

IPv6 CONSORTIUM TEST SUITE

Open Shortest Path First version 3 (OSPFv3)
Multi-System Interoperability Test Suite

Technical Document

Version 1.6



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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 functionality of their OSPFv3 based products. This test suite has been designed to test the interoperability of the device under test with other OSPFv3 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.

The tests do not determine if a product conforms to the OSPFv3 standards but they are designed as interoperability tests. These tests provide one method to isolate problems within the OSPFv3 capable device that will affect the interoperability performance. Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other OSPFv3 capable devices. However, these tests do provide a reasonable level of confidence that the RUT will function well in many OSPFv3 capable environments.

Abbreviations and Acronyms

ASBR: **AS** Boundary **R**outer
ABR: Area **B**order **R**outer
BDR: **B**ackup **D**esignated **R**outer
DD: **D**atabase **D**escription
DR: **D**esignated **R**outer
G: **G**enerator / Traffic Analyzer
LSA: **L**ink **S**tate **A**dvertisement
M: **M**onitor or packet capturer
MTU: **M**aximum **T**ransmission **U**nit
NBMA: **N**on-**B**roadcast **M**ulti-**A**ccess
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 the first line of the test block. The Test Label is composed of the short test suite name, the group number, and the test number within the group, separated by periods. So, test label OSPFv3_Interop.1.2 refers to the second test of the first test group in the OSPFv3 Interoperability Test Suite.
- Purpose:** The Purpose is a short statement describing what the test attempts to achieve. It is usually phrased as a simple assertion of the feature or capability to be tested.
- References:** The References section lists cross-references to the specifications and 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.
- Discussion:** The Discussion 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.
- Procedure:** This section of the test description contains the step-by-step instructions for carrying out the test. These steps include such things as enabling interfaces, unplugging devices from the network, or sending packets from a test station. The test procedure also cues the tester to make observations, which are interpreted in accordance with the observable results given for that test part.
- Observable Results:** This 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:** This 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 2328 – OSPF, Version 2. Moy, J., Ascend Communications, Inc. April, 1998.
- Request for Comments 2740 – OSPF for IPv6. Coltun, R., Siara Systems; Ferguson, D., Juniper Networks; Moy, J., Sycamore Networks. December, 1999.

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Group 1: Link Scope

Scope

The following tests cover interoperability amongst OSPFv3 capable routers connected to the same link.

Overview

These tests are designed to verify that the RUT correctly participates in the OSPFv3 Hello Protocol, DR and BDR election, and the failure of either the DR or BDR.

Test OSPFv3_Interop.1.1: Hello Protocol, DR Election

Purpose: To verify that the RUT correctly participates in the Hello Protocol DR election process.

References: [OSPF 2328] Sections 7.3, 9.4, 9.5, and 9.5.1
[OSPF 2740] Sections 3.2.1.1, 3.2.2.1, and A.3.2

Resource Requirements: RUT and an analyzer

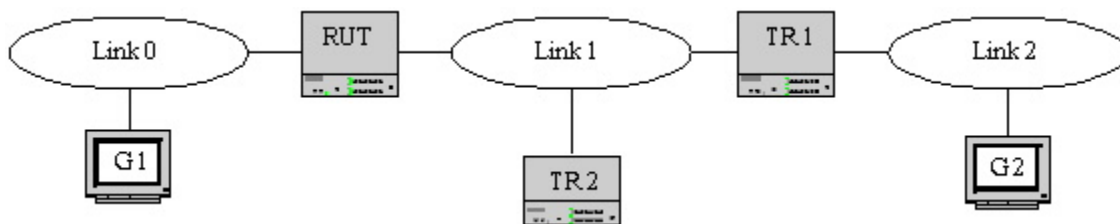
Discussion: The Hello Protocol is essential to the election of the Designated Router for a given link. A router's Hello Packet contains its Router Priority, which is configurable on a per-interface basis. When a router's interface first becomes functional, it checks to see whether there is currently a Designated Router for the network. If there is, it accepts that Designated Router, regardless of its Router Priority.

If the router is eligible to become Designated Router, it must periodically send Hello Packets to all neighbors that are also eligible. In addition, if the router is itself the Designated Router or Backup Designated Router, it must also send periodic Hello Packets to all other neighbors.

The choice of Designated Router and Backup Designated Router are now indicated within Hellos by their Router Ids, instead of by their interface addresses. Advertising the Designated Router (or Backup Designated Router) as 0.0.0.0 indicates that the Designated Router (or Backup Designated Router) has not yet been chosen.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup: Configure the routers as shown below. Each router should be configured with the same Area ID, a HelloInterval of 10, and a RouterDeadInterval of 40. If a link is not assigned to a particular area in the setup, the default area of 0.0.0.0 is used. Each link has a separate, unique prefix associated with it.



Procedure:

Part A: Synchronizing of databases, RUT as DR

1. Enable OSPFv3 on the RUT. Wait at least RouterDeadInterval.
2. Enable OSPFv3 on TR1. Let it synchronize with the RUT.
3. Enable OSPFv3 on TR2.
4. Transmit traffic from G1 to G2.
5. Observe the traffic transmitted on all links.

Part B: Synchronizing of databases, RUT as BDR

6. Disable OSPFv3 on all routers.

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7. Enable OSPFv3 on TR1. Wait at least RouterDeadInterval.
8. Enable OSPFv3 on the RUT. Let it synchronize with TR1.
9. Enable OSPFv3 on TR2.
10. Transmit traffic from G1 to G2.
11. Observe the traffic transmitted on all links.

Part C: Synchronizing of databases, RUT as DR Other

12. Disable OSPFv3 on all routers.
13. Enable OSPFv3 on TR1. Wait at least RouterDeadInterval.
14. Enable OSPFv3 on TR2. Let it synchronize with TR1.
15. Enable OSPFv3 on the RUT.
16. Transmit traffic from G1 to G2.
17. Observe the traffic transmitted on all links.

Observable Results:

- In Part A, the RUT, TR1, and TR2 should become neighbors and synchronize their databases. The E bit should be set in all the Hello packets. The RUT should be elected the DR for Link 1, and TR1 should be elected BDR. Traffic should be transmitted from G1 to G2 through all links.
- In Part B, the RUT, TR1, and TR2 should become neighbors and synchronize their databases. The E bit should be set in all the Hello packets. TR1 should be elected the DR for Link 1, and the RUT should be elected BDR. Traffic should be transmitted from G1 to G2 through all links.
- In Part C, the RUT, TR1, and TR2 should become neighbors and synchronize their databases. The E bit should be set in all the Hello packets. TR1 should be elected the DR for Link 1, and TR2 should be elected BDR. The RUT should assume the role of DR Other. Traffic should be transmitted from G1 to G2 through all links.

Possible Problems: None.

Test OSPFv3_Interop.1.2: Hello Protocol, Hello Packet Mismatch

Purpose: To verify that the RUT correctly participates in the Hello Protocol and that any mismatch between the Hello packets causes the packets to be dropped.

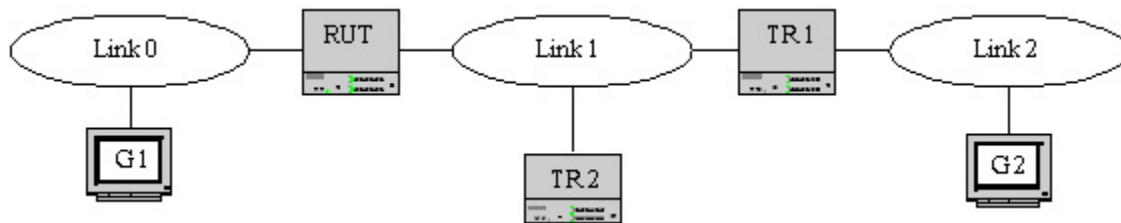
References: [OSPF 2328] Sections 10.5
[OSPF 2740] Sections 3.2.1.1, 3.2.2.1, and A.3.2

Resource Requirements: RUT and an analyzer

Discussion: On a multi-access link, the Area ID, HelloInterval, and RouterDeadInterval defined in an incoming Hello packet should match the configuration of the receiving interface. Otherwise, the Hello packet should be dropped and the sender should not be accepted as a neighbor.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup: Configure the routers as shown below. Each router should be configured with the same Area ID, a HelloInterval of 10, and a RouterDeadInterval of 40. If a link is not assigned to a particular area in the setup, the default area of 0.0.0.0 is used. Each link has a separate, unique prefix associated with it.



Procedure:

Part A: Hello Mismatch, Different HelloInterval

1. Disable OSPFv3 on all routers.
2. Configure the RUT, TR1, and TR2 to have the same Area ID and RouterDeadInterval values.
3. Configure the RUT to have a different HelloInterval than TR1 and TR2.
4. Enable OSPFv3 on the RUT, TR1, and TR2.
5. Transmit traffic from G1 to G2.
6. Observe the traffic transmitted on all links.

Part B: Hello Mismatch, Different RouterDeadInterval

7. Disable OSPFv3 on all routers.
8. Configure the RUT, TR1, and TR2 to have the same Area ID and Hello Interval values.
9. Configure the RUT to have a different RouterDeadInterval than TR1 and TR2.
10. Enable OSPFv3 on the RUT, TR1, and TR2.
11. Transmit traffic from G1 to G2.
12. Observe the traffic transmitted on all links.

Part C: Hello Mismatch, Different Area ID

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13. Disable OSPFv3 on all routers.
14. Configure the RUT, TR1, and TR2 to have the same RouterDeadInterval and Hello Interval values.
15. Configure the RUT to have a different Area ID than TR1 and TR2.
16. Enable OSPFv3 on the RUT, TR1, and TR2.
17. Transmit traffic from G1 to G2.
18. Observe the traffic transmitted on all links.

Observable Results:

- In Parts A, B, and C, the RUT should not become neighbors with TR1 and TR2, nor should the RUT synchronize its database with TR1 and TR2. Traffic should not be transmitted from G1 to G2 through Link 1.

Possible Problems: None.

Test OSPFv3_Interop.1.3: DR Failure, BDR Failure

Purpose: To verify that the RUT can recover the failure of the DR or BDR on a given network and assume a newly elected identity.

References: [OSPF 2328] Sections 7.4, 9.4, 9.5, and 10.5

Resource Requirements: RUT and an analyzer

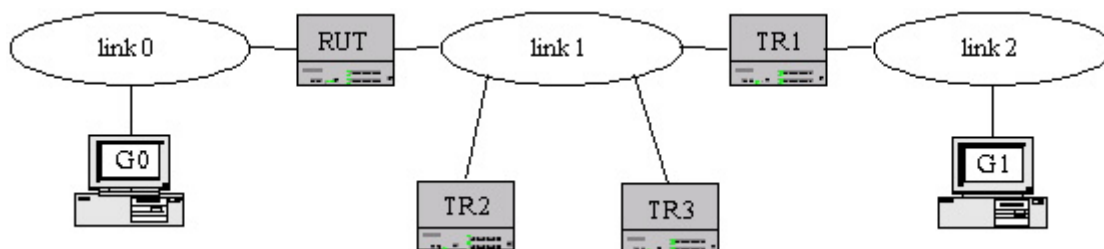
Discussion: In order to make the transition to a new Designated Router smoother, there is a Backup Designated Router for each multi-access link. When the Designated Router fails, the BDR is promoted to DR, and a new BDR is elected (if there are any eligible routers). Similar to the Designated Router, the Backup Designated Router is adjacent to all routers on the link. Therefore, when it promotes itself to DR, it does not need to go through the database description process again with any of the routers on the link. The Backup Designated Router is also adjacent to all routers on the network, and becomes Designated Router when the previous Designated Router fails. If there were no Backup Designated Router, when a new Designated Router became necessary, new adjacencies would have to be formed between the new Designated Router and all other routers attached to the network.

Calculate the new Backup Designated Router as follows. Only routers on the list that have not declared themselves DR are eligible to become BDR.. If one or more of these routers have declared themselves to be BDR, the one having the highest Priority is declared BDR. If there is a tie, the one with the highest Router ID is declared BDR. If no routers have declared themselves to be BDR (excluding those routers who have declared themselves DR), choose the router having the highest Router Priority and use Router ID to break ties.

Calculate the new DR as follows. If one or more routers have declared themselves DR, the one having the highest Priority is declared DR. In case of a tie, the one with the highest Router ID is chosen. If no routers have declared themselves DR, assign the DR to be the same as the newly elected BDR.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup: Configure the routers as shown below. Configure the RUT, TR1 and TR2 to have HelloInterval 10 and RouterDeadInterval 40. If a link is not assigned to a particular area in the setup, the default area of 0.0.0.0 is used.



Procedure:

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Part A: DR fails, RUT as BDR

1. Enable OSPFv3 on TR1. Wait at least RouterDeadInterval.
2. Enable OSPFv3 on the RUT.
3. Enable OSPFv3 on TR2.
4. Disable OSPFv3 on TR1. Wait at least RouterDeadInterval.
5. Restart OSPFv3 on TR1.
6. Transmit traffic from G1 to G2.
7. Observe the traffic transmitted on all links.

Part B: DR fails, RUT as DR Other

8. Stop OSPFv3 on all routers.
9. Enable OSPFv3 on TR1. Wait at least RouterDeadInterval.
10. Enable OSPFv3 on TR2.
11. Enable OSPFv3 on the RUT.
12. Disable OSPFv3 on TR1. Wait at least RouterDeadInterval.
13. Restart OSPFv3 on TR1.
14. Transmit traffic from G1 to G2.
15. Observe the traffic transmitted on all links.

Part C: BDR fails, RUT as DR

16. Disable OSPFv3 on all routers.
17. Enable OSPFv3 on the RUT. Wait at least RouterDeadInterval.
18. Enable OSPFv3 on TR1.
19. Enable OSPFv3 on TR2.
20. Disable OSPFv3 on TR1. Wait at least RouterDeadInterval.
21. Restart OSPFv3 on TR1.
22. Transmit traffic from G1 to G2.
23. Observe the traffic transmitted on all links.

Part D: BDR fails, RUT as DR Other – Higher Priority

24. Disable OSPFv3 on all routers.
25. Enable OSPFv3 on TR1. Wait at least RouterDeadInterval.
26. Enable OSPFv3 on TR2.
27. Enable OSPFv3 on the RUT with a priority of 2.
28. Enable OSPFv3 on TR3 with a priority of 1.
29. Disable OSPFv3 on TR2. Wait at least RouterDeadInterval.
30. Restart OSPFv3 on TR2.
31. Transmit traffic from G1 to G2.
32. Observe the traffic transmitted on all links.

Part E: BDR fails, RUT as DR Other – Lower Priority

33. Disable OSPFv3 on all routers.
34. Enable OSPFv3 on TR1. Wait at least RouterDeadInterval.
35. Enable OSPFv3 on TR2.
36. Enable OSPFv3 on the RUT with a priority of 1.
37. Enable OSPFv3 on TR3 with a priority of 2.
38. Disable OSPFv3 on TR2. Wait at least RouterDeadInterval.
39. Restart OSPFv3 on TR2.
40. Transmit traffic from G1 to G2.
41. Observe the traffic transmitted on all links.

Part F: BDR fails, RUT as DR Other – Higher Router ID

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42. Disable OSPFv3 on all routers.
43. Enable OSPFv3 on TR1. Wait at least RouterDeadInterval.
44. Enable OSPFv3 on TR2.
45. Enable OSPFv3 on the RUT with a priority of 1.
46. Enable OSPFv3 on TR3 with a priority of 1. TR3's Router ID is lower than the RUT's.
47. Disable OSPFv3 on TR2. Wait at least RouterDeadInterval.
48. Restart OSPFv3 on TR2.
49. Transmit traffic from G1 to G2.

Part G: BDR fails, RUT as DR Other – Lower Router ID

50. Disable OSPFv3 on all routers.
51. Enable OSPFv3 on TR1. Wait at least RouterDeadInterval.
52. Enable OSPFv3 on TR2.
53. Enable OSPFv3 on the RUT with a priority of 1.
54. Enable OSPFv3 on TR3 with a priority of 1. TR3's Router ID is higher than the RUT's.
55. Disable OSPFv3 on TR2. Wait at least RouterDeadInterval.
56. Restart OSPFv3 on TR2.
57. Transmit traffic from G1 to G2.

Observable Results:

- In Part A, initially, TR1 should be elected the DR for Link 1, and the RUT should be elected BDR. When OSPFv3 is disabled on TR1, the RUT should wait at least 40 seconds before claiming to be the new DR for Link 1. RUT, TR2, and TR1 should be DR, BDR, and DR Other respectively. The RUT and TR1 should synchronize their databases. Traffic should be transmitted from G1 to G2 through all links.
- In Part B, initially, TR1 should be elected the DR for Link 1, and TR2 should be elected BDR. When OSPFv3 is disabled on TR1, the RUT should wait at least 40 seconds before claiming to be the new BDR for Link 1. TR2, the RUT, and TR1 should be DR, BDR, and DR Other respectively. The RUT and TR1 should synchronize their databases. Traffic should be transmitted from G1 to G2 through all links.
- In Part C, the RUT should be elected the DR for Link 1, and initially, TR1 should be elected BDR. When OSPFv3 is disabled on TR1, TR2 should wait at least 40 seconds before claiming to be the new BDR for Link 1. The RUT, TR2, and TR1 should be DR, BDR, and DR Other respectively. The RUT and TR1 should synchronize their databases. Traffic should be transmitted from G1 to G2 through all links.
- In Part D, initially, TR1 should be elected the DR for Link 1, and TR2 should be elected BDR. When OSPFv3 is disabled on TR2, the RUT should wait at least 40 seconds before claiming to be the new BDR for Link 1. TR1, the RUT, TR2, and TR3 should be DR, BDR, DR Other and DR Other respectively. The RUT, TR2, and TR3 should synchronize their databases. Traffic should be transmitted from G1 to G2 through all links.
- In Part E, initially, TR1 should be elected the DR for Link 1, and TR2 should be elected BDR. When OSPFv3 is disabled on TR2, the TR3 should wait at least 40 seconds before claiming to be the new BDR for Link 1. TR1, TR3, TR2, and the RUT should be DR, BDR, DR Other and DR Other respectively. The RUT and TR3 should synchronize their databases. Traffic should be transmitted from G1 to G2 through all links.
- In Part F, initially, TR1 should be elected the DR for Link 1, and TR2 should be elected BDR. When OSPFv3 is disabled on TR2, the RUT should wait at least 40 seconds before claiming to be the new BDR for Link 1. TR1, the RUT, TR2, and TR3 should be DR, BDR, DR Other and DR

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Other respectively. The RUT, TR2, and TR3 should synchronize their databases. Traffic should be transmitted from G1 to G2 through all links.

- In Part G, initially, TR1 should be elected the DR for Link 1, and TR2 should be elected BDR. When OSPFv3 is disabled on TR2, the TR3 should wait at least 40 seconds before claiming to be the new BDR for Link 1. TR1, TR3, TR2, and the RUT should be DR, BDR, DR Other and DR Other respectively. The RUT and TR3 should synchronize their databases. Traffic should be transmitted from G1 to G2 through all links.

Possible Problems: None.

Group 2: Area Scope

Scope

The following tests cover interoperability amongst OSPFv3 capable routers connected to the same area.

Overview

These tests are designed to verify that the RUT makes correct forwarding decisions and propagates all necessary routing information within an area.

Test OSPFv3_Interop.2.1: Intra-area Route Verification

Purpose: To verify that the RUT makes the correct routing decisions within an area.

References: [OSPF 2328] Section 3
[OSPF 2740] Section 2.3

Resource Requirements: RUT and an analyzer

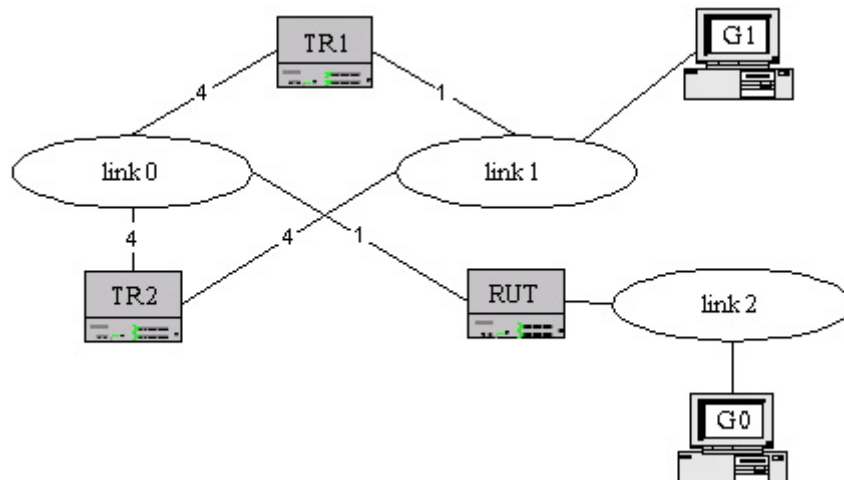
Discussion: RFC 2740 added the notion of flooding scope to OSPF for IPv6. The area scope is used for Router-LSAs, Network-LSAs, Inter-Area-Prefix-LSAs, Inter-Area-Router-LSAs, and Intra-Area-Prefix-LSAs. Using these LSAs, in addition to the Link-LSA, a router should be able to make all necessary routing decisions for destinations within an area.

As areas are introduced, it is no longer true that all routers in the AS have an identical link-state database. A router actually has a separate link-state database for each area it is connected to. Two routers belonging to the same area have, for that area, they have identical area link-state databases.

Routing in the Autonomous System takes place on two levels, depending on whether the source and destination of a packet reside in the same area (intra-area routing is used) or different areas (inter-area routing is used). In intra-area routing, the packet is routed solely on information obtained within the area; no routing information obtained from outside the area can be used. This protects intra-area routing from the injection of bad routing information.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup: Configure the routers as shown below. TR1 should have the highest Router ID. The RUT should be the only router sending Router Advertisements. If a link is not assigned to a particular area in the setup, the default area of 0.0.0.0 is used.



Procedure:

Part A: One Intermediate Hop

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1. Enable OSPFv3 on all routers.
2. Execute traceroute from G0 to G1.

Part B: One Intermediate Hop, Alternate Route

3. Configure the metric for the TR1's interface to Link 1 to 4.
4. Configure the metric for the TR2's interface to Link 1 to 1.
5. Allow time for new topology information to be propagated.
6. Execute traceroute from G0 to G1.

Observable Results:

- In Part A, the RUT should use TR1 as a first hop to Link 1. TR1 should forward the traffic directly to Link 1.
- In Part B, the RUT should use TR2 as a first hop for the traffic destined for Link 1. TR2 should forward the traffic directly to Link 1.

Possible Problems: None.

Group 3: Autonomous System Scope

Scope

The following tests cover interoperability amongst OSPFv3 capable routers connected to the same AS, but not necessarily the same area.

Overview

These tests are designed to verify that the RUT makes correct forwarding decisions and propagates all necessary routing information within an AS with multiple areas.

Test OSPFv3_Interop.3.1: Intra-area Route Preference

Purpose: To verify that the RUT makes the correct routing decisions when both intra-area and inter-area routes are available.

References: [OSPF 2328] Sections and 3.2 16.2 (6)
[OSPF 2740] Section 2.3

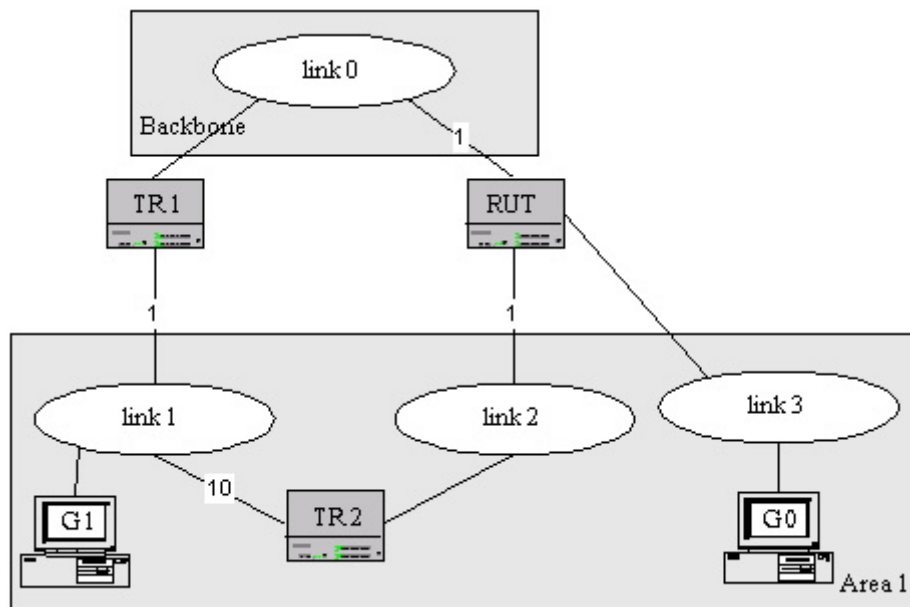
Resource Requirements: RUT and an analyzer

Discussion: RFC 2740 added the notion of flooding scope to OSPF for IPv6. The AS scope is used for AS-external-LSAs. These, along with Router-LSAs, Network-LSAs, Inter-Area-Prefix-LSAs, Inter-Area-Router-LSAs, Intra-Area-Prefix-LSAs, and Link-LSAs, a router should be able to make all necessary routing decisions for destinations within an Autonomous System.

When choosing a path to a destination, intra-area paths are always preferred to inter-area paths.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup: Configure the routers as shown below. All router belong to the same Autonomous System. The RUT should be the only router configured to transmit Router Advertisements. TR1 should have the highest Router ID. If a link is not assigned to a particular area in the setup, the default area of 0.0.0.0 is used.



Procedure:

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1. Enable OSPFv3 on all the routers.
2. Execute traceroute from G0 to G1.

Observable Results:

- The RUT should choose the intra-area path with TR2's interface to Link 2 as a first hop to G1 on Link 1. Link 0 should not observe the traffic destined for G1.

Possible Problems: None.

Test OSPFv3_Interop.3.2: Inter-Area Routes through Transit Areas

Purpose: To verify that the RUT makes the correct routing decisions within an Autonomous System across transit areas.

References: [OSPF 2328] Sections 3.2, 16.2 and 16.3
[OSPF 2740] Sections 2.3 and 3.8.3

Resource Requirements: RUT and an analyzer

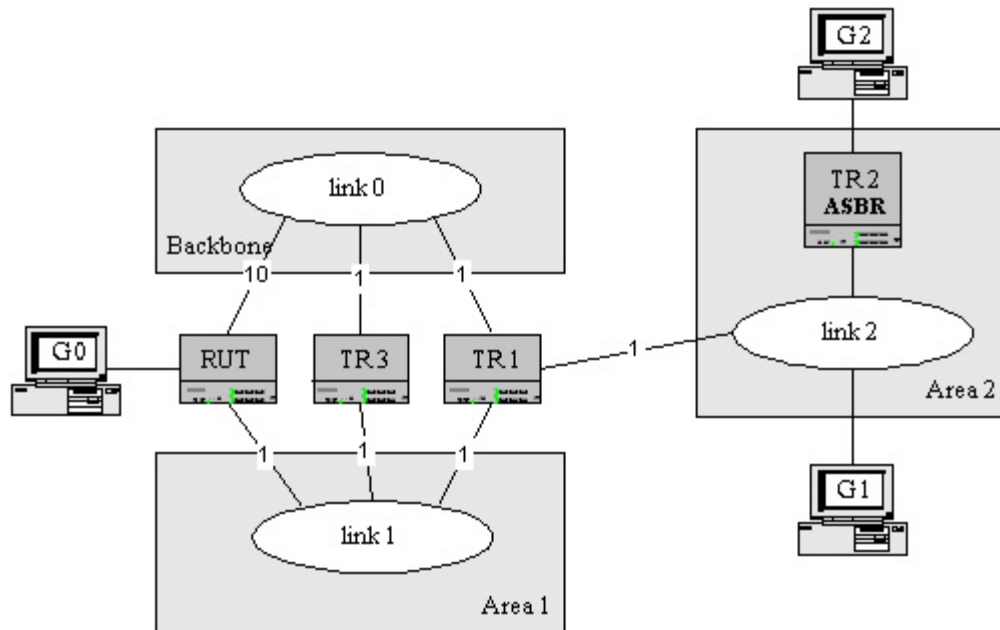
Discussion: RFC 2740 added the notion of flooding scope to OSPF for IPv6. The AS scope is used for AS-external-LSAs. These, along with Router-LSAs, Network-LSAs, Inter-Area-Prefix-LSAs, Inter-Area-Router-LSAs, Intra-Area-Prefix-LSAs, and Link-LSAs, a router should be able to make all necessary routing decisions for destinations within an Autonomous System.

An OSPF router calculates inter-area routes by examining inter-area-prefix-LSAs or inter-area-router-LSAs. Routers attached to a single area examine that area's inter-area-prefix-LSAs and inter-area-router-LSAs. If the router is an ABR, only backbone inter-area-prefix-LSAs or inter-area-router-LSAs are examined (or transit areas, as described below). To calculate the cost of an inter-area path to a destination N, a router combines the cost advertised in the corresponding inter-area-prefix-LSA or inter-area-router-LSA with the cost of the best intra-area route to the advertising ABR. If multiple ABRs are advertising routes to the same destination, the router should use the path with the lowest total cost (intra-area cost to the ABR plus advertised cost).

If an ABR is attached to a transit area (an area with one or more virtual links in it), the router should also examine the inter-area-prefix-LSAs and inter-area-router-LSAs from that area for routing inter-area traffic in addition to the inter-area-prefix-LSAs and inter-area-router-LSAs in the backbone. Therefore, transit areas are the only non-backbone areas that may carry data traffic that neither originates nor terminates in the area itself. Transit area inter-area-prefix-LSAs and inter-area-router-LSAs are examined after the best inter-area route through the backbone is chosen. If any of the transit area inter-area-prefix-LSAs or inter-area-router-LSAs provide better routes to a network than a backbone route, the transit area path is used. If the router does not already have a route to the network described by the transit area inter-area-prefix-LSA or inter-area-router-LSA it should not install a route. In other words, a transit area inter-area-prefix-LSA or inter-area-router-LSA may only be used if the network is reachable through the backbone as well.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup: Configure the routers as shown below. All router belong to the same Autonomous System. The RUT should be the only router configured to transmit Router Advertisements. TR1 should have the highest Router ID. If a link is not assigned to a particular area in the setup, the default area of 0.0.0.0 is used.



Procedure:

Part A: No Virtual Link

1. Enable OSPFv3 on all routers.
2. Execute traceroute from G0 to G1.

Part B: Inter-Area Transit Area path to Network

3. A virtual link is configured between the RUT and TR1 in area 1.
4. Enable OSPFv3 on all routers.
5. Execute traceroute from G0 to G1.

Part C: Inter-Area Transit Area path to ASBR

6. Enable OSPFv3 on all routers.
7. Configure TR2 to send Router Advertisements on its interface to G2 for prefix 5005::/64.
8. Configure TR2 to be an ASBR advertising an external route to prefix 5005::/64 (without the forwarding address set).
9. Execute traceroute from G0 to G2.

Part D: No Backbone path to network

10. Enable OSPFv3 on all routers except for TR3.
11. Configure TR2 to send Router Advertisements on its interface to G2 for prefix 5005::/64.
12. Configure TR2 to be an ASBR advertising an external route to prefix 5005::/64 (without the forwarding address set).
13. Disable RUT's connection to link 0.
14. Execute traceroute from G0 to G1.

Part E: No Backbone path to ASBR

15. Keep the same configurations from Part D.
16. Execute traceroute from G0 to G2.

Observable Results:

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- In Part A, the RUT should use TR1's interface on link 0 as a first hop to G1 on link 2. TR1 should forward traffic directly to link 2.
- In Part B, the RUT should use TR1's interface on link 1 as a first hop to G1 on link 2. TR1 should forward the traffic directly to Link 2.
- In Part C, the RUT should use TR1's interface on link 1 as a first hop to TR2 on link 2. TR2 should forward the traffic to G2 on the link external to the AS.
- In Parts D and E, the traceroute procedure should not be successful as the RUT should have no route to link 2 or the ASBR TR2.

Possible Problems: None.

Test OSPFv3_Interop.3.3: Intra-AS Paths to ASBR

Purpose: To verify that the RUT makes the correct routing decisions within an Autonomous System across multiple areas.

References: [OSPF 2328] Sections 16.4.1 and 16.4 (3)
[OSPF 2740] Sections 2.3 and 3.8.4

Resource Requirements: RUT and an analyzer

Discussion: RFC 2740 added the notion of flooding scope to OSPF for IPv6. The AS scope is used for AS-external-LSAs. These, along with Router-LSAs, Network-LSAs, Inter-Area-Prefix-LSAs, Inter-Area-Router-LSAs, Intra-Area-Prefix-LSAs, and Link-LSAs, a router should be able to make all necessary routing decisions for destinations within an Autonomous System.

When calculating an AS External route, the AS-External-LSA is examined. If no forwarding address is set, packets should be sent to the ASBR itself. Select the routing table entry to the ASBR with the least cost. When there are multiple least cost entries, the entry associated with the largest Area ID is chosen.

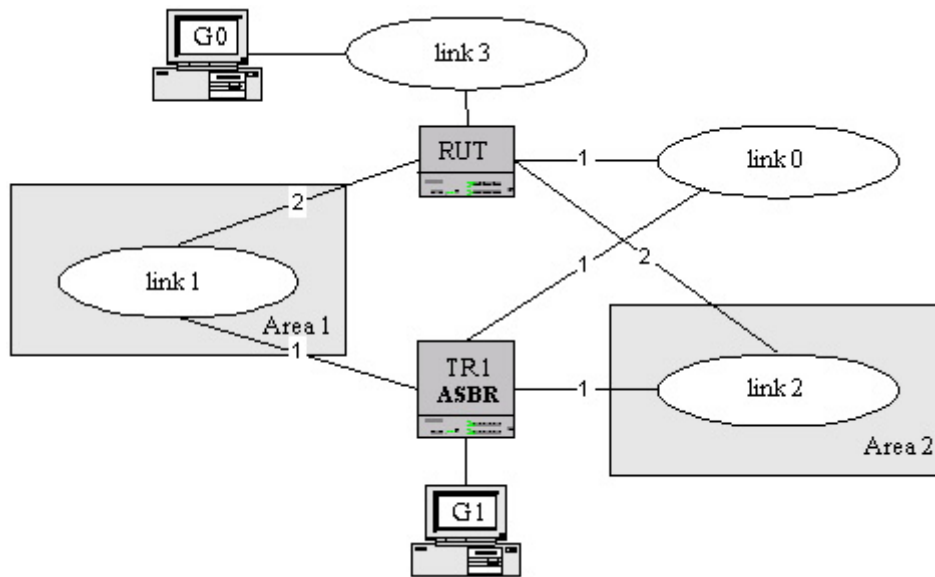
Instead of comparing the AS-external-LSA's Forwarding address field to 0.0.0.0 to see whether a forwarding address has been used, bit F of the external-LSA is examined. A forwarding address is in use if and only if bit F is set.

External Path Preferences:

- Intra-area paths using non-backbone areas are always the most preferred.
- The other paths, intra-area backbone paths and inter-area paths, are of equal preference.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup: Configure the routers as shown below. All router belong to the same Autonomous System. The RUT should be the only router configured to transmit Router Advertisements. TR1 should have the highest Router ID. If a link is not assigned to a particular area in the setup, the default area of 0.0.0.0 is used.



Procedure:

1. Enable OSPFv3 on all the routers.
2. Configure TR1 to send Router Advertisements on its interface to G1 for prefix 5005::/64.
3. Configure TR1 to be an ASBR advertising an external route to prefix 5005::/64 (without the forwarding address set).
4. Execute traceroute from G0 to G1.

Observable Results:

- The RUT should use TR1's interface to link 2 (through area 2) as a first hop to G1. No link other than Link 2 and Link 3 should observe the traffic destined for G1.

Possible Problems: None.

Group 4: Inter-Autonomous System Scope

Scope

The following tests cover interoperability amongst OSPFv3 capable routers connected to different Autonomous Systems.

Overview

These tests are designed to verify that the RUT is able to route between Autonomous Systems running different routing protocols and makes correct forwarding decisions by choosing the appropriate ASBR.

Test OSPFv3_Interop.4.1: Type 1 and Type 2 Metrics

Purpose: To verify that the RUT chooses paths correctly based on type 1 and type 2 metrics.

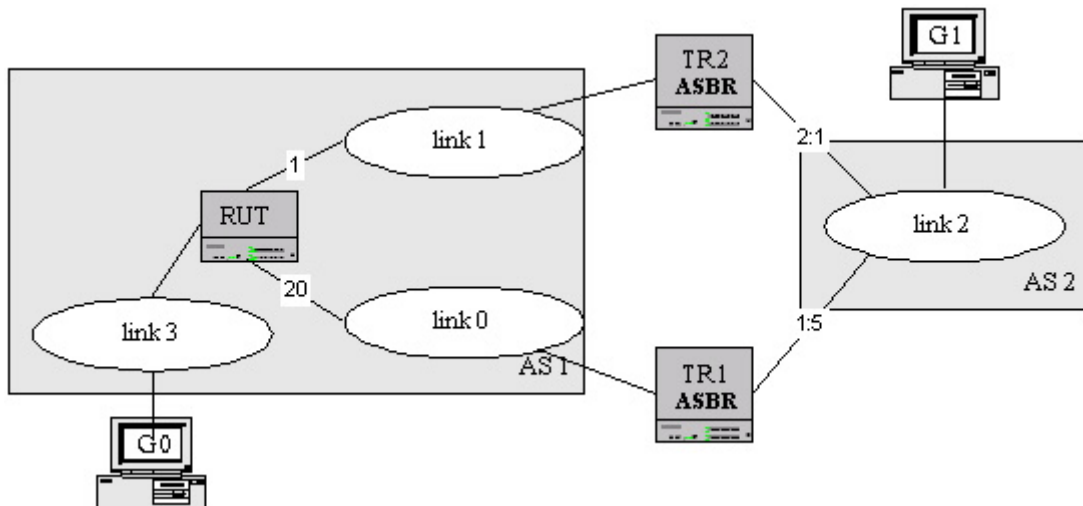
References: [OSPF 2328] Sections 16.4 (6b)

Resource Requirements: RUT and an analyzer

Discussion: AS-external-LSAs can be advertised with either type 1 or type 2 metrics. Type 1 metrics are comparable to the link state metric, while type 2 metrics are assumed to be larger than the cost of any intra-AS path. When multiple ASBRs are originating AS-external-LSAs to the same destination, a router should always prefer those using type 1 metrics to those using type 2 metrics. If multiple ASBRs are advertising type 2 metrics, the ASBR advertising the lowest type 2 metric is always chosen.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup: If a link is not assigned to a particular area in the setup, the default area of 0.0.0.0 is used. Configure TR2 and TR1 to both be ASBRs, and to advertise the same external prefix for link 2.



Procedure:

Part A: Type 1 and Type 2 Metrics

1. Enable OSPFv3 on all routers.
2. Execute traceroute from G0 to G1.
3. Observe the traffic transmitted on all links.

Part B: Type 2 Metrics

4. Enable OSPFv3 on all routers.
5. Change TR1's metric to link 2 to be type 2 with a cost of 2.
6. Change the RUT metric to link 0 to have a cost of 1, and its metric to link 1 to have a cost of 20.

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7. Execute traceroute from G0 to G1
8. Observe the traffic transmitted on all links.

Observable Results:

- In Part A, the RUT should use TR1 as a first hop to G1.
- In Part B, the RUT should use TR2 as a first hop to G1.

Possible Problems: None.