layer address is copied from the Target Link-Layer option. If a Neighbor Cache entry is created for the target its reachability MUST be set to STALE as specified in section 7.3.3. If a cache entry already existed and it is updated with a different link-layer address, its reachability state MUST also be set to STALE. If the link-layer address is the same as that already in the cache, the cache entry's state remains unchanged. This test applies only to Hosts.

Test Setup: Default Setup 1.

Procedure: (2.8.3.0.1a)

- Create Neighbor Cache entry in state STALE.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Target Link-Layer option with the link-layer address of TR-2.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-2 as the first-hop.	The NUT should have process the Redirect message normally.
5 seconds after the response to the Request the NUT should transmit Neighbor Solicitations for TR-2.	The NUT's Neighbor Cache entry for TR-2 should have been in state STALE.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.3.0.1b)

- Create Neighbor Cache entry in state REACHABLE.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-2 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-2 and create a Neighbor Cache entry for TR-2 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Target Link-Layer option with the link-layer address of TR-2.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-2 as the first-hop.	The NUT should have process the Redirect message normally.
The NUT should not transmit Neighbor Solicitations for TR-2.	The NUT's Neighbor Cache entry for TR-2 should have been in state REACHABLE.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Procedure: (2.8.3.0.1c)

- Update Neighbor Cache entry from state REACHABLE to state STALE.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-2 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-2 and create a Neighbor Cache entry for TR-2 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Target Link-Layer option with a **different** link-layer address of TR-2.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using the new link-layer address of TR-2 as the first-hop.	The NUT should have process the Redirect message normally.
The NUT should transmit Neighbor Solicitations for TR-2.	The NUT's Neighbor Cache entry for TR-2 should have been updated from state REACHABLE to state STALE upon the receipt of the Redirect message.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **redirected_next_hop_unreachable.redirect.nd.v6.ip** (2.8.3.0.2)

Purpose: Verify that a host goes back to using the original first hop router when the host is unable to resolve the address of a new first-hop learned from a Redirect message.

References:

- [ND] – Sections 6.3.6, 7.3.3 and 8

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: July 20, 1998

Discussion: The policy for selecting routers from the Default Router List is as follows: Routers that are reachable or probably reachable (i.e., in any state other than INCOMPLETE) SHOULD be preferred over routers whose reachability is unknown or suspect (i.e., in the INCOMPLETE state, or for which no Neighbor Cache entry exists). When a node needs to perform address resolution on a neighboring address, it creates an entry in the INCOMPLETE state and initiates address resolution as specified in Section 7.2. If address resolution fails, the entry SHOULD be deleted, so that subsequent traffic to that neighbor invokes the next-hop determination procedure again. Invoking next-hop determination at this point insures that alternate default routers are tried. This test applies only to Hosts.

Test Setup: Default Setup 1.

Procedure: (2.8.3.0.2a)

- Redirect message does not contain a Target Link-Layer Address option.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an Echo Request to the NUT and responds to Neighbor Solicitations from the NUT. Wait for an Echo Reply from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should respond to the Request using TR-1 as the first-hop.	TR-1 is the only router on the NUT's Default Router List.
TR-1 transmits a Redirect message to the NUT.	The ICMPv6 Destination Address is equal to the global address of TN-2. The ICMPv6 Target Address is equal to the link-local address of TR-2. Does not contain a Target Link-Layer option.
TR-1 forwards an Echo Request from TN-2 to the NUT.	The IPv6 Source Address is equal to the off-link global address of TN-2. The IPv6 Destination Address is equal to the global address of the NUT.
The NUT should transmit Neighbor Solicitations to the Link-Local Address of TR-2. TR-2 does not respond.	The NUT should try to resolve the address of TR-2 since the Redirect message did not contain a Target Link-Layer option.
The NUT should respond to the Request using TR-1 as the first-hop.	Since address resolution failed for TR-2 the NUT should continue to use TR-1 as the first-hop.
Perform test cleanup procedure.	Cause the NUT to transition neighbor cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

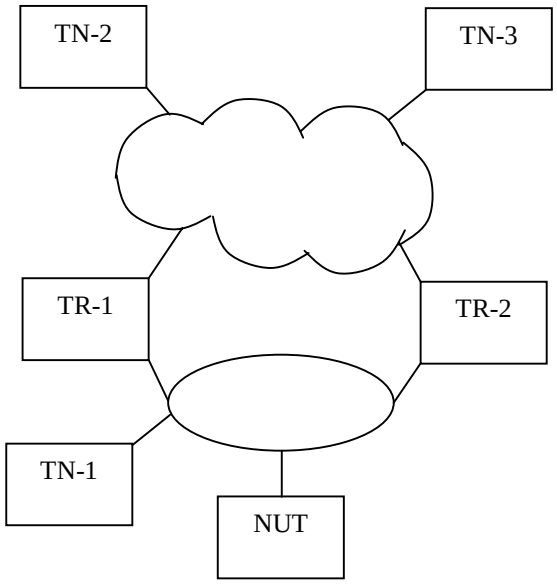
PATH MTU DISCOVERY

Scope
The following tests cover Path MTU Discovery for Internet Protocol version 6. The Path MTU Discovery protocol is a technique to dynamically discover the PMTU of a path. The basic idea is that a source node initially assumes that the PMTU of a path is the (known) MTU is the first hop in the path. If any of the packets sent on that path are too large to be forwarded by some node along the path, that node will discard them and return ICMPv6 Packet Too Big messages. Upon receipt of such a message, the source node reduces its assumed PMTU for the path based on the MTU of the constricting hop as reported in the Packet Too Big message. The Path MTU Discovery process ends when the node's estimate of the PMTU is less than or equal to the actual PMTU.

Overview
These tests are designed to verify conformance with the Path MTU Discovery Specification.

Default Setup

TR: Test Router
TN: Test Node
NUT: Node Under Test
RUT: Router Under Test



Default Packets

Router Advertisement

IPv6 Header Source Address: TR's Link-Local Address Destination Address: all-nodes multicast address Next Header: 58
ICMPv6 Header Type: 134 Code: 0 M Bit (managed): 0 O Bit (other): 0 Router Lifetime: 20 seconds Reachable Time: 10 seconds Retrans Timer: 1 second
Prefix Option Type: 3 L Bit (on-link flag): 1 A Bit (addr conf): 1 Valid Lifetime: 20 seconds Preferred Lifetime: 20 seconds Prefix: link's prefix

Echo Request

IPv6 Header Payload Length: 1400 bytes Next Header: 58
ICMPv6 Header Type: 128 Code: 0

Packet Too Big message	Redirect message
IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: NUT's Link Local Address	IPv6 Header Next Header: 58 Source Address: TR's Link Local Address Destination Address: NUT's Link Local Address
ICMPv6 Header Type: 2 Code: 0 MTU: 1280	ICMPv6 Header Type: 137 Code: 0
Invoking Packet	Invoking Packet

Test Label: **invalid_mtu.mtu.v6.ip** (3.0.0.0.1)

Purpose: Verify that adverse affects do not occur on the receipt of a Packet Too Big message indicating an invalid MTU for a path.

References:

- None. This is a basic packet processing test.

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: October 30, 1998

Discussion: The action taken by a node for receiving a Packet Too Big message with an invalid MTU is not defined, however, adverse affects should not occur as a result.

Test Setup: Default Setup.

Procedure: (30001a)

- MTU equal to zero.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an ICMPv6 Echo Request to the NUT and responds to Neighbor Solicitations from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-1 as the first-hop.	None.
TR-1 transmits a Packet Too Big message to the NUT.	Contains an invalid MTU field value of zero.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-1 as the first-hop.	Adverse effects should not occur as a result of the invalid MTU field in the Packet Too Big message.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Procedure: (30001b)

- MTU equal to 0x1FFFFFFF.

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an ICMPv6 Echo Request to the NUT and responds to Neighbor Solicitations from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-1 as the first-hop.	None.
TR-1 transmits a Packet Too Big message to the NUT.	Contains an invalid MTU field value of 0x1FFFFFFF.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-1 as the first-hop.	Adverse effects should not occur as a result of the invalid MTU field in the Packet Too Big message.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **redirected_path.mtu.v6.ip** (3.0.0.0.2)

Purpose: Verify that a host properly processes a Packet Too Big message indicating a reduction in the MTU for a path that has been redirected.

References:

- [PMTU] – Section 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: October 30, 1998

Discussion: When a host receives a Packet Too Big message, it MUST reduce its estimate of the PMTU for the relevant path, based on the value of the MTU field in the message. The precise behavior of a node in this circumstance is not specified, since different applications may have different requirements, and since different implementation architectures may favor different strategies. This test only applies to hosts.

Test Setup: Default Setup.

Procedure: (30002a)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an ICMPv6 Echo Request to the NUT and responds to Neighbor Solicitations from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-1 as the first-hop.	None.
TR-1 transmits a Redirect message to the NUT.	Default Packet.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-2 as the first-hop.	None.
TR-2 transmits a Packet Too Big message to the NUT.	Default Packet.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should fragment the response to the Request using TR-2 as the first-hop.	The NUT should process the Packet Too Big message normally.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **non_zero_icmpv6_code.mtu.v6.ip** (3.2.0.0.1)

Purpose: Verify that a node properly processes a Packet Too Big message with a non-zero ICMPv6 Code field.

References:

- [PMTU]
- [ICMPv6] – Section 3.2

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: October 30, 1998

Discussion: The ICMPv6 Code field is set to zero by the sender and ignored by the receiver.

Test Setup: Default Setup.

Procedure: (32001a)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an ICMPv6 Echo Request to the NUT and responds to Neighbor Solicitations from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-1 as the first-hop.	None.
TR-1 transmits a Packet Too Big message to the NUT.	Contains an invalid ICMPv6 Code field value of 0xFF.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should fragment the response to the Request using TR-1 as the first-hop.	The NUT should ignore the invalid ICMPv6 Code field and process the Packet Too Big message normally.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **packet_too_big_generation.mtu.v6.ip** (3.2.0.0.2)

Purpose: Verify that a router transmits a Packet Too Big message in response to a packet that it cannot forward due to the Path MTU.

References:

- [PMTU]
- [ICMPv6] – Section 3.2

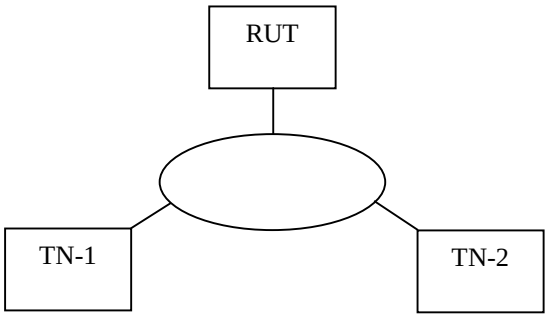
Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: October 30, 1998

Discussion: A Packet Too Big message MUST be sent by a router in response to a packet that it cannot forward because the packet is larger than the MTU of the outgoing link. This test applies only to Routers.

Test Setup: Configure the RUT with a link MTU equal to the IPv6 minimum link MTU (1280).



Procedure: (32002a)

Steps	Notes
TN-1 transmits an ICMPv6 Echo Request to the RUT and responds to Neighbor Solicitations from the RUT.	Cause the RUT to resolve the address of TN-1 and create a Neighbor Cache entry for TN-1 in state REACHABLE.
TN-2 transmits an Echo Request to TN-1 using the RUT as the first-hop.	Default ICMPv6 Echo Request.
The RUT should transmit a Packet Too Big message to TN-2.	The RUT should not forward the Echo Request due to PMTU limitations.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **reduce_pmtu_on-link.mtu.v6.ip** (3.3.0.0.1)

Purpose: Verify that a node properly processes a Packet Too Big message indicating a reduction in Path MTU for a link-local destination.

References:

- [PMTU] – Section 3

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: October 30, 1998

Discussion: Path MTU Discovery must be performed even in cases where a node "thinks" a destination is attached to the same link as itself. In a situation such as when a neighboring router acts as a proxy for some destination, the destination can appear to be directly connected but is in fact more than one hop away.

Test Setup: Default Setup.

Procedure: (33001a)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an ICMPv6 Echo Request to the NUT and responds to Neighbor Solicitations from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 transmits an Echo Request to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request.	None.
TR-1 transmits a Packet Too Big message to the NUT.	Default Packet.
TR-1 transmits an Echo Request to the NUT.	Default ICMPv6 Echo Request.
The NUT should fragment the response to the Request.	The NUT should process the Packet Too Big message normally.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **reduce_pmtu_off-link.mtu.v6.ip** (3.4.0.0.1)

Purpose: Verify that a node properly reduces its estimate of the MTU for a path due to a Packet Too big message indicating a reduction in the Path MTU for a global destination.

References:

- [PMTU] – Section 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: October 30, 1998

Discussion: When a node receives a Packet Too Big message, it MUST reduce its estimate of the PMTU for the relevant path, based on the value of the MTU field in the message. The precise behavior of a node in this circumstance is not specified, since different applications may have different requirements, and since different implementation architectures may favor different strategies.

Test Setup: Default Setup.

Procedure: (34001a)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an ICMPv6 Echo Request to the NUT and responds to Neighbor Solicitations from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-1 as the first-hop.	None.
TR-1 transmits a Packet Too Big message to the NUT.	Default Packet.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should fragment the response to the Request using TR-1 as the first-hop.	The NUT should process the Packet Too Big message normally.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **ipv6_minumum_link_mtu.mtu.v6.ip** (3.4.0.0.2)

Purpose: Verify that a node does not reduce its estimate of the Path MTU below the IPv6 minimum link MTU.

References:

- [PMTU] – Section 4
- [IPv6-SPEC] – Section 5

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: October 30, 1998

Discussion: A node MUST NOT reduce its estimate of the Path MTU below the IPv6 minimum link MTU.
Note: A node may receive a Packet Too Big message reporting a next-hop MTU that is less than the IPv6 minimum link MTU. In that case, the node is not required to reduce the size of the subsequent packets sent on the path to less than the IPv6 minimum link MTU, but rather must include a Fragment header in those packets.
IPv6 requires that every link in the internet have a MTU of 1280 octets or greater. On any link that cannot convey a 1280-octet packet in one piece, link-specific fragmentation and reassembly must be provided at a layer below IPv6.
In response to an IPv6 packet that is sent to an IPv4 destination (i.e., a packet that undergoes translation from IPv6 to IPv4), the originating IPv6 node may receive an ICMPv6 Packet Too Big message reporting a Next-Hop MTU less than 1280. In that case, the IPv6 node is not required to reduce the size of subsequent packets to less than 1280, but must include a Fragment header in those packets so that the IPv6-to-IPv4 translating router can obtain a suitable Identification value to use in resulting IPv4 fragments. Note that this means the payload may have to be reduced to 1232 octets (1280 minus 40 for the IPv6 header and 8 for the Fragment header), and smaller still if additional extension headers are used.

Test Setup: Default Setup.

Procedure: (34002a)

- reduce estimate below IPv6 minimum link MTU

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an ICMPv6 Echo Request to the NUT and responds to Neighbor Solicitations from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-1 as the first-hop.	None.
TR-1 transmits a Packet Too Big message to the NUT.	Contains a MTU field value < 1280 octets.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should response to the Request.	The NUT should not reduce its estimate of the PMTU below the IPv6 minimum link MTU based on the value of the MTU field in the Packet Too Big message.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Procedure: (34002b)

- reduce size of packets below IPv6 minimum link MTU

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an ICMPv6 Echo Request to the NUT and responds to Neighbor Solicitations from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-1 as the first-hop.	None.
TR-1 transmits a Packet Too Big message to the NUT.	Contains a MTU field value of 512 octets.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Payload Length: 768 octets.
The NUT should respond to the Request.	The NUT should not reduce the size of packets to below the IPv6 minimum link MTU based on the value of the MTU field in the Packet Too Big message. Instead it should include a Fragment Header in those packets.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **increase_estimate.mtu.v6.ip** (3.4.0.0.3)

Purpose: Verify that a node does not increase its estimate of the MTU for a path due to a Packet Too Big message.

References:

- [PMTU] – Section 4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: October 30, 1998

Discussion: A node MUST NOT increase its estimate of the Path MTU in response to the contents of a Packet Too Big message. A message purporting to announce an increase in the Path MTU might be a stale packet that has been floating around in the network, a false packet injected as part of a denial-of-service attack, or the result of having multiple paths to the destination, each with a different PMTU. This test applies only to Hosts.

Test Setup: Default Setup.

Procedure: (34003a)

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an ICMPv6 Echo Request to the NUT and responds to Neighbor Solicitations from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-1 as the first-hop.	None.
TR-1 transmits a Packet Too Big message to the NUT.	Default Packet.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should fragment the response to the Request using TR-1 as the first-hop.	The NUT should process the Packet Too Big message normally.
TR-1 transmits a Packet Too Big message to the NUT.	Contains an MTU field value > 1280 octets.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should fragment the response to the Request using TR-1 as the first-hop.	The NUT should not process the second Packet Too Big message indicating an increase in the PMTU.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.

Test Label: **ra_with_mtu_option.mtu.v6.ip** (3.9.0.0.1)

Purpose: Verify that a node properly processes a Router Advertisement with an MTU option.

References:

- [PMTU]
- [ND] – Sections 4.2 and 6.3.4

Resource Requirements:

- Packet generator
- Monitor to capture packets

Last Modification: January 14, 1999

Discussion: The receipt of a Router Advertisement MUST NOT invalidate all information received in a previous advertisement or from another source. However, when received information for a specific parameter (e.g., Link MTU) or option (e.g., Lifetime on a specific Prefix) differs from information received earlier, and the parameter/option can only have one value, the most recently received information is authoritative.
If the MTU option is present, hosts SHOULD copy the option's value into LinkMTU so long as the value is greater than or equal to the minimum link MTU [IPv6-SPEC] and does not exceed the default LinkMTU value specified in the link type specific document. This test applies only to Hosts.

Test Setup: Default Setup.

Procedure: (39001a)

- Reduce estimate due to MTU option.

Steps	Notes
TR-1 transmits a Router Advertisement with an MTU option to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time. Cause the NUT to set the link MTU to 1280 octets.
TR-1 transmits an ICMPv6 Echo Request to the NUT and responds to Neighbor Solicitations from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should fragment the response to the Request using TR-1 as the first-hop.	The NUT should have adjusted its estimate of the link MTU to the value in the MTU option in the Router Advertisement.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Procedure: (39001b)

- raise estimate due to MTU option

Steps	Notes
TR-1 transmits a Router Advertisement to the all-nodes multicast address.	Cause the NUT to add TR-1 to its Default Router List. Cause the NUT to auto-configure its global address from the link's prefix. Cause the NUT to compute Reachable Time.
TR-1 transmits an ICMPv6 Echo Request to the NUT and responds to Neighbor Solicitations from the NUT.	Cause the NUT to resolve the address of TR-1 and create a Neighbor Cache entry for TR-1 in state REACHABLE.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should respond to the Request using TR-1 as the first-hop.	None.
TR-1 transmits a Packet Too Big message to the NUT.	Default Packet.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should fragment the response to the Request using TR-1 as the first-hop.	The NUT should process the Packet Too Big message normally.
TR-1 transmits a Router Advertisement with an MTU option to the all-nodes multicast address.	MTU equal to 1500 octets.
TR-1 forwards an Echo Request from TN-2 to the NUT.	Default ICMPv6 Echo Request.
The NUT should fragment the response to the Request using TR-1 as the first-hop.	The NUT should not increase its estimate of the link MTU due to the Router Advertisement.
Perform the test cleanup procedure.	Cause the NUT to transition Neighbor Cache entries created in this test to state INCOMPLETE.

Possible Problems: None.