ROUTING CONSORTIUM

Open Shortest Path First (OSPF)
NSSA Option Test Suite

Technical Document

Revision 1.9

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MODIFICATION RECORD

Version 1.9 — May 5, 2009
- Reworded Test 'Originating Type-5 LSAs' Part B.

Version 1.8 — June 1, 2007
- Updated Test 1.9

Version 1.7 — December 18, 2004
- Updated tests 1.7, 1.10 and 1.11

Version 1.6 — February 20, 2004
- Updated tests 1.8, 1.9 and 1.11

Version 1.5 — February 10, 2004
- Fixed typos in all tests
- Updated diagrams in tests 1.7 and 1.10

Version 1.4 — January 6, 2004
- Fixed test 1.2's network numbers
- Removed unnecessary test 1.8
- Merged test 1.9 with 1.5

January 7, 2004
- Updated diagrams
- Fixed typos

January 8, 2004
- Final review

Version 1.3 — December 23, 2003
- Wrote and combined similar tests
- Grouped all the sections

December 31, 2003
- Updated and finished test 1.13

Version 1.2 — December 2, 2003
- Updated references

Version 1.1 — October 31, 2002
- Added more tests and references

Version 1.0 — July 9, 2002

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Ethan Burns	University of New Hampshire
Michael Cleary	University of New Hampshire
Barbara Hill	University of New Hampshire
Kari Revier	University of New Hampshire

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 functionality of their OSPF based products. This test suite has been designed to test the Interoperability of the device under test with other OSPF Capable devices. This test suite focuses on testing configurations of the network that could cause problems when deployed if the device under test does not operate properly with the devices that it is connected to.

Abbreviations and Acronyms

ASBR: **A**utonomous **S**ystem **B**oundary **R**outer

LSA: **L**ink **S**tate **A**dvertisement

NSSA: **N**ot **S**o **S**tubby **A**rea

RUT: **R**outer **U**nder **T**est

TR: **T**esting **R**outer

TEST ORGANIZATION

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

Test Label: The Test Label and title comprise is the first line of the test block. The test label is composed by concatenating the short test suite name, the group number, and the test number within the group, separated by periods. The **Test Number** is the group and test number, also separated by a period. So, test label OSPF_NSSA.1.2 refers to the second test of the first test group in the OSPF NSSA Conformance suite. The test number is 1.2.

Purpose: The Purpose section is a short statement describing what the test attempts to achieve. It is usually phrased as a simple assertion of the feature or capability to be tested.

References: The References section lists cross-references to the specifications and documentation that might be helpful in understanding and evaluating the test and results.

Last Modification The Last Modification section lists the last date that the current test was modified.

Discussion: The Discussion section is a general discussion of the test and relevant section of the specification, including any assumptions made in the design or implementation of the test as well as known limitations.

Test Setup: The Test Setup section describes the configuration of all devices prior to the start of the test. Different parts of the procedure may involve configuration steps that deviate from what is given in the test setup. If a value is not provided for a protocol parameter, then the protocol's default is used for that parameter.

Procedure: The Procedure section contains the step-by-step instructions for carrying out the test. The steps include such things as enabling interfaces, unplugging devices from the network, or transmitting packets from a test station. The test procedure also cues the tester to make observations, which are interpreted in accordance with the observable results given for that test part.

Observable Results: The Observable Results section lists observable results that can be examined by the tester to verify that the RUT is operating properly. When multiple observable results are possible, this section provides a short discussion on how to interpret them. The determination of a pass or fail for each test is usually based on how the RUT's behavior compares to the results described in this section.

Possible Problems: The Possible Problems section contains a description of known issues with the test procedure, which may affect test results in certain situations.

REFERENCES

The following documents are referenced in this text:

- Request for Comments 3101 – The OSPF Not-So-Stubby Area (NSSA) Option
- Request for Comments 2328 – OSPF Version 2

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Test OSPF_NSSA.1.1: N-Bit

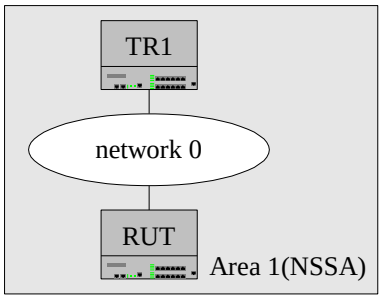
Purpose: To verify that a router sets the N-bit in it's Options field of a Hello packet and can transmit and receive Type-7 LSAs.

References: [3101] Section 1.3

Last Modification: January 8, 2004

Discussion: NSSAs are defined in much the same manner as existing stub areas. To support NSSAs, a new option bit (the N-bit) and a new type of LSA (Type-7) are defined. The N-bit ensures that routers belonging to an NSSA agree on its configuration. Similar to the stub area's use of the E-bit, both NSSA neighbors must agree on the setting of the N-bit or the OSPF neighbor adjacency will not form.

Test Setup: Configure the routers as shown below. If a network is not assigned to a particular area, the default area of 0.0.0.0 is used. Configure the RUT to be in NSSA area 0.0.0.1. TR1 is in NSSA area 0.0.0.1.



Procedure:

Part A: The RUT and TR1 agree on the N-bit

1. OSPF is enabled on TR1.
2. Enable OSPF on the RUT.
3. Observe the packets transmitted on network 0.

Part B: The RUT and TR1 disagree on the N-bit

4. TR1 no longer considers area 0.0.0.1 to be an NSSA.
5. Re-start OSPF on the routers.
6. Observe the packets transmitted on network 0.

Part C: The RUT and TR1 disagree on the N-bit

7. TR1 considers area 0.0.0.1 to be an NSSA.
8. Configure the RUT to no longer consider area 0.0.0.1 to be an NSSA.
9. Re-start OSPF on the routers.
10. Observe the packets transmitted on network 0.

Part D: The RUT originates a Type-7 LSA

11. Configure the RUT to consider area 0.0.0.1 to be an NSSA.
12. Configure the RUT to export an external route into OSPF.
13. Observe the packets transmitted on network 0.

Part E: The RUT receives a Type-7 LSA

14. TR1 exports an external route into OSPF.
15. Observe the packets transmitted on network 0.

Observable Results:

- In Part A, the RUT should list TR1 as a neighbor, and have the N-bit set and the E-bit cleared in its Hello packets.
- In Part B, the RUT should not list TR1 as a neighbor. The RUT should have the N-bit set in its Hello packets.
- In Part C, the RUT should no longer list TR1 as a neighbor. The RUT should have the E-bit set and the N-bit cleared in its Hello packets.
- In Part D, the RUT should originate a new Type-7 LSA.
- In Part E, the RUT should accept the Type-7 LSA originated by TR1, and add it into its database.

Possible Problems: None.

Test OSPF_NSSA 1.2: Type-5 LSAs are not flooded into NSSA

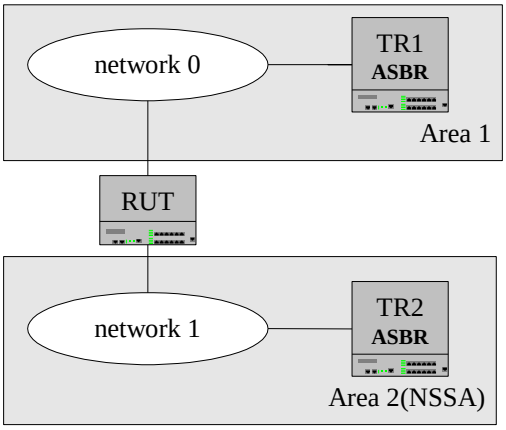
Purpose: To verify that a router does not flood Type-5 LSAs into an NSSA area, and does not flood Type-7 LSAs out of the originating NSSA area.

References: [3101] Section 1.3

Last Modification: January 8, 2004

Discussion: Type-7 LSAs may be originated by and advertised throughout an NSSA; as with stub areas, Type-5 LSAs are not flooded into NSSAs and do not originate there.
Type-7 LSAs are advertised only within a single NSSA; they are not flooded into the backbone area or any other area by border routers, though the information which they contain may be propagated into the backbone area.

Test Setup: Configure the routers as shown below. If a network is not assigned to a particular area, the default area of 0.0.0.0 is used. The RUT is configured to have its interface to network 0 in area 0.0.0.1 and its interface to network 1 in NSSA area 0.0.0.2.



Procedure:

Part A: The RUT does not flood Type-5 LSA into NSSA

1. OSPF is enabled on the routers.
2. TR1 should export an external route into OSPF.
3. Observe the packets transmitted on network 0.

Part B: The RUT does not flood Type-7 LSA out of the NSSA

4. TR2 should export an external route into OSPF as a Type-7 LSA.
5. Observe the packets transmitted on network 1.

*Part C: The RUT does not flood Type-7 LSA into another NSS*A

6. Configure area 0.0.0.1 to be an NSSA area.
7. TR2 should export an external route into OSPF as a Type-7 LSA.
8. Observe the packets transmitted on network 1.

Observable Results:

- In Part A, the RUT should not flood the Type-5 LSA from TR1 to network 1. The RUT may perform Type-5 to Type-7 LSA translation, in which case the RUT will flood a Type-7 LSA to network 1 containing the information in the Type-5 LSA.
- In Part B, the RUT should not flood the Type-7 LSA from TR2 to network 0. The RUT may perform Type-7 to Type-5 LSA translation, in which case the RUT will flood a Type-5 LSA to network 0 containing the information in the Type-7 LSA.
- In Part C, the RUT should not flood the Type-7 LSA from TR2 to network 0.

Possible Problems: None.

Test OSPF_NSSA 1.3: Flooding a default route

Purpose: To verify that a router properly floods a default route into an NSSA area.

References: [3101] Section 1.3

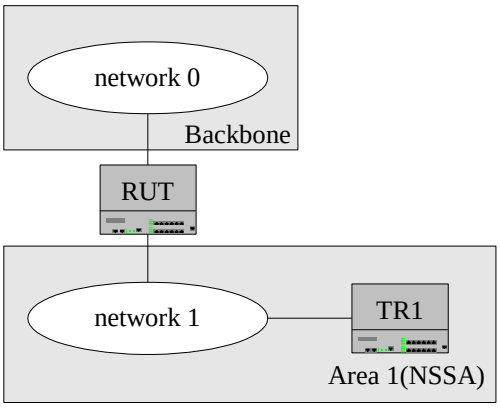
Last Modification: January 8, 2004

Discussion: An NSSA border router should originate a default LSA (IP network is 0.0.0.0/0) into the NSSA. Default routes are necessary because NSSAs do not receive full routing information and must have a default route in order to route to AS-external destinations.

When summary routes are not imported into an NSSA, the default LSA originated into it by its border routers must be a Type-3 summary-LSA. This default summary-LSA insures intra-AS connectivity to the rest of the OSPF domain, as its default summary route is preferred over the default route of a Type-7 default LSA.

When summary routes are imported into the NSSA, the default LSA originated by a NSSA border router into the NSSA should be a Type-7 LSA.

Test Setup: Configure the routers as shown below. If a network is not assigned to a particular area, the default area of 0.0.0.0 is used.



Procedure:

Part A: The RUT transmits a Type-3 default summary LSA

1. Configure the RUT to transmit a default summary-LSA with summary routes disabled.
2. OSPF is enabled on the routers.
3. Observe the packets transmitted on network 1.

Part B: The RUT transmits a Type-7 default LSA

4. Configure the RUT to transmit a default summary-LSA with summary routes enabled.
5. Observe the packets transmitted on network 1.

Part C: P-bit clear

6. Observe the header options of the Type-7 default LSA.

Observable Results:

- In Part A, the RUT should originate a summary-network-LSA on network 1 with the Link State ID of 0.0.0.0 and a netmask of 0.0.0.0.

- In Part B, the RUT should originate a Type-7 default LSA on network 1 with the Link State ID of 0.0.0.0 and a netmask of 0.0.0.0.
- In Part C, the RUT should not set the P-bit in the Type-7 default LSA.

Possible Problems: None.

Test OSPF_NSSA 1.4: Configuring of summary LSAs

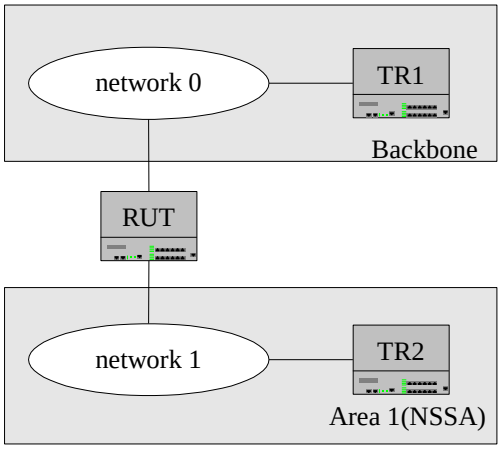
Purpose: To verify that a router does not originate Type-3 summary-LSAs when it is configured not to, and to verify that a router does not flood Type-4 summary-LSAs into an NSSA area.

References: [3101] Section 1.3

Last Modification: February 10, 2004

Discussion: Like stub areas, NSSA border routers optionally import summary route into their NSSAs as Type-3 summary-LSAs. If the import is disabled, particular care should be taken to ensure that summary routing is not obscured by an NSSA's Type-7 AS-external-LSAs. This may happen when the AS's other IGPs, like RIP and ISIS, leak routing information into the NSSA. In these cases all summary routes should be imported into the NSSA. The recommended default behavior is to import summary routes into NSSAs. Since Type-5 AS-external-LSAs are not flooded into NSSAs, NSSA border routers should not originate Type-4 summary-LSAs into their NSSAs.

Test Setup: Configure the routers as shown below. If a network is not assigned to a particular area, the default area of 0.0.0.0 is used.



Procedure:

Part A: The RUT is configured to flood summary routes

1. Configure the RUT to import summary routes into NSSA.
2. Enable OSPF on the RUT.
3. Observe the packets transmitted on network 1.

Part B: The RUT is configured not to flood summary routes

4. Configure the RUT not to import summary routes into NSSA.
5. Re-start OSPF on the RUT.
6. Observe the packets transmitted on network 1.

Part C: The RUT does not flood Type-4 summary-LSAs into NSSA

7. TR1 should export an external route to OSPF.
8. Observe the packets transmitted on network 1.

Part D: The RUT does not originate Type-4 summary LSA

9. Re-start OSPF on the routers.

10. Configure the RUT to export an external route into NSSA.
11. Observe packets on network 1.

Observable Results:

- In Part A, the RUT should originate a Type-3 summary-LSA to network 1 for network 0.
- In Part B, the RUT should not originate a Type-3 summary-LSA to network 1.
- In Part C, the RUT should not originate a Type-4 summary LSA to network 1.
- In Part D, the RUT should not originate a Type-4 summary LSA on network 1.

Possible Problems: None.

Test OSPF_NSSA.1.5: Type-7 Address Range Parameters

Purpose: To verify that Type-7 address ranges can be configured with the appropriate options.

References: [3101] Section 2.2

Last Modification: January 8, 2004

Discussion: NSSA border router may be configured with Type-7 address ranges. A Type-7 address range includes the following configurable items:

- An [address, mask] pair
- A status indication of either Advertise or DoNotAdvertise
- An external route tag

All tests in this section are implicitly tested by other tests. They are here only as a checklist.

Possible Problems: None.

Test OSPF_NSSA.1.6: Originating Type-7 AS-External LSAs

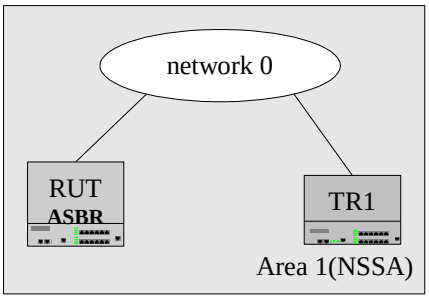
Purpose: To verify that a router with a Type-7 LSA will originate a new LSA if the connection is lost.

References: [3101] Section 2.3

Last Modification: February 10, 2004

Discussion: When a router is forced to pick a forwarding address for a Type-7 LSA, preference should be given first to the router's internal addresses (provided internal addressing is supported). If internal addresses are not available, preference should be given to the router's active OSPF stub network addresses. When the interface whose IP address is the LSA's forwarding address transitions to a Down state), the router must select a new forwarding address for the LSA and then re-originate it. If one is not available the LSA should be flushed.

Test Setup: Configure the routers as shown below. If a network is not assigned to a particular area, the default area of 0.0.0.0 is used.



Procedure:

Part A: The RUT's forwarding address for its Type-7 LSA goes down

1. Configure the RUT to advertise an external route to network 1 with a forwarding address set.
2. Enable OSPF on the routers.
3. Observe the forwarding address of the RUT's Type-7 LSA on network 0.
4. Remove the external route on the RUT.
5. Configure the RUT to advertise a route to network 1 without the forwarding address set.
6. Observe the traffic transmitted on network 0.

Observable Results:

- In Part A, the RUT should max-Age the first LSA and originate a new LSA where the forwarding address is different.

Possible Problems: None.

Test OSPF_NSSA.1.7: Type-7 Preference Rules

Purpose: To verify that a router properly administers the tie-breaking rules for functionally equivalent Type-7 LSAs.

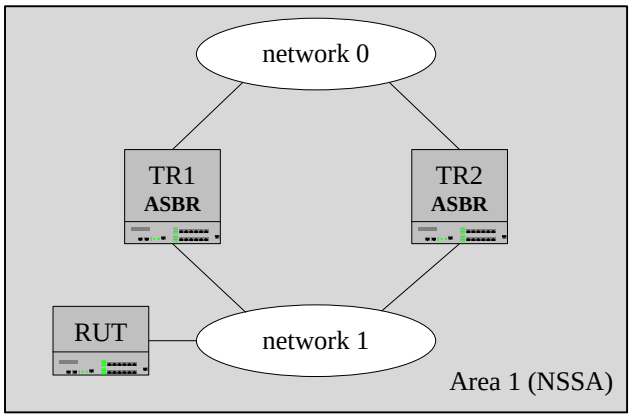
References: [3101] Section 2.4
[2328] Section 12.4.4.1

Last Modification: December 18, 2004

Discussion: If an NSSA's border router originates a Type-5 LSA with a forwarding address from the NSSA, it should also originate a Type-7 LSA into the NSSA. If two NSSA routers, both reachable from one another over the NSSA, originate functionally equivalent Type-7 LSAs (i.e., same destination, cost and non-zero forwarding address), then the router having the least preferred LSA should flush its LSA. Preference between two Type-7 LSAs is determined by the following tiebreaker rules:

1. An LSA with the P-bit set is preferred over one with the P-bit clear.
2. If the P-bit settings are the same, the LSA with the higher router ID is preferred.

Test Setup: Configure the routers as shown below. If a network is not assigned to a particular area, the default area of 0.0.0.0 is used.



Procedure:

Part A: TR1 has higher router-id

1. TR1 and TR2 advertise external routes to network 2 with the same cost and forwarding address on network 0.
2. TR1 has a higher router-id than TR2.
3. OSPF is restarted on the routers.
4. Observe the RUT's routing table.

Part B: TR1 has P-bit clear

5. TR2's interface to network 0 is disabled.
6. OSPF is restarted on the routers.
7. Observe the RUT's routing table.

Part C: TR1 has lower router-id

8. TR2's interface to network 0 is enabled.

9. TR1 has a lower router-id than TR2.
10. OSPF is restarted on the routers.
11. Observe the RUT's routing table.

Part D: TR1 with P-bit set

12. TR1's interface to network 0 is disabled.
13. OSPF is restarted on the routers.
14. Observe the RUT's routing table.

Observable Results:

- In Parts A and D, TR1's Type-7 LSA should be preferred. The RUT should have a path to the external route with TR1 set as the next hop.
- In Parts B and C, TR2's Type-7 LSA should be preferred. The RUT should have a path to the external route with TR2 set as the next hop.

Possible Problems: None.

Test OSPF_NSSA.1.8: NSSATranslatorRole Always

Purpose: To verify that a router properly implements the configuration parameter NSSATranslatorRole.

References: [3101] Section 3.1

Last Modification: February 20, 2004

Discussion: A new area configuration parameter, NSSATranslatorRole, is defined in Appendix D. It specifies whether or not an NSSA router will unconditionally translate Type-7 LSAs to Type-5 LSAs when acting as an NSSA border router. When NSSATranslatorRole is set to Always, Type-7 LSAs are always translated regardless of the translator state of other NSSA border routers.

When an NSSA router with the NSSA's NSSATranslatorRole set to Always attains border router status, it should change NSSATranslatorState from disabled to enabled. When it loses border router status, it should change NSSATranslatorState from enabled to disabled.

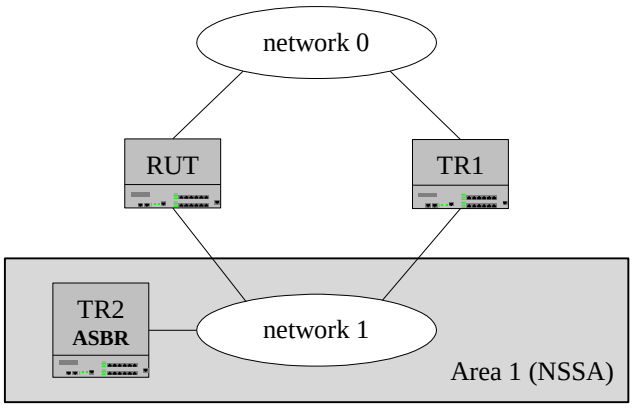
When an NSSA border router's NSSATranslatorState changes from disabled to either enabled or elected, it begins translating the NSSA's Type-7 LSAs into Type-5 LSAs. When its NSSATranslatorState changes from either enabled or elected to disabled, it ceases translating the NSSA's Type-7 LSAs into Type-5 LSAs.

An NSSA router who's NSSATranslatorRole is set to Always should re-originate a router-LSA into the NSSA whenever its NSSATranslatorState changes.

A new bit, Nt, is defined for the router-LSAs of NSSAs. When an NSSA border router has its NSSATranslatorState enabled, it sets bit Nt in the router-LSA it originates into the NSSA.

All NSSA border routers must set the E-bit in the Type-1 router-LSAs of their directly attached non-stub areas.

Test Setup: Configure the routers as shown below. If a network is not assigned to a particular area, the default area of 0.0.0.0 is used.



Procedure:

Part A: The RUT's NSSATranslatorRole set to Always

1. TR2 is an ASBR advertising an external route.
2. Configure the RUT's NSSATranslatorRole to Always.
3. TR1's NSSATranslatorRole is Candidate.
4. OSPF is enabled on TR1 and TR2.

5. Enable OSPF on the RUT.
6. Observe the packets transmitted on all networks.

Part B: The RUT's NSSATranslatorState changes to disabled

7. Disable the RUT's interface to network 0.
8. Observe the packets transmitted on all networks.

Part C: The RUT's NSSATranslatorState changes to enabled

9. Enable the RUT's interface to network 0.
10. Observe the packets transmitted on all networks.

Part D: TR1 and the RUT's NSSATranslatorRole set to Always

11. TR1's NSSATranslatorRole is set to Always.
12. Re-start OSPF on the routers.
13. Observe the packets transmitted on network 0.

Observable Results:

- In Part A, the RUT's NSSATranslatorState should be "enabled" and the Nt-bit should be set in its router-LSAs for network 1. The RUT should also translate TR2's Type-7 LSA into a Type-5LSA and transmit it to network 0.
- In Part B, the RUT's NSSATranslatorState should be "disabled" and it should transmit a router-LSA to network 1 without the Nt-bit.
- In Part C, the RUT's NSSATranslatorState should be "enabled" and it should transmit a router-LSA to network 1 with the Nt-bit set. The RUT should translate TR2's type-7 LSA and transmit it to network 0.
- In Part D, the RUT should continue to translate TR2's Type-7 LSAs into Type-5 LSAs and transmit them to network 0.

Possible Problems: None.

Test OSPF_NSSA.1.9: NSSATranslatorRole Candidate

Purpose: To verify that a router properly implements the parameter NSSATranslatorRole when set to Candidate.

References: [3101] Section 3.1

Last Modification: February 20, 2004

Discussion: An NSSA border router whose NSSA's NSSATranslatorRole is set to Candidate must maintain a list of the NSSA's border routers that are reachable both over the NSSA and as ASBRs over the AS's transit topology. If there exists another border router in this list whose router-LSA has bit Nt set or who has a higher router ID, then its NSSATranslatorState is disabled. Otherwise its NSSATranslatorState is elected.

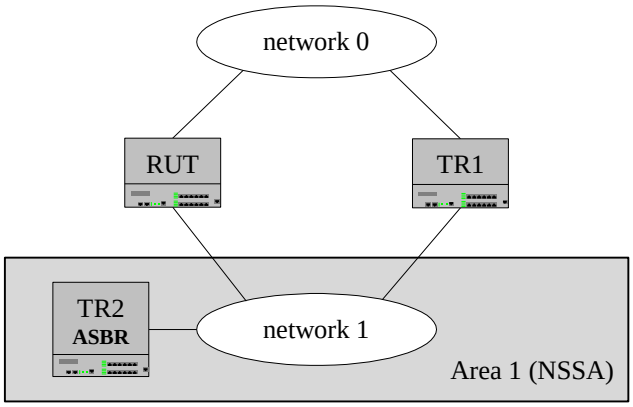
If an elected translator determines its services are no longer required, it continues to perform its translation duties for the additional time interval defined by a new area configuration parameter, TranslatorStabilityInterval. This minimizes excessive flushing of translated Type-7 LSAs and provides for a more stable translator transition. The default value for the TranslatorStabilityInterval parameter has been defined as 40 seconds.

By default all NSSA routers initialize NSSATranslatorState to disabled. When an NSSA border router's NSSATranslatorState changes from disabled to either enabled or elected, it begins translating the NSSA's Type-7 LSAs into Type-5 LSAs. When its NSSATranslatorState changes from either enabled or elected to disabled, it ceases translating the NSSA's Type-7 LSAs into Type-5 LSAs.

All NSSA border routers must set the E-bit in the Type-1 router-LSAs of their directly attached non-stub areas, even when they are not translating.

A new bit, Nt, is defined for the router-LSAs of NSSAs. When an NSSA border router has its NSSATranslatorState enabled, it sets bit Nt in the router-LSA it originates into the NSSA.

Test Setup: Configure the routers as shown below. If a network is not assigned to a particular area, the default area of 0.0.0.0 is used.



Procedure:

Part A: The RUT's NSSATranslatorRole set to Candidate

1. Configure the RUT's NSSATranslatorRole to Candidate.
2. TR2 is an ASBR advertising an external route.
3. Configure the RUT's router-id to be higher than that of TR1.
4. TR1's NSSATranslatorRole is set to Candidate.
5. Enable OSPF on the routers.
6. Observe the packets transmitted on network 1.

Part B: TR1 has higher router-id

7. Configure the RUT's router-id to be lower than that of TR1.
8. Observe the packets transmitted on network 1.

Part C: TR1's NSSATranslatorRole set to Always

9. Configure the RUT's router-id to be higher than that of TR1.
10. Re-start OSPF on the routers.
11. After the RUT transmits TR2's Type-7 LSA, TR1's NSSATranslatorRole is set to Always.
12. Observe the packets transmitted on network 1.

Observable Results:

- In Part A, the RUT should set its NSSATranslatorState to "elected" and translate TR2's Type-7 LSAs into Type-5 LSAs, which are then transmitted on network 0. The RUT should also transmit a router-LSA without the Nt-bit set on network 1.
- In Part B, the RUT should continue to transmit the Type-5 LSA for 40 seconds after it synchronizes with TR1.
- In Part C, the RUT should wait 40 seconds before it ceases to transmit the Type-7 LSA.

Possible Problems: None.

Test OSPF_NSSA.1.10: Translating Type-7 LSAs

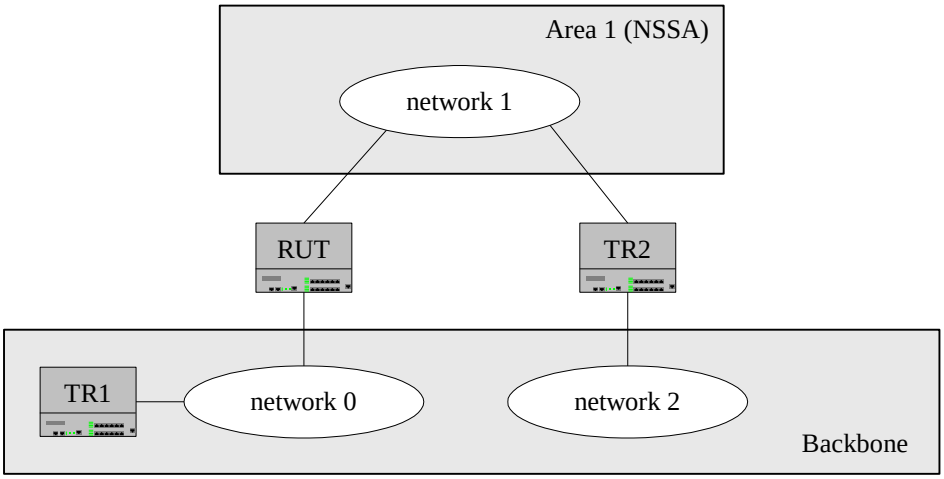
Purpose: To verify that a router properly translates Type-7 LSAs.

References: [3101] Section 3.2 (1)

Last Modification: December 18, 2004

Discussion: If the Type-7 LSA has the P-bit clear, or its forwarding address is set to 0.0.0.0, or the most specific Type-7 address range that subsumes the LSA's network has DoNotAdvertise status, then do nothing with this Type-7 LSA and consider the next one in the list. Otherwise term the LSA as translatable and proceed.

Test Setup: Configure the routers as shown below. If a network is not assigned to a particular area, the default area of 0.0.0.0 is used. Configure the RUT's NSSATranlatorRole to always.



Procedure:

Part A: P-Bit clear

1. TR2 is an ASBR advertising an external route.
2. Start OSPF on the routers.
3. Observe the packets transmitted on network 0.

Part B: Most Specific Type-7 address range set to DoNotAdvertise

4. Configure an address range on the RUT, which contains the network of the AS External LSA being advertised by TR2, and set it to DoNotAdvertise.
5. Re-start OSPF on the routers.
6. Observe the packets transmitted on network 0.

Observable Results:

- In Parts A and B, the RUT should not translate TR2's Type-7 LSA into a Type-5 LSA.

Possible Problems: None.

Test OSPF_NSSA.1.11: Originating Type-5 LSAs

Purpose: To verify that a router properly originates Type-5 LSAs.

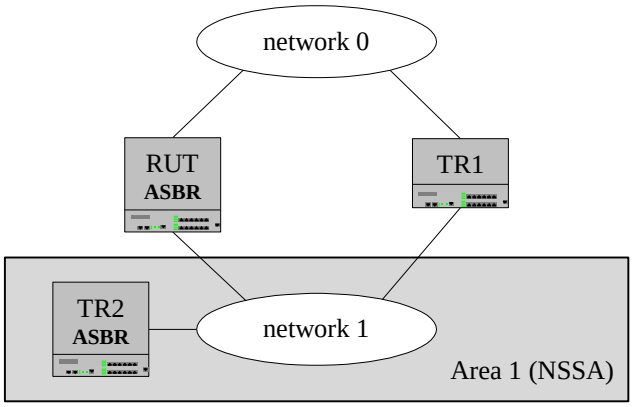
References: [3101] Section 3.2 (2), (3)

Last Modification: December 18, 2004

Discussion: If the Type-7 LSA is not contained in any explicitly configured Type-7 address range and the calculating router has the highest router ID amongst NSSA translators that have originated a functionally equivalent Type-5 LSA (i.e. same destination, cost and non-zero forwarding address) and that are reachable over area 0 and the NSSA, then a Type-5 LSA should be generated if there is currently no Type-5 LSA originating from this router corresponding to the Type-7 LSA's network, or there is an existing Type-5 LSA and either it corresponds to a local OSPF external source whose path type and metric is less preferred , or it doesn't and the Type-5 LSA's path type or cost(s) have changed or the forwarding address no longer maps to a translatable Type-7 LSA.

The newly originated Type-5 LSA will describe the same network and have the same network mask, path type, metric, forwarding address and external route tag as the Type-7 LSA. The advertising router field will be the router ID of this NSSA border router. The link-state ID is equal to the LSA's network address (in the case of multiple originations of Type-5 LSAs with the same network address but different mask, the link-state ID can also have one or more of the network's "host" bits set).

Test Setup: Configure the routers as shown below. If a network is not assigned to a particular area, the default area of 0.0.0.0 is used.



Procedure:

Part A: The RUT translates Type-7 LSA

1. TR2 is an ASBR advertising a Type-7 LSA with a path type 1 and metric 1.
2. TR1's NSSATranslatorRole is set to Always.
3. Configure the RUT as an ASBR; it should not be advertising any routes at this time.
4. Configure the RUT's NSSATranslatorRole as Always, and it's router-id to be higher than that of TR1.
5. Start OSPF on the routers.
6. Observe the packets transmitted on network 0.

Part B: External network in Address Range

7. Configure a Type-7 address range on the RUT, which contains the network in TR2's Type-7 external LSA, set to advertise.
8. Re-start OSPF on the routers.
9. Observe the packets transmitted on network 0.

Part C: The RUT has lower router-id

10. Remove the address range on the RUT.
11. Configure the RUT's router-id to be lower than that of TR1.
12. Re-start OSPF on the routers.
13. Observe the packets transmitted on network 0.

Part D: Existing Type-5 LSA with less preferred metric and path

14. Configure the RUT to advertise a Type-5 LSA for the same network as the Type-7 LSA originated by TR2. The LSA should have the same forwarding address as that of TR2 with a path type of 2 and a metric of 10.
15. Configure the RUT to have a higher router-id than that of TR1.
16. Re-start OSPF on the routers.
17. Observe the traffic transmitted on network 0.

Part E: Existing Type-5 LSA with more preferred metric and path

18. TR2's external route has a path type of 2 and a metric of 15.
19. Re-start OSPF on the routers.
20. Observe the packets transmitted on network 0.

Part F: Cost Change

21. Configure the RUT to no longer be an ASBR.
22. Observe the packets transmitted on network 0 and network 1.
23. TR2's AS External metric is set to 12.
24. Observe the packets transmitted on network 0 and network 0.

Part G: Path Type Changes

25. TR2's AS external path type is set to 1.
26. Observe the packets transmitted on network 0 and network 1.

Observable Results:

- In Part A, the RUT should originate a Type-5 LSA on network 0 which describes the same network, netmask, path type, metric, forwarding address and external route tag as the Type-7 LSA. The advertising router field should be set to the RUT's router-id. The link-state ID should be the same as the LSA's network address.
- In Part B, the RUT should not translate TR2's Type-7 LSA and the RUT should translate the address range.
- In Part C, the RUT should translate TR2's Type-7 LSA and originate an equivalent Type-5 LSA on network 0.
- In Part D, the RUT should translate TR2's Type-7 LSA and originate an equivalent Type-5 LSA on network 0.
- In Part E, the RUT should not translate TR2's Type-7 LSA. It should only transmit it's own, locally sourced, Type-5 LSA to network 0.
- In Part F, after the RUT has flushed its LSA and the cost has changed in TR2's external LSA, the RUT should translate TR2's updated Type-7 LSA into an equivalent Type-5 LSA.
- In Part G, the RUT should translate TR2's updated Type-7 LSA into an equivalent Type-5 LSA.

Possible Problems: None.

Test OSPF_NSSA.1.12: Type-7 Address Range Translation

Purpose: To verify that a router properly translates a Type-7 address range into a single Type-5 LSA.

References: [3101] Section 3.2 (3)

Last Modification: January 8, 2004

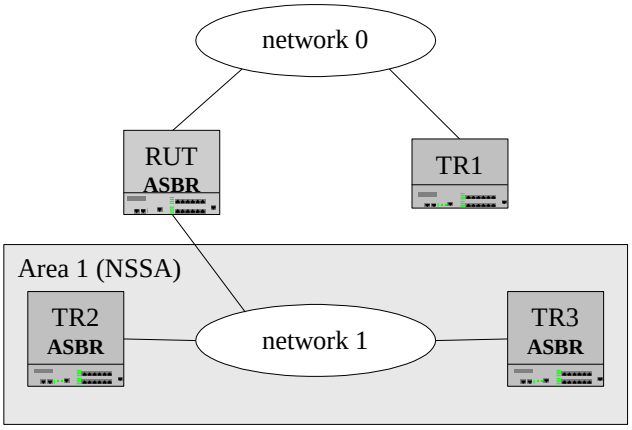
Discussion: The path type and metric of the Type-7 address range is determined from the path types and metrics of those translatable Type-7 LSAs that best match the range plus any locally sourced Type-5 LSAs whose network has the same [address,mask] pair. If any of these LSAs have a path type of 2, the range's path type is 2, otherwise it is 1. If the range's path type is 1 its metric is the highest cost amongst these LSAs; if the range's path type is 2 its metric is the highest Type-2 cost + 1 amongst these LSAs. 1 is added to the Type-2 cost to ensure that the translated Type-5 LSA does not appear closer on the NSSA border than a translatable Type-7 LSA whose network has the same [address,mask] pair and Type-2 cost.

A Type-5 LSA is generated from the Type-7 address range when there is currently no Type-5 LSA originated by this router whose network has the same [address,mask] pair as the range or there is but either its path type or metric has changed or its forwarding address is non-zero.

The newly generated Type-5 LSA will have a link-state ID equal to the Type-7 address range's address (in the case of multiple originations of Type-5 LSAs with the same network address but different mask, the link-state ID can also have one or more of the range's "host" bits set). The advertising router field will be the router ID of this area border router. The network mask and the external route tag are set to the range's configured values. The forwarding address is set to 0.0.0.0. The path type and metric are set to the range's path type and metric as defined and computed above.

Test Setup: Configure the routers as shown below. If a network is not assigned to a particular area, the default area of 0.0.0.0 is used. The RUT, TR2 and TR3 are ASBRs advertising AS external LSAs as follows:

- TR3 2.2.10.0/24 Next hop on net 1, path type 2, metric 1
- TR2 2.2.11.0/24 Next hop on net 1, path type 2, metric 3
- RUT 2.2.12.0/24 Next hop on net 1, path type 1, metric 5



Procedure:

Part A: Address Range with Path type 2

1. Configure an address range on the RUT for all the networks advertised by the RUT and its neighbors.
2. Start OSPF on all the routers.
3. Observe the packets transmitted on network 0.

Part B: Path type 2 metric change

4. TR2's LSA path type is set to 1 and its metric is set to 3.
5. Observe the packets transmitted on network 0.

Part C: Address Range with Path type 1

6. TR3's LSA path type is set to 1 and its metric is set to 1.
7. Observe the packets transmitted on network 0.

Observable Results:

- In Part A, the RUT should transmit a Type-5 LSA to network 0 for the Type-7 address range. The link state ID should equal that of the Type-7 address range. The advertising router field should be set to the RUT's router-id. The netmask and external route tags should be set to the range's values and the forwarding address should be set to 0.0.0.0. The path type should be 2 with a metric of 4.
- In Part B, after TR2 updates its router-LSA, the RUT should retransmit the Type-5 LSA to network 0 with an updated metric of 2. All the other values should remain the same.
- In Part C, after TR3 updates its router LSA, the RUT should retransmit the type-5 LSA to network 0 with an updated path type of 1 and metric of 5. All other values should remain the same.

Possible Problems: None.