

## IPv6 Test Service

### OSPFv3 Interoperability Test Plan

Version 2.1



---

University of New Hampshire  
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IPv6 Test Service  
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## References

|                     |  |
|---------------------|--|
| [OSPFv2]            | RFC2328 OSPF Version 2. J. Moy. April 1998. (Format: TXT, HTML) (Obsoletes RFC2178) (Updated by RFC5709, RFC6549, RFC6845, RFC6860, RFC7474, RFC8042) (Also STD0054) (Status: INTERNET STANDARD) (DOI: 10.17487/RFC2328)             |
| [OSPF IPv6]         | RFC5340 OSPF for IPv6. R. Coltun, D. Ferguson, J. Moy, A. Lindem. July 2008. (Format: TXT, HTML) (Obsoletes RFC2740) (Updated by RFC6845, RFC6860, RFC7503, RFC8362) (Status: PROPOSED STANDARD) (DOI: 10.17487/RFC5340)             |
| [OSPF LLS]          | RFC5613 OSPF Link-Local Signaling. A. Zinin, A. Roy, L. Nguyen, B. Friedman, D. Yeung. August 2009. (Format: TXT, HTML) (Obsoletes RFC4813) (Status: PROPOSED STANDARD) (DOI: 10.17487/RFC5613)                                      |
| [NIST IPv6 Profile] | "NIST IPv6 Profile", NIST Special Publication (NIST SP) - 500-267Ar1, November 2020. <a href="https://doi.org/10.6028/NIST.SP.500-267Ar1">https://doi.org/10.6028/NIST.SP.500-267Ar1</a>   |
| [USGv6-R1]          | "USGv6 Profile", NIST Special Publication (NIST SP) - 500-267Br1, November 2020. <a href="https://doi.org/10.6028/NIST.SP.500-267Br1">https://doi.org/10.6028/NIST.SP.500-267Br1</a>   |
| [OSPF IPsec]        | RFC4552 Authentication/Confidentiality for OSPFv3. M. Gupta, N. Melam. June 2006. (Format: TXT, HTML) (Status: PROPOSED STANDARD) (DOI: 10.17487/RFC4552)  |
| [OSPF Auth]         | RFC7166 Supporting Authentication Trailer for OSPFv3. M. Bhatia, V. Manral, A. Lindem. March 2014. (Format: TXT, HTML) (Obsoletes RFC6506) (Status: PROPOSED STANDARD) (DOI: 10.17487/RFC7166)                                       |
| [IPsec]             | RFC4301 Security Architecture for the Internet Protocol. S. Kent, K. Seo. December 2005. (Format: TXT, HTML) (Obsoletes RFC2401) (Updates RFC3168) (Updated by RFC6040, RFC7619) (Status: PROPOSED STANDARD) (DOI: 10.17487/RFC4301) |
| [ESP]               | RFC4303 IP Encapsulating Security Payload (ESP). S. Kent. December 2005. (Format: TXT, HTML) (Obsoletes RFC2406) (Status: PROPOSED STANDARD) (DOI: 10.17487/RFC4303)   |

## 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.

The tests do not determine if a product conforms to the OSPF standards but they are designed as interoperability tests. These tests provide one method to isolate problems within the OSPF 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 OSPF capable devices. However, these tests do provide a reasonable level of confidence that the RUT will function well in most OSPF capable environments.

## Common Configuration

### Topology

- The Router Under Test (RUT) assumes the role of TR1 for all test cases and topologies unless otherwise specified.
- Host devices may be simulated traffic generators and need not be independent implementations of Hosts.
- Each link should have consistent contiguous IPv6 subnets that should be used throughout the duration of the tests.
- Any link not specified in the test setup's topology is shut down.
- Any Router ID may be used
  - The resulting ordering of the Router ID's must be  $TR1 < TR2 < TR3 < TR4$ .
- All Routers have the following configuration for all interfaces:
  - Cost 1
  - Area 0
  - HelloInterval (10)
  - RouterDeadInterval (40)
  - Priority 1



## Group 1: DR / BDR

### Overview

The goal of this section is to confirm the interoperability of Designated Router (DR), Backup Designated Router (BDR) and DR - Other Elections, Promotion, and general negotiation in several use cases.

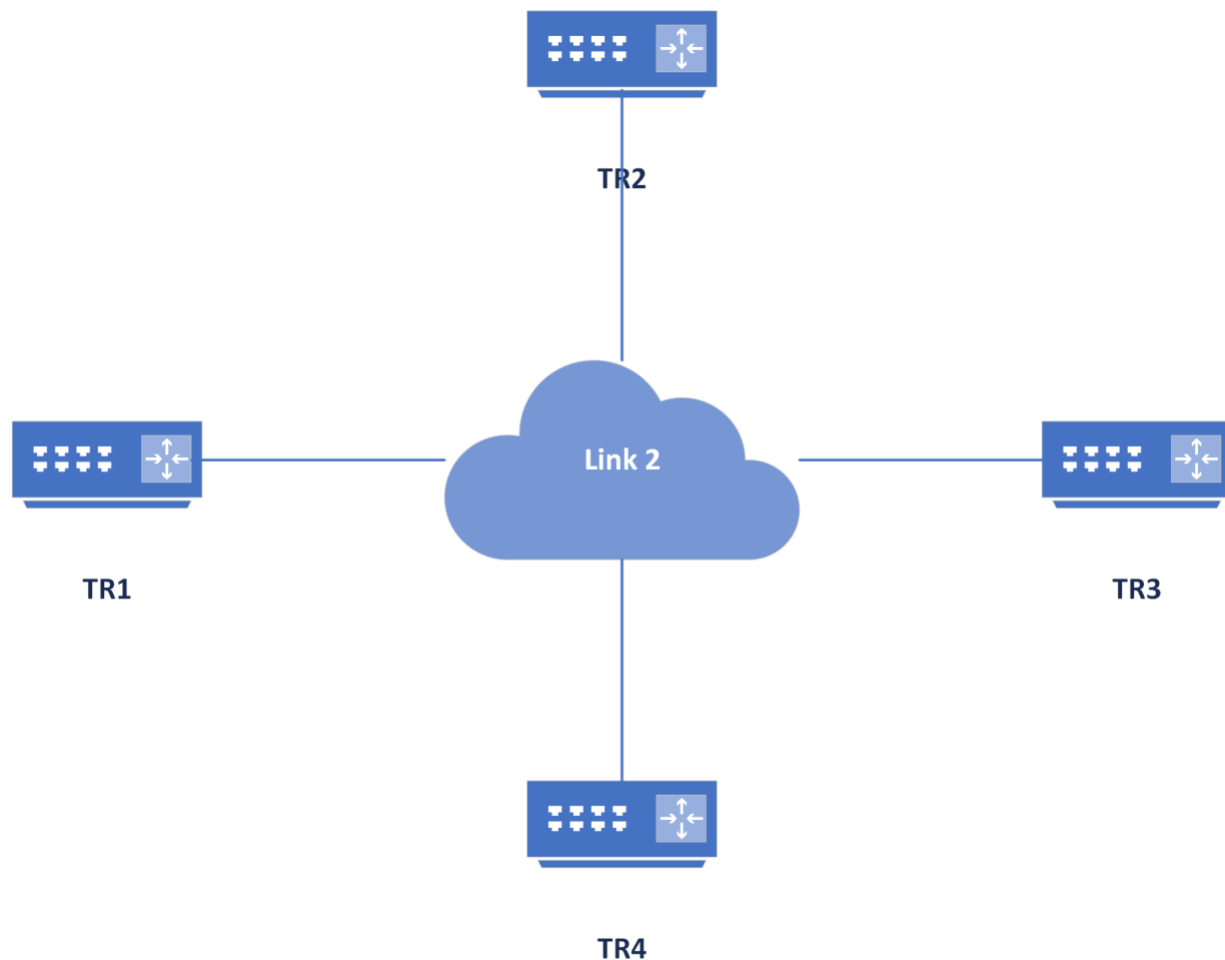
### OSPFv3.IO.1.1: DR/BDR Election based on Router ID

**Purpose:** Test the Election of DR, BDR, or DR Other based on the Router ID.

**References:**

- [OSPFv2] – 7.3, 7.4, 9.4, 9.5, 10
- [OSPF IPv6] – 4.2.1, 4.2.2, A.3

**Test Setup:** All Routers follow [common configuration](#).



**Procedure:**

**Part A: DR/BDR Election Based on Router ID**

| Step | Action                            | Expected Result |
|------|-----------------------------------|-----------------|
| 1.   | Shutdown OSPFv3 on all Routers.   |                 |
| 2.   | Enable OSPFv3 on TR1 and TR4.     |                 |
| 3.   | Wait at least RouterDeadInterval. | Link 2:         |

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|    |                                   |  |
|----|-----------------------------------|--|
|    |                                   | TR4 – DR<br>TR1 – BDR  |
| 4. | Enable OSPFv3 on TR2 and TR3.     |  |
| 5. | Wait at least RouterDeadInterval. | Link 2:<br>TR4 – DR<br>TR1 – BDR<br>TR2 – DR Other<br>TR3 – DR Other |

Part B: TR1 promoted from DR Other to BDR

| Step | Action                             | Expected Result  |
|------|------------------------------------|--|
| 6.   | Shutdown OSPFv3 on all Routers.    |  |
| 7.   | Enable OSPFv3 on TR1, TR3, and TR4 |  |
| 8.   | Wait at least RouterDeadInterval.  | Link 2:<br>TR4 – DR<br>TR3 – BDR<br>TR1 – DR Other                   |
| 9.   | Shutdown OSPFv3 on TR4.            |  |
| 10.  | Wait at least RouterDeadInterval.  | Link 2:<br>TR3 – DR<br>TR1 – BDR                                     |
| 11.  | Enable OSPFv3 on TR4.              |  |
| 12.  | Wait at least RouterDeadInterval.  | Link 2:<br>TR3 – DR<br>TR1 – BDR<br>TR4 – DR Other                   |
| 13.  | Enable OSPFv3 on TR2.              |  |
| 14.  | Wait at least RouterDeadInterval.  | Link 2:<br>TR3 – DR<br>TR1 – BDR<br>TR4 – DR Other<br>TR2 – DR Other |

Part C: TR1 promoted from BDR to DR

| Step | Action                            | Expected Result                  |
|------|-----------------------------------|----------------------------------|
| 15.  | Shutdown OSPFv3 on all Routers.   |                                  |
| 16.  | Enable OSPFv3 on TR2.             |                                  |
| 17.  | Wait at least RouterDeadInterval. | Link 2:<br>TR2 – DR              |
| 18.  | Enable OSPFv3 on TR1.             |                                  |
| 19.  | Wait at least RouterDeadInterval. | Link 2:<br>TR2 – DR<br>TR1 – BDR |

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|     |                                   |  |
|-----|-----------------------------------|--|
| 20. | Enable OSPFv3 on TR3 and TR4.     |  |
| 21. | Wait at least RouterDeadInterval. | Link 2:<br>TR2 – DR<br>TR1 – BDR<br>TR3 – DR Other<br>TR4 – DR Other |
| 22. | Shutdown OSPFv3 on TR2.           |  |
| 23. | Wait at least RouterDeadInterval. | Link 2:<br>TR1 – DR<br>TR4 – BDR<br>TR3 – DR Other                   |
| 24. | Enable OSPFv3 on TR2.             |  |
| 25. | Wait at least RouterDeadInterval. | Link 2:<br>TR1 – DR<br>TR4 – BDR<br>TR3 – DR Other<br>TR2 – DR Other |

**Possible Problems:**

- None

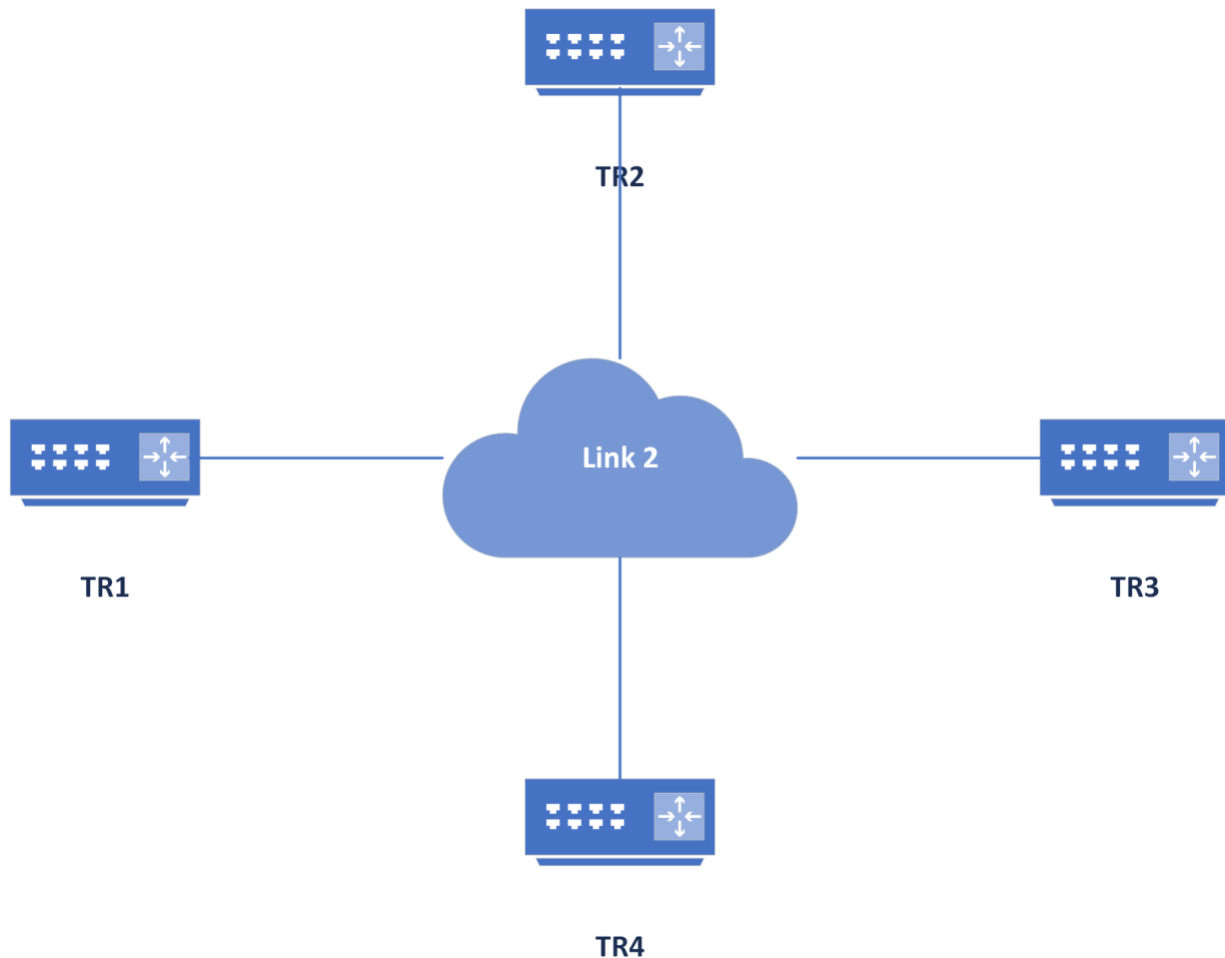
### OSPFv3.IO.1.2: DR/BDR Election based on Router Priority

**Purpose:** Test the Election of DR, BDR, or DR Other based on the Router Priority.

**References:**

- [OSPFv2] – 7.3, 7.4, 9.4, 9.5, 10
- [OSPF IPv6] – 4.2.1, 4.2.2, A.3

**Test Setup:** All Routers follow [common configuration](#).



**Procedure:**

Part A: DR/BDR Election Based on Router Priority

| Step | Action  | Expected Result |
|------|---|-----------------|
| 1.   | Shutdown OSPFv3 on all Routers.                 |                 |
| 2.   | Configure Router Priority on Link2:<br>TR1 – 10 |                 |

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|    |  |  |
|----|--|--|
|    | TR2 – 5<br>TR3 – 2<br>TR4 – 1  |  |
| 3. | Enable OSPFv3 on all routers.  |  |
| 4. | Wait at least RouterDeadInterval and observe Hello packets from all routers. | Link 2:<br>TR1 – DR<br>TR2 – BDR<br>TR3 – DR Other<br>TR4 – DR Other |
| 5. | Shutdown OSPFv3 on TR1.  |  |
| 6. | Wait at least RouterDeadInterval and enable OSPFv3 on TR1.                   |  |
| 7. | Wait at least RouterDeadInterval and observe Hello packets from all routers. | Link 2:<br>TR2 – DR<br>TR3 – BDR<br>TR4 – DR Other<br>TR1 – DR Other |

Part B: TR1 Router Priority 0

| Step | Action  | Expected Result  |
|------|---|--|
| 8.   | Shutdown OSPFv3 on all Routers.   |  |
| 9.   | Configure Router Priority on Link2:<br>TR1 – 0<br>TR2 – 5<br>TR3 – 2<br>TR4 – 1 |  |
| 10.  | Enable OSPFv3 on all routers.   |  |
| 11.  | Wait at least RouterDeadInterval and observe Hello packets from all routers.    | Link 2:<br>TR2 – DR<br>TR3 – BDR<br>TR4 – DR Other<br>TR1 – DR Other |

Possible Problems:

- None

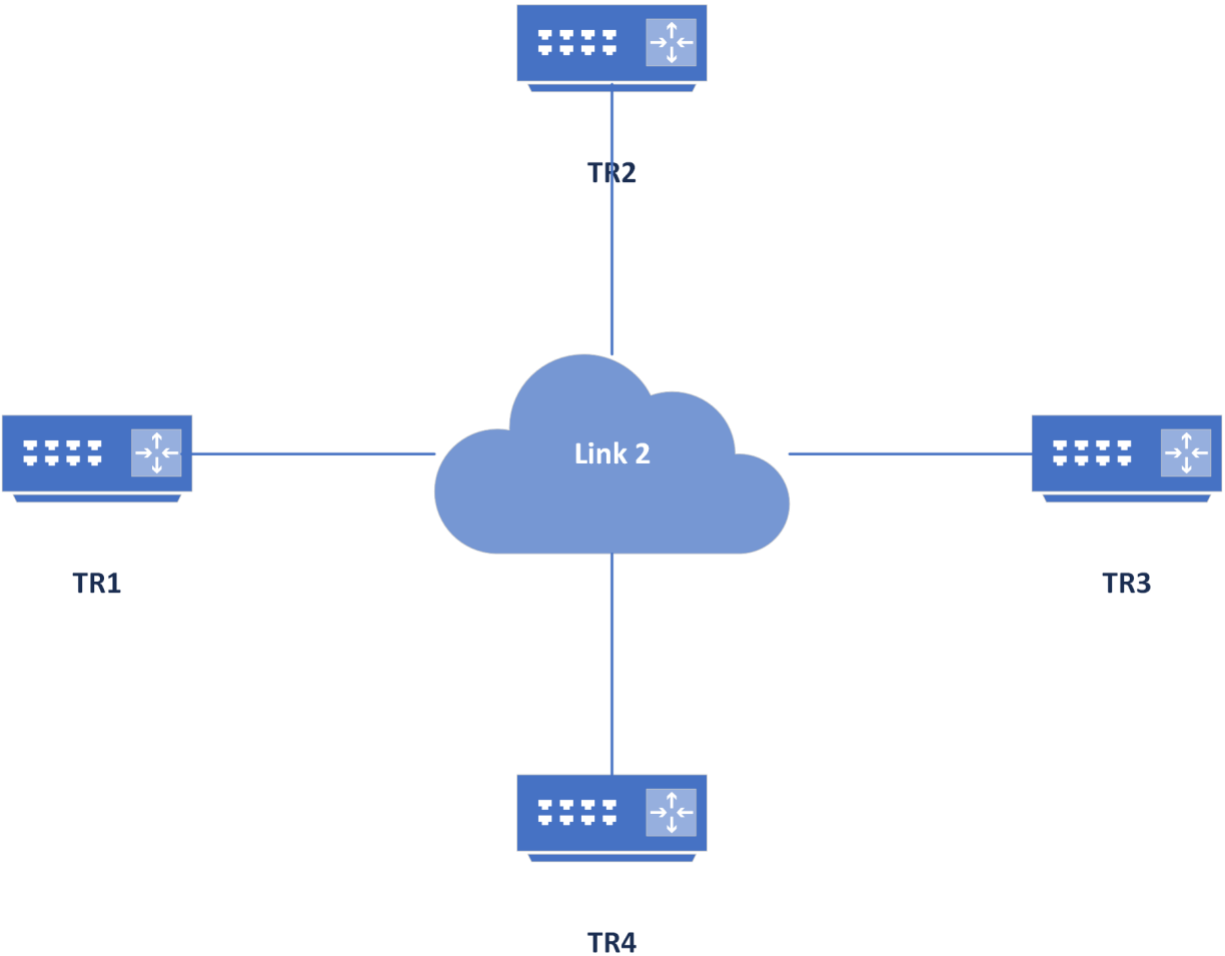
OSPFv3.IO.1.3: Hello Protocol – Hello Packet Mismatch

**Purpose:** Test the Hello protocol in situations where variables are mismatched.

**References:**

- [OSPFv2] – 10.5
- [OSPF IPv6] – 4.2.1, 4.2.2, A.3

**Test Setup:** All Routers follow [common configuration](#).



**Procedure:**

Part A: HelloInterval Mismatch

| Step | Action  | Expected Result |
|------|---|-----------------|
| 1.   | Shutdown OSPFv3 on all Routers.               |                 |
| 2.   | Configure HelloInterval on Link2:<br>TR1 – 20 |                 |

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|    |   |   |
|----|---|---|
|    | TR2 – 10<br>TR3 – 10<br>TR4 – 10  |   |
| 3. | Enable OSPFv3 on all routers.   |   |
| 4. | Wait at least HelloInterval and observe Hello packets from all routers. | Link 2:<br>TR2, TR3, and TR4 are neighbors, neither are neighbors with TR1.<br><br>TR1 indicates no neighbors.  |
| 5. | Wait for adjacency to form in state Full.                               | TR4 synchronize database with TR3 and TR2.<br>TR3 synchronize database with TR4 and TR2.<br><br>TR1 does not synchronize its database with either TR2, TR3, or TR4. |
| 6. | Configure HelloInterval on TR2 to 20.                                   |   |
| 7. | Wait at least HelloInterval and observe Hello packets from all routers. | Link 2:<br>TR1 and TR2, are neighbors, neither are neighbors with TR3 nor TR4.<br><br>TR3 and TR4, are neighbors, neither are neighbors with TR1 nor TR2.           |
| 8. | Wait for adjacency to form in state Full.                               | TR1 and TR2 synchronize databases.<br>TR1 does not synchronize its database with either TR3 or TR4.   |

**Part B: RouterDeadInterval Mismatch**

| Step | Action   | Expected Result  |
|------|--|--|
| 9.   | Shutdown OSPFv3 on all Routers.  |  |
| 10.  | Configure RouterDeadInterval on Link2:<br>TR1 – 60<br>TR2 – 40<br>TR3 – 40<br>TR4 – 40 |  |
| 11.  | Enable OSPFv3 on all routers.  |  |
| 12.  | Wait at least HelloInterval and observe Hello packets from all routers.                | Link 2:<br>TR2, TR3, and TR4 are neighbors, neither are neighbors with TR1.<br><br>TR1 indicates no neighbors. |



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|     |   |   |
|-----|---|---|
| 13. | Wait for adjacency to form in state Full.                               | TR4 synchronize database with TR3 and TR2.<br>TR3 synchronize database with TR4 and TR2.<br><br>TR1 does not synchronize its database with either TR2, TR3, or TR4. |
| 14. | Configure RouterDeadInterval on TR2 to 60.                              |   |
| 15. | Wait at least HelloInterval and observe Hello packets from all routers. | Link 2:<br>TR1 and TR2, are neighbors, neither are neighbors with TR3 nor TR4.<br><br>TR3 and TR4, are neighbors, neither are neighbors with TR1 nor TR2.           |
| 16. | Wait for adjacency to form in state Full.                               | TR1 and TR2 synchronize databases.<br>TR1 does not synchronize its database with either TR3 or TR4.   |

**Part C: Area Mismatch**

| Step | Action   | Expected Result   |
|------|--|---|
| 17.  | Shutdown OSPFv3 on all Routers.  |   |
| 18.  | Configure Area on Link2:<br>TR1 – Area 1<br>TR2 – Area 0<br>TR3 – Area 0<br>TR4 – Area 0 |   |
| 19.  | Enable OSPFv3 on all routers.  |   |
| 20.  | Wait at least HelloInterval and observe Hello packets from all routers.                  | Link 2:<br>TR2, TR3, and TR4 are neighbors, neither are neighbors with TR1.<br><br>TR1 indicates no neighbors.  |
| 21.  | Wait for adjacency to form in state Full.  | TR4 synchronize database with TR3 and TR2.<br>TR3 synchronize database with TR4 and TR2.<br><br>TR1 does not synchronize its database with either TR2, TR3, or TR4. |
| 22.  | Configure Area 1 on TR2.   |   |

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|     |   |   |
|-----|---|---|
| 23. | Wait at least HelloInterval and observe Hello packets from all routers. | Link 2:<br>TR1 and TR2, are neighbors, neither are neighbors with TR3 nor TR4.<br><br>TR3 and TR4, are neighbors, neither are neighbors with TR1 nor TR2. |
| 24. | Wait for adjacency to form in state Full.                               | TR1 and TR2 synchronize databases.<br>TR1 does not synchronize its database with either TR3 or TR4.   |

**Possible Problems:**

- Changing the HelloInterval in Step 6, RouterDeadInterval in step 14, and Area in 22 may require restarting OSPFv3 on TR2. If necessary, shutdown OSPFv3 prior to reconfiguring and wait RouterDeadInterval prior to enabling OSPFv3.

## Group 2: Intra-Area Routes

### Overview

The goal of this section is to confirm calculation and use of the shortest path among intra-area routes.

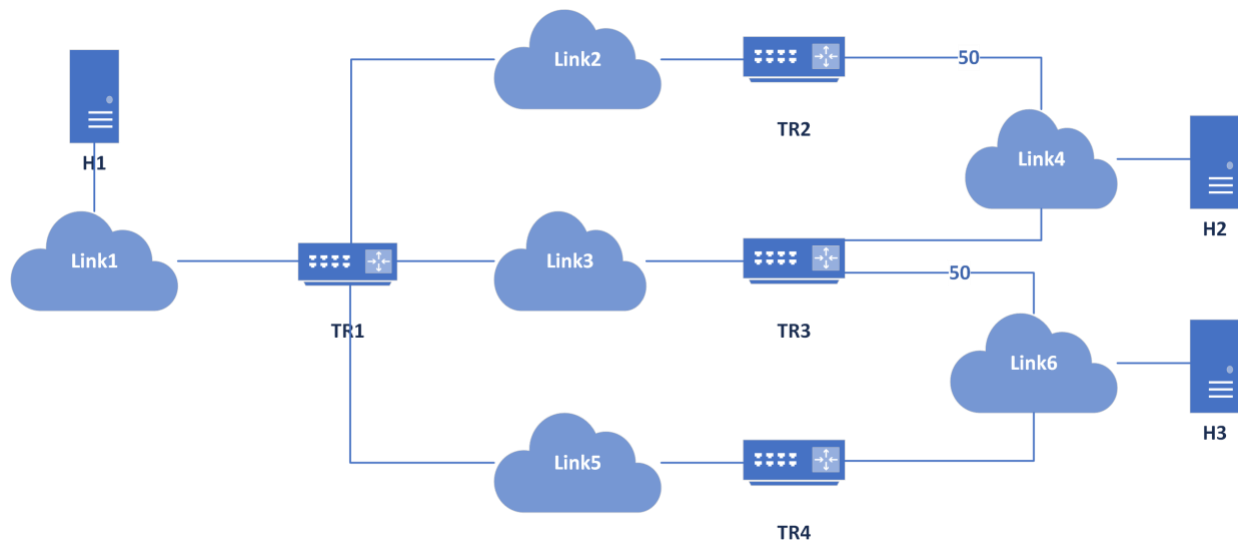
### OSPFv3.IO.2.1: Area – Shortest Path Selection

**Purpose:** Test the determination and use of the shortest path for routes with source, destination, and path entirely within the same area.

**References:**

- [OSPFv2] – 13, 16.1
- [OSPF IPv6] – 2.3, 4.5, 4.8.1

**Test Setup:** All Routers follow [common configuration](#).



**Procedure:**

**Part A: Shortest Path Selection**

| Step | Action  | Expected Result   |
|------|---|---|
| 1.   | Shutdown OSPFv3 on all Routers.                       |   |
| 2.   | Update Link Cost:<br>TR2: Link4: 50<br>TR3: Link6: 50 |   |
| 3.   | Enable OSPFv3 on all routers.                         |   |
| 4.   | Wait for adjacency to form in state Full.             |   |
| 5.   | Transmit Traffic from H1 to H2.                       | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link4<br>5 H2 |

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|    |                                 |   |
|----|---------------------------------|---|
| 6. | Transmit Traffic from H1 to H3. | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link5<br>4 Link6<br>5 H3 |
|----|---------------------------------|---|

Part B: Alternate Shortest Path

| Step | Action  | Expected Result   |
|------|---|---|
| 7.   | Shutdown OSPFv3 on all Routers.   |   |
| 8.   | Update Link Cost:<br>TR2: Link4: 50<br>TR3: Link4: 100<br>TR3: Link6: 50<br>TR4: Link6: 100 |   |
| 9.   | Enable OSPFv3 on all routers.   |   |
| 10.  | Wait for adjacency to form in state Full.   |   |
| 11.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 12.  | Transmit Traffic from H1 to H3.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link6<br>5 H3 |

Part C: Path Failure causes Route Update

| Step | Action  | Expected Result                   |
|------|---|-----------------------------------|
| 13.  | Shutdown OSPFv3 on all Routers.                       |                                   |
| 14.  | Update Link Cost:<br>TR2: Link4: 50<br>TR3: Link6: 50 |                                   |
| 15.  | Enable OSPFv3 on all routers.                         |                                   |
| 16.  | Wait for adjacency to form in state Full.             |                                   |
| 17.  | Transmit Traffic from H1 to H2.                       | Traffic Route:<br>1 H1<br>2 Link1 |

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|     |   |   |
|-----|---|---|
|     |   | 3 Link3<br>4 Link4<br>5 H2                                      |
| 18. | Continue to Transmit Traffic from H1 to H2.   |   |
| 19. | Shutdown TR3's interface to Link 4 and wait at least RouterDeadInterval.                                      | Packet loss may be observed while database is updated.          |
| 20. | Wait for the appropriate LSAs to be transmitted and acknowledged, and for the flooding procedure to complete. | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 21. | Discontinue Traffic from H1 to H2.<br>Enable OSPFv3 on TR3.   |   |
| 22. | Wait for adjacency to form in state Full.   |   |
| 23. | Transmit Traffic from H1 to H3  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link5<br>4 Link6<br>5 H3 |
| 24. | Continue to Transmit Traffic from H1 to H3.   |   |
| 25. | Shutdown OSPFv3 on TR4 and wait at least RouterDeadInterval.  | Packet loss may be observed while database is updated.          |
| 26. | Wait for the appropriate LSAs to be transmitted and acknowledged, and for the flooding procedure to complete. | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link6<br>5 H3 |

**Part D: Recalculate Shortest Path**

| Step | Action  | Expected Result |
|------|---|-----------------|
| 27.  | Shutdown OSPFv3 on all Routers.                       |                 |
| 28.  | Update Link Cost:<br>TR2: Link4: 50<br>TR3: Link6: 50 |                 |
| 29.  | Enable OSPFv3 on all routers.                         |                 |

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|     |   |   |
|-----|---|---|
| 30. | Wait for adjacency to form in state Full.   |   |
| 31. | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link4<br>5 H2 |
| 32. | Update Link Cost:<br>TR3: Link4: 100  |   |
| 33. | Wait for the appropriate LSAs to be transmitted and acknowledged, and for the flooding procedure to complete. |   |
| 34. | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 35. | Transmit Traffic from H1 to H3.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link5<br>4 Link6<br>5 H3 |
| 36. | Update Link Cost:<br>TR4: Link6: 100  |   |
| 37. | Wait for the appropriate LSAs to be transmitted and acknowledged, and for the flooding procedure to complete. |   |
| 38. | Transmit Traffic from H1 to H3.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link6<br>5 H3 |

**Possible Problems:**

- None

## Group 3: Inter-Area Routes

### Overview

The goal of this section is to confirm calculation and use of the shortest path among inter-area routes.



### OSPFv3.IO.3.1: AS - Shortest Path Selection

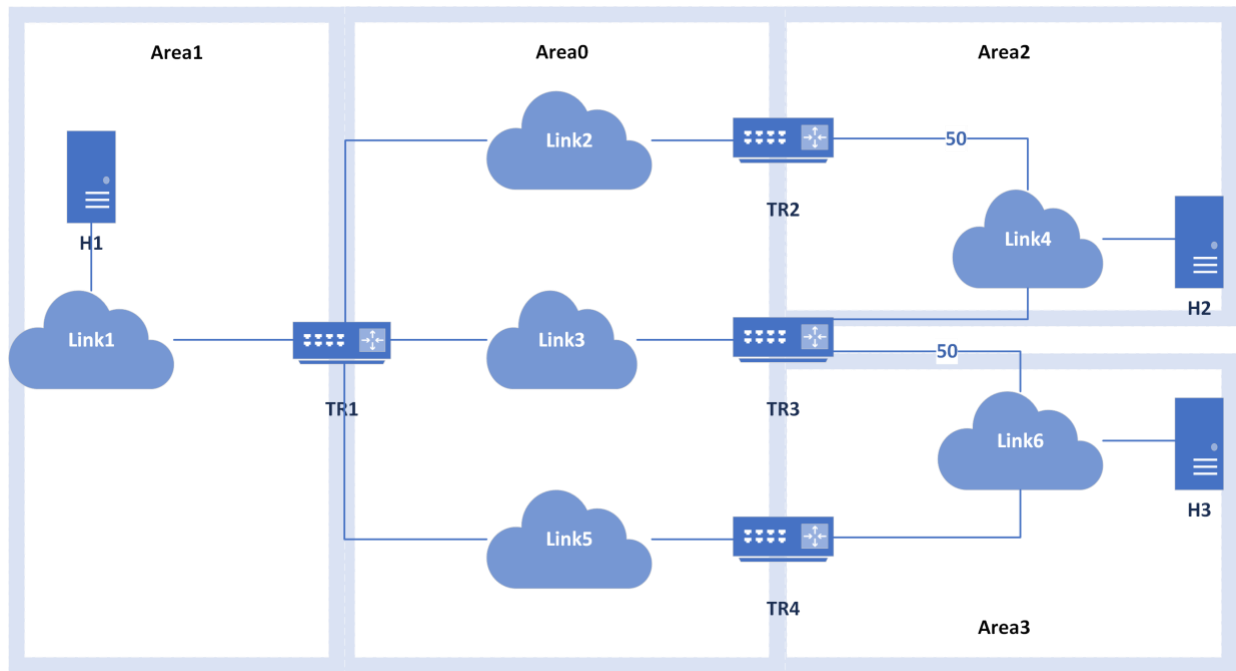
**Purpose:** Test the determination and use of the shortest path for routes with source, destination, and path entirely within the same AS.

**References:**

- [OSPFv2] – 13, 16.2
- [OSPF IPv6] – 2.3, 4.5, 4.8.2

**Test Setup:** All Routers follow [common configuration](#).

- Area Assignments
  - TR1
    - Link1: Area 1
    - Link2: Area 0
    - Link3: Area 0
    - Link5: Area 0
  - TR2
    - Link2: Area 0
    - Link4: Area 2
  - TR3
    - Link3: Area 0
    - Link4: Area 2
    - Link6: Area 3
  - TR4
    - Link5: Area 0
    - Link6: Area 3



**Procedure:**

**Part A: Shortest Path Selection**

| Step | Action  | Expected Result   |
|------|---|---|
| 1.   | Shutdown OSPFv3 on all Routers.                       |   |
| 2.   | Update Link Cost:<br>TR2: Link4: 50<br>TR3: Link6: 50 |   |
| 3.   | Enable OSPFv3 on all routers.                         |   |
| 4.   | Wait for adjacency to form in state Full.             |   |
| 5.   | Transmit Traffic from H1 to H2.                       | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link4<br>5 H2 |
| 6.   | Transmit Traffic from H1 to H3.                       | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link5<br>4 Link6<br>5 H3 |

**Part B: Alternate Shortest Path**

| Step | Action | Expected Result |
|------|--------|-----------------|
|------|--------|-----------------|

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|     |   |   |
|-----|---|---|
| 7.  | Shutdown OSPFv3 on all Routers.   |   |
| 8.  | Update Link Cost:<br>TR2: Link4: 50<br>TR3: Link4: 100<br>TR3: Link6: 50<br>TR4: Link6: 100 |   |
| 9.  | Enable OSPFv3 on all routers.   |   |
| 10. | Wait for adjacency to form in state Full.   |   |
| 11. | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 12. | Transmit Traffic from H1 to H3.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link6<br>5 H3 |

Part C: Path Failure causes Route Update

| Step | Action  | Expected Result   |
|------|---|---|
| 13.  | Shutdown OSPFv3 on all Routers.   |   |
| 14.  | Update Link Cost:<br>TR2: Link4: 50<br>TR3: Link6: 50                   |   |
| 15.  | Enable OSPFv3 on all routers.   |   |
| 16.  | Wait for adjacency to form in state Full.                               |   |
| 17.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link4<br>5 H2 |
| 18.  | Continue to Transmit Traffic from H1 to H2.                             |   |
| 19.  | Shutdown TR3's interface to Link4 and wait at least RouterDeadInterval. | Packet loss may be observed while database is updated.          |

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|     |   |   |
|-----|---|---|
| 20. | Wait for the appropriate LSAs to be transmitted and acknowledged, and for the flooding procedure to complete. | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 21. | Discontinue Traffic from H1 to H2.<br>Enable OSPFv3 on TR3.   |   |
| 22. | Wait for adjacency to form in state Full.   |   |
| 23. | Transmit Traffic from H1 to H3.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link5<br>4 Link6<br>5 H3 |
| 24. | Continue to Transmit Traffic from H1 to H3.   |   |
| 25. | Shutdown OSPFv3 on TR4 and wait at least RouterDeadInterval.  | Packet loss may be observed while database is updated.          |
| 26. | Wait for the appropriate LSAs to be transmitted and acknowledged, and for the flooding procedure to complete. | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link6<br>5 H3 |

Part D: Recalculate Shortest Path

| Step | Action  | Expected Result   |
|------|---|---|
| 27.  | Shutdown OSPFv3 on all Routers.                       |   |
| 28.  | Update Link Cost:<br>TR2: Link4: 50<br>TR3: Link6: 50 |   |
| 29.  | Enable OSPFv3 on all routers.                         |   |
| 30.  | Wait for adjacency to form in state Full.             |   |
| 31.  | Transmit Traffic from H1 to H2.                       | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link4<br>5 H2 |

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|     |   |   |
|-----|---|---|
| 32. | Update Link Cost:<br>TR3: Link4: 100  |   |
| 33. | Wait for the appropriate LSAs to be transmitted and acknowledged, and for the flooding procedure to complete. |   |
| 34. | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 35. | Transmit Traffic from H1 to H3.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link5<br>4 Link6<br>5 H3 |
| 36. | Update Link Cost:<br>TR4: Link6: 100  |   |
| 37. | Wait for the appropriate LSAs to be transmitted and acknowledged, and for the flooding procedure to complete. |   |
| 38. | Transmit Traffic from H1 to H3.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link6<br>5 H3 |

**Possible Problems:**

- None

### OSPFv3.IO.3.2: Virtual Link Connecting a Remote Area

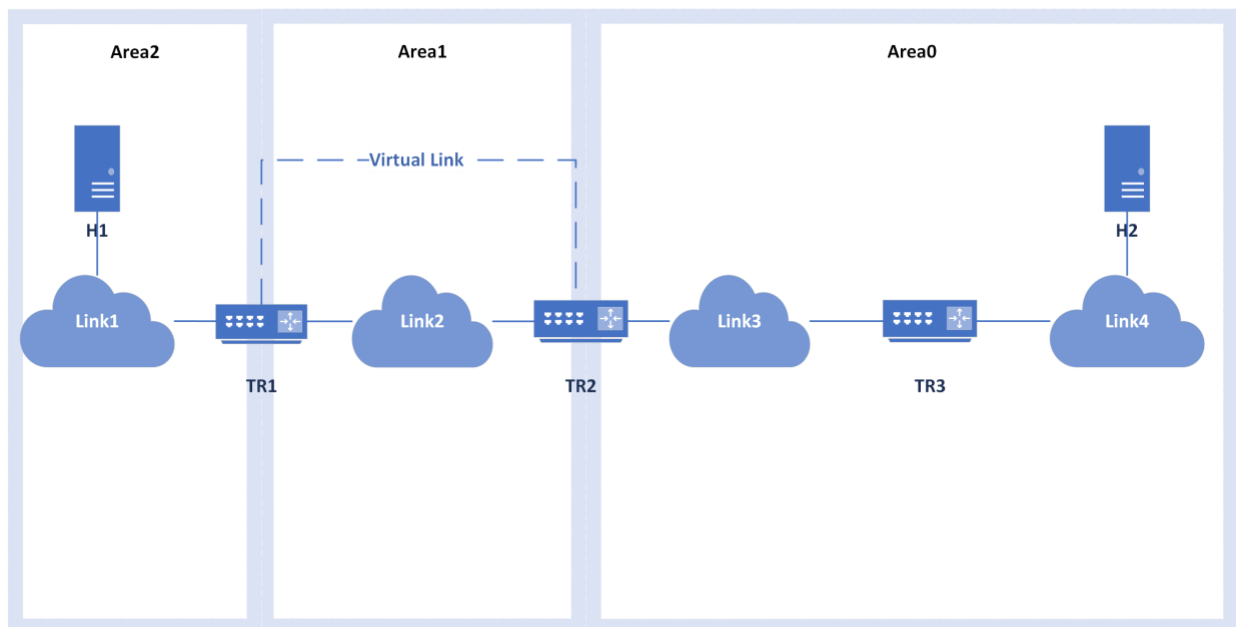
**Purpose:** Test the functionality of a path that includes an ABR connected to the backbone via a virtual link.

**References:**

- [OSPFv2] – 15
- [OSPF IPv6] – 4.7

**Test Setup:** All Routers follow [common configuration](#).

- Area Assignments
  - TR1
    - Link1: Area 2
    - Link2: Area 1
  - TR2
    - Link2: Area 1
    - Link3: Area 0
  - TR3
    - Link3: Area 0
    - Link4: Area 0



**Procedure:**

Part A: Disconnected Area without Virtual Link

| Step | Action                          | Expected Result |
|------|---------------------------------|-----------------|
| 1.   | Shutdown OSPFv3 on all Routers. |                 |

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|    |   |   |
|----|---|---|
| 2. | Enable OSPFv3 on all routers.             |   |
| 3. | Wait for adjacency to form in state Full. |   |
| 4. | Transmit Traffic from H2 to H1.           | Traffic is not transmitted from H2 to H1 as the topology has no route to Link1. |

**Part B: Virtual Link Connecting Backbone**

| Step | Action  | Expected Result   |
|------|---|---|
| 5.   | Shutdown OSPFv3 on all Routers.                         |   |
| 6.   | Configure a Virtual Link between TR1 and TR2 in Area 1. |   |
| 7.   | Enable OSPFv3 on all routers.                           |   |
| 8.   | Wait for adjacency to form in state Full.               |   |
| 9.   | Transmit Traffic from H2 to H1.                         | Traffic Route:<br>1 H2<br>2 Link4<br>3 Link3<br>4 Link2<br>5 H1                 |
| 10.  | Remove the Virtual Link between TR1 and TR2 in Area 1.  |   |
| 11.  | Wait at least HelloInterval.                            |   |
| 12.  | Transmit Traffic from H2 to H1.                         | Traffic is not transmitted from H2 to H1 as the topology has no route to Link1. |

**Possible Problems:**

- None

### OSPFv3.IO.3.3: Prefer Intra-Area Routes over Inter-Area Routes

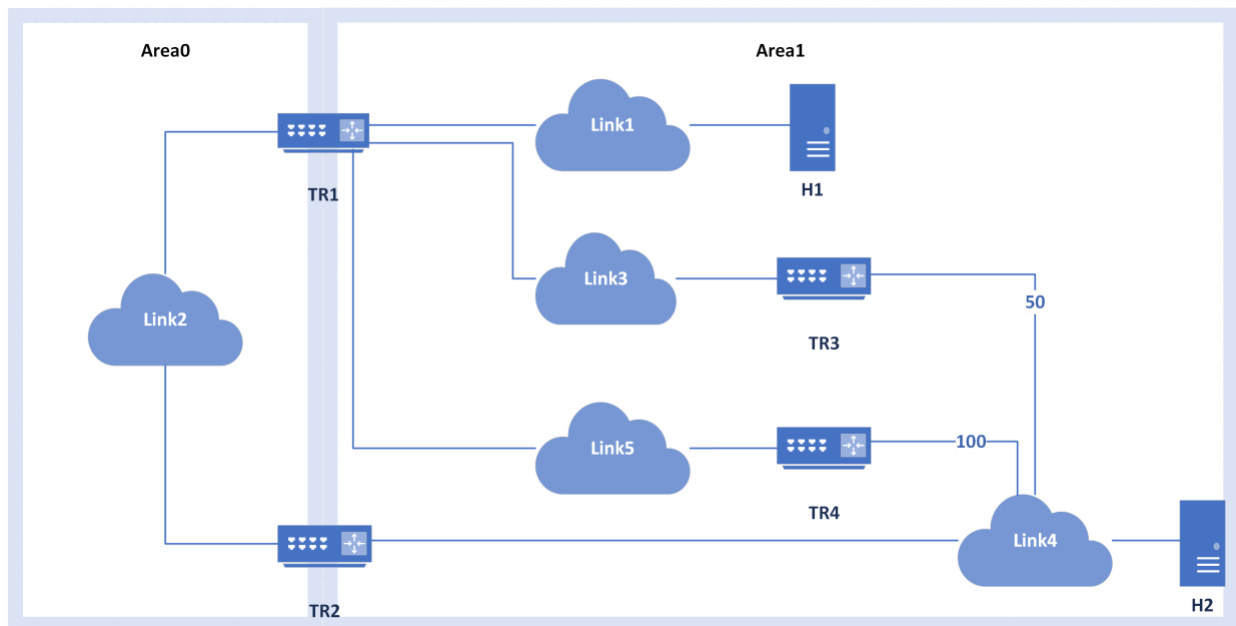
**Purpose:** Test that higher cost Intra-Area Routes are preferred over lower cost Inter-Area Routes across the backbone.

**References:**

- [OSPFv2] – 3.2, 16.2(6)
- [OSPF IPv6] – 2.3

**Test Setup:** All Routers follow [common configuration](#).

- Area Assignments
  - TR1
    - Link1: Area 1
    - Link2: Area 0
    - Link3: Area 1
  - TR2
    - Link2: Area 0
    - Link4: Area 1
  - TR3
    - Link3: Area 1
    - Link4: Area 1
  - TR4
    - Link5: Area 1
    - Link4: Area 1





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**Procedure:**

| Step | Action   | Expected Result  |
|------|--|--|
| 1.   | Shutdown OSPFv3 on all Routers.                        |  |
| 2.   | Update Link Cost:<br>TR3: Link4: 50<br>TR4: Link4: 100 |  |
| 3.   | Enable OSPFv3 on all routers.                          |  |
| 4.   | Wait for adjacency to form in state Full.              |  |
| 5.   | Transmit Traffic from H1 to H2.                        | Although the shortest path by cost to H2 is through Area 0, traffic is routed using the Intra-Area 1 route.<br><br>Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link4<br>5 H2 |
| 6.   | Shutdown OSPFv3 on TR3.                                |  |
| 7.   | Transmit Traffic from H1 to H2.                        | Although the shortest path by cost to H2 is through Area 0, traffic is routed using the Intra-Area 1 route.<br><br>Traffic Route:<br>1 H1<br>2 Link1<br>3 Link5<br>4 Link4<br>5 H2 |

**Possible Problems:**

- None

## Group 4: External Routes

### **Overview**

The goal of this section is to confirm calculation and use of routes outside the Autonomous System.

### OSPFv3.IO.4.1: Stub Area

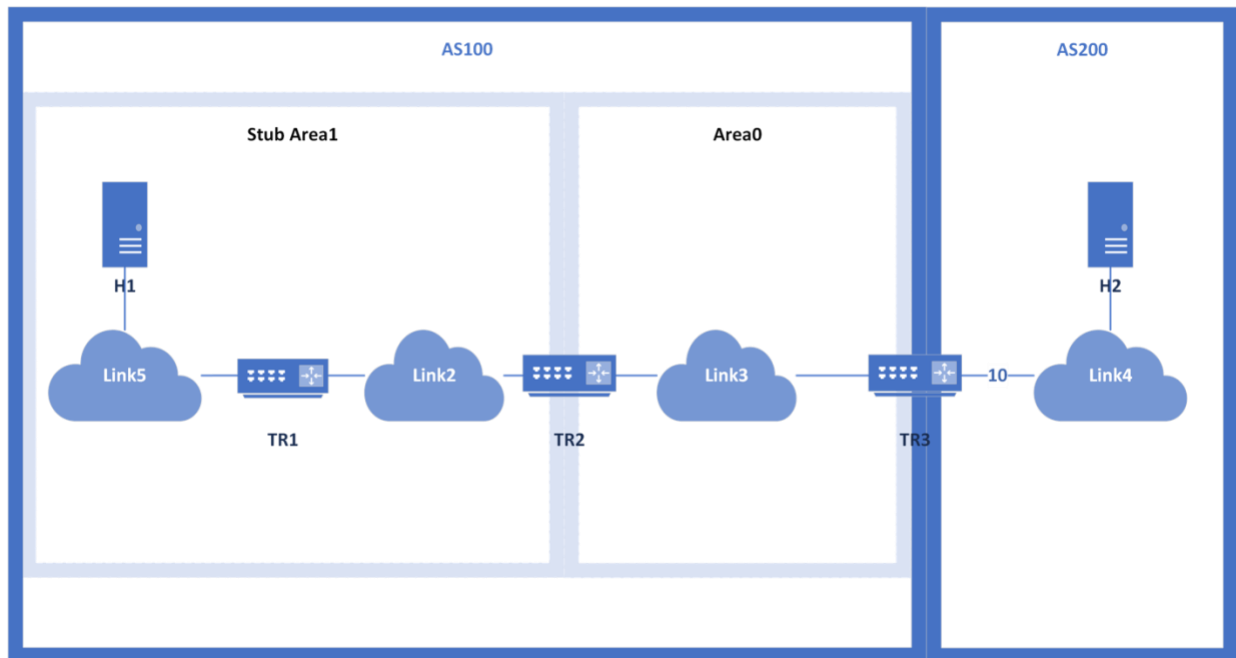
**Purpose:** Test that a Stub Area does not receive AS-External-LSAs from an ABR.

**References:**

- [OSPFv2] – 3.6, 4.2, 4.5, 9.5
- [OSPF IPv6] – 2.10, A.4.5

**Test Setup:** All Routers follow [common configuration](#).

- Area Assignments
  - TR1 (AS 100)
    - Link5: Stub Area 1
    - Link2: Stub Area 1
  - TR2 (ABR - AS 100)
    - Link2: Stub Area 1
    - Link3: Area 0
  - TR3 (ASBR)
    - Link3: Area 0
    - Link4: AS 200



**Procedure:**

**Part A: TR2 ABR**

| Step | Action                          | Expected Result |
|------|---------------------------------|-----------------|
| 1.   | Shutdown OSPFv3 on all Routers. |                 |

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|    |   |  |
|----|---|--|
| 2. | Update Link Cost:<br>TR3: Link4: 10   |  |
| 3. | Enable OSPFv3 on all routers.   |  |
| 4. | Wait for adjacency to form in state Full.   |  |
| 5. | Configure TR3 to redistribute Link4 with external metric Type 1 and without forwarding address into AS 100. |  |
| 6. | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link5<br>3 Link2<br>4 Link3<br>5 Link4<br>6 H2 |

Part B: TR1 ABR

| Step | Action   | Expected Result  |
|------|--|--|
| 7.   | Shutdown OSPFv3 on all Routers.  |  |
| 8.   | Update Link Cost:<br>TR3: Link4: 10  |  |
| 9.   | Swap TR1 and TR2. TR1 is an ABR connected to Link2 (Stub Area 1) and Link3 (Area 0). TR2 is connected to Link 5 and Link 2, both in Stub Area 1. |  |
| 10.  | Enable OSPFv3 on all routers.  |  |
| 11.  | Wait for adjacency to form in state Full.  |  |
| 12.  | Configure TR3 to redistribute Link4 with external metric Type 1 without forwarding address into AS 100.  |  |
| 13.  | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link5<br>3 Link2<br>4 Link3<br>5 Link4<br>6 H2 |

Possible Problems:

- None

### OSPFv3.IO.4.2: ASBR Type1 and Type2 External Routes

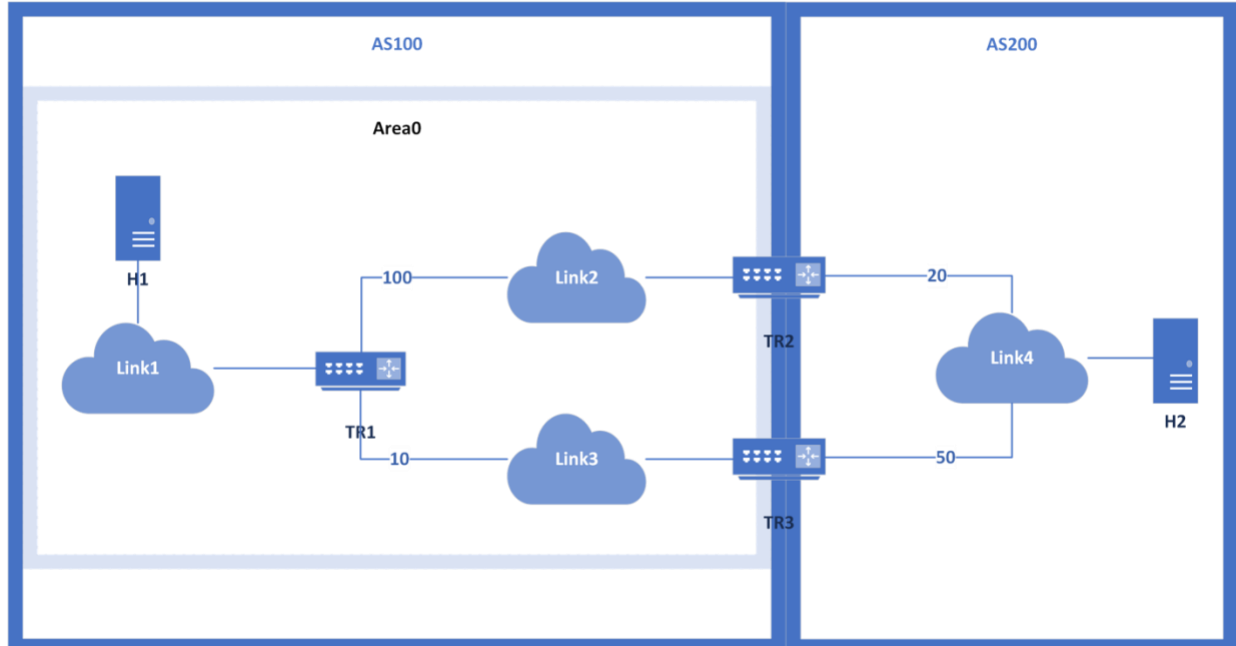
**Purpose:** Test the determination and use of the shortest path for Type1 and Type2 External Routes from an ASBR.

**References:**

- [OSPFv2] – 2.3, 11, 16.4
- [OSPF IPv6] – 4.4, 4.5

**Test Setup:** All Routers follow [common configuration](#).

- Area Assignments
  - TR1 (AS 100)
    - Link1: Area 0
    - Link2: Area 0
    - Link3: Area 0
  - TR2 (ABR - AS 100)
    - Link2: Area 0
    - Link4: AS 200
  - TR3 (ASBR)
    - Link3: Area 0
    - Link4: AS 200



**Procedure:**

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Part A: Type 2 External Metrics

| Step | Action  | Expected Result   |
|------|---|---|
| 1.   | Shutdown OSPFv3 on all Routers.   |   |
| 2.   | Update Link Cost:<br>TR1: Link2: 100<br>TR1: Link3: 10<br>TR2: Link4: 20<br>TR3: Link4: 50                      |   |
| 3.   | Enable OSPFv3 on all routers.   |   |
| 4.   | Wait for adjacency to form in state Full.   |   |
| 5.   | Configure TR2 and TR3 to redistribute Link4 with external metric Type 2 into AS 100 without forwarding address. |   |
| 6.   | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

Part B: Type 1 External Metrics

| Step | Action  | Expected Result   |
|------|---|---|
| 7.   | Shutdown OSPFv3 on all Routers.   |   |
| 8.   | Update Link Cost:<br>TR1: Link2: 100<br>TR1: Link3: 10<br>TR2: Link4: 20<br>TR3: Link4: 50                      |   |
| 9.   | Enable OSPFv3 on all routers.   |   |
| 10.  | Wait for adjacency to form in state Full.   |   |
| 11.  | Configure TR2 and TR3 to redistribute Link4 with external metric Type 1 into AS 100 without forwarding address. |   |
| 12.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link4<br>5 H2 |

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Part C: Type 1 External Metrics Precedence

| Step | Action   | Expected Result   |
|------|--|---|
| 13.  | Shutdown OSPFv3 on all Routers.  |   |
| 14.  | Update Link Cost:<br>TR1: Link2: 100<br>TR1: Link3: 10<br>TR2: Link4: 20<br>TR3: Link4: 50   |   |
| 15.  | Enable OSPFv3 on all routers.  |   |
| 16.  | Wait for adjacency to form in state Full.  |   |
| 17.  | Configure TR2 to redistribute Link4 with external metric Type 1 into AS 100 without forwarding address.<br>Configure TR3 to redistribute Link4 with external metric Type 2 into AS 100 without forwarding address. |   |
| 18.  | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

Possible Problems:

- None

### OSPFv3.IO.4.3: Intra-AS Paths to ASBR, Prefer Larger Area ID

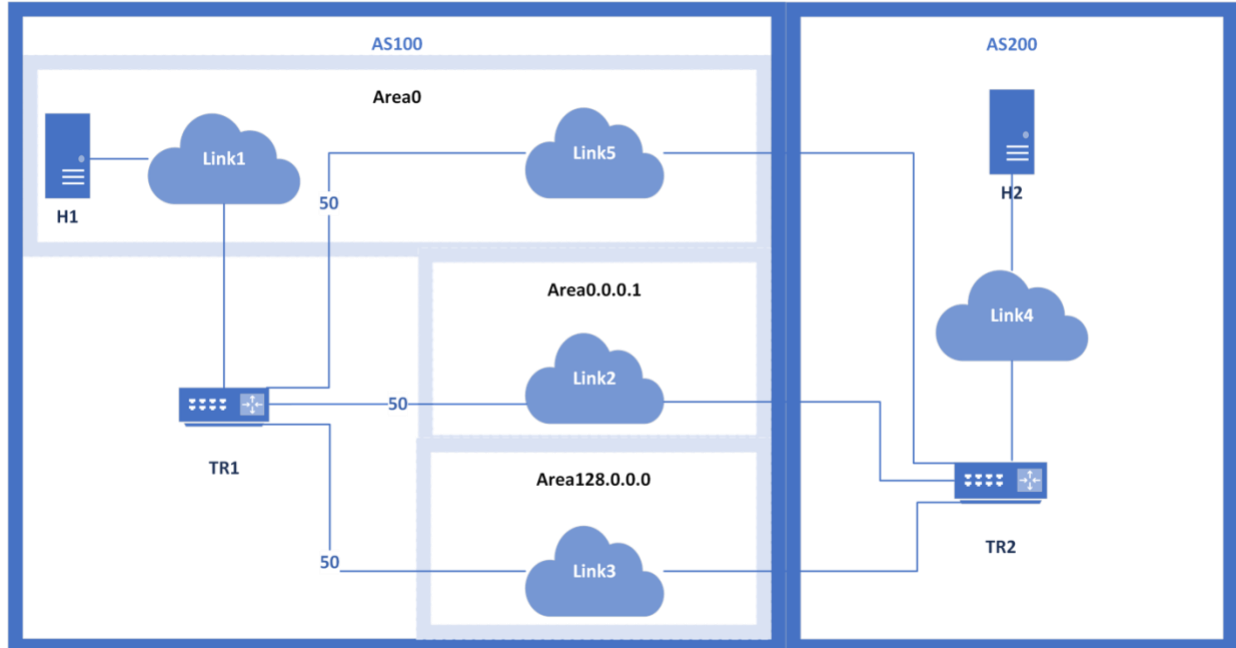
**Purpose:** Test the determination and use of the Intra-AS path through the Largest Area ID for External Routes from an ASBR.

**References:**

- [OSPFv2] – 16.4, 16.4.1
- [OSPF IPv6] – 2.3, 4.8.5

**Test Setup:** All Routers follow [common configuration](#).

- Area Assignments
  - TR1 (AS 100)
    - Link1: Area 0
    - Link2: Area 0.0.0.1
    - Link3: Area 128.0.0.0
    - Link5: Area 0
  - TR2 (ASBR)
    - Link2: AS 100, Area 0.0.0.1
    - Link3: AS 100, Area 128.0.0.0
    - Link4: AS 200
    - Link5: AS 100, Area 0



**Procedure:**



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| Step | Action  | Expected Result   |
|------|---|---|
| 1.   | Shutdown OSPFv3 on all Routers.   |   |
| 2.   | Update Link Cost:<br>TR1: Link5: 50<br>TR1: Link2: 50<br>TR1: Link3: 50                                 |   |
| 3.   | Enable OSPFv3 on all routers.   |   |
| 4.   | Wait for adjacency to form in state Full.   |   |
| 5.   | Configure TR2 to redistribute Link4 with external metric Type 2 into AS 100 without forwarding address. |   |
| 6.   | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link4<br>5 H2 |

**Possible Problems:**

- None

#### OSPFv3.IO.4.4: Intra-AS Paths to ASBR, Prefer Non-Backbone Area

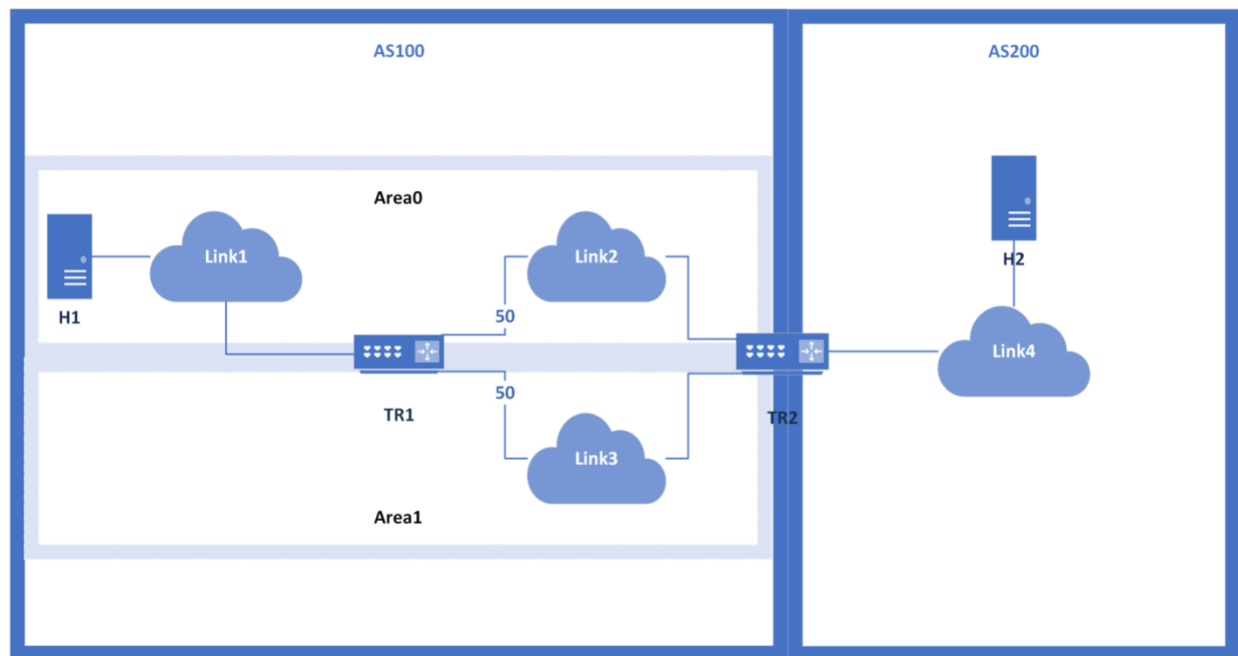
**Purpose:** Test the determination and use of the Intra-AS path through Non-Backbone Areas for External Routes from an ASBR.

**References:**

- [OSPFv2] – 16.4, 16.4.1
- [OSPF IPv6] – 2.3, 4.8.5

**Test Setup:** All Routers follow [common configuration](#).

- Area Assignments
  - TR1 (AS 100)
    - Link1: Area 0
    - Link2: Area 0
    - Link3: Area 1
  - TR2 (ASBR)
    - Link2: AS 100, Area 0
    - Link3: AS 100, Area 1
    - Link4: AS 200



**Procedure:**

| Step | Action                          | Expected Result |
|------|---------------------------------|-----------------|
| 1.   | Shutdown OSPFv3 on all Routers. |                 |

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|    |   |   |
|----|---|---|
| 2. | Update Link Cost:<br>TR1: Link2: 50<br>TR1: Link3: 50   |   |
| 3. | Enable OSPFv3 on all routers.   |   |
| 4. | Wait for adjacency to form in state Full.   |   |
| 5. | Configure TR2 to redistribute Link4 with external metric Type 2 into AS 100 without forwarding address. |   |
| 6. | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link4<br>5 H2 |

**Possible Problems:**

- None

### OSPFv3.IO.4.5: Inter-Area Routes through Transit Areas

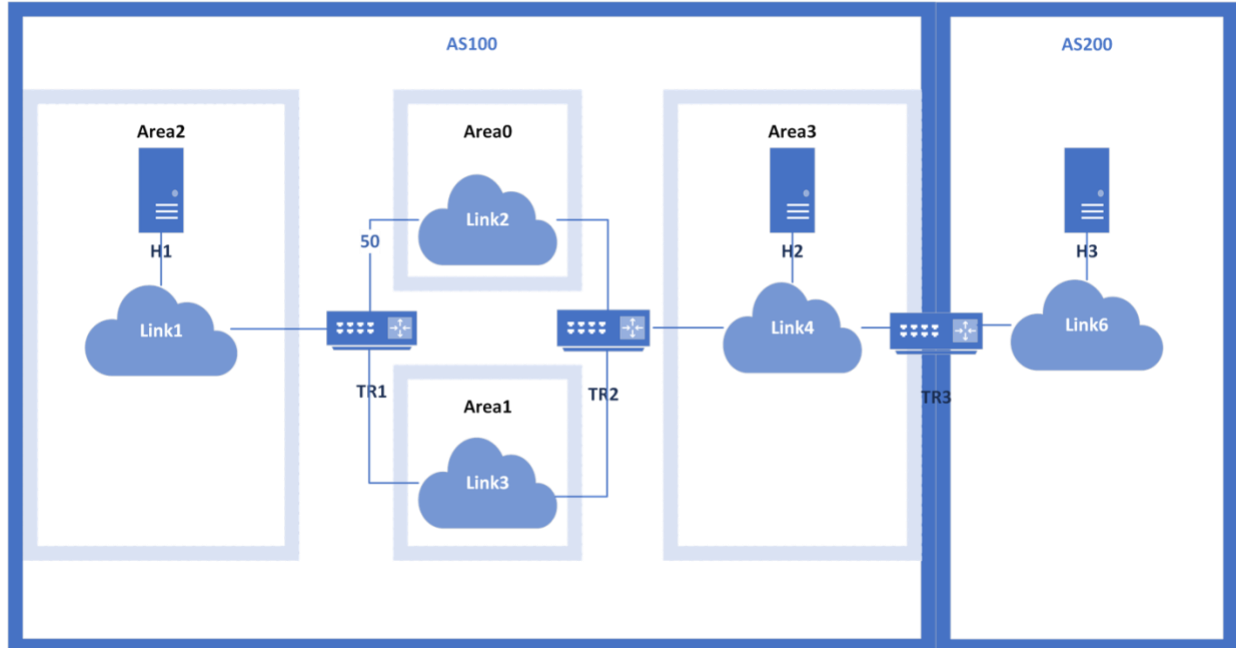
**Purpose:** Test the determination and use of Inter-Area routes within an AS

**References:**

- [OSPFv2] – 3.2, 15, 16.2, 16.3
- [OSPF IPv6] – 2.3, 4.8.4

**Test Setup:** All Routers follow [common configuration](#).

- Area Assignments
  - TR1 (AS 100)
    - Link1: Area 2
    - Link2: Area 0
    - Link3: Area 1
  - TR2 (AS 100)
    - Link2: Area 0
    - Link3: Area 1
    - Link4: Area 3
  - TR2 (ASBR)
    - Link4: AS 100, Area 3
    - Link6: AS 200



**Procedure:**

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Part A: Inter-Area Route

| Step | Action  | Expected Result  |
|------|---|--|
| 1.   | Shutdown OSPFv3 on all Routers.   |  |
| 2.   | Update Link Cost:<br>TR1: Link2: 50   |  |
| 3.   | Enable OSPFv3 on all routers.   |  |
| 4.   | Wait for adjacency to form in state Full.   |  |
| 5.   | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2            |
| 6.   | Configure TR3 to redistribute Link6 with external metric Type 2 into AS 100 without forwarding address. |  |
| 7.   | Transmit Traffic from H1 to H3.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 Link6<br>6 H3 |

Part B: Virtual Link with Inter-Area Route

| Step | Action  | Expected Result   |
|------|---|---|
| 8.   | Shutdown OSPFv3 on all Routers.                         |   |
| 9.   | Update Link Cost:<br>TR1: Link2: 50                     |   |
| 10.  | Enable OSPFv3 on all routers.                           |   |
| 11.  | Configure a Virtual Link between TR1 and TR2 in Area 1. |   |
| 12.  | Wait for adjacency to form in state Full.               |   |
| 13.  | Transmit Traffic from H1 to H2.                         | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link4<br>5 H2 |

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|     |   |  |
|-----|---|--|
| 14. | Configure TR3 to redistribute Link6 with external metric Type 2 into AS 100 without forwarding address. |  |
| 15. | Transmit Traffic from H1 to H3.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link3<br>4 Link4<br>5 Link6<br>6 H3 |

**Part C: No Path to Backbone Area**

| Step | Action   | Expected Result                   |
|------|--|-----------------------------------|
| 16.  | Shutdown OSPFv3 on all Routers.  |                                   |
| 17.  | TR1 Interface to Link2 is disconnected.<br>Ensure no virtual links are configured on any TRs.<br><br>Link Cost:<br>TR1: Link2: 50 (disconnected) |                                   |
| 18.  | Enable OSPFv3 on all routers.  |                                   |
| 19.  | Wait for adjacency to form in state Full.  |                                   |
| 20.  | Transmit Traffic from H2 to H1.  | Traffic is not transmitted to H1. |
| 21.  | Configure TR3 to redistribute Link6 with external metric Type 2 into AS 100 without forwarding address.  |                                   |
| 22.  | Transmit Traffic from H3 to H1.  | Traffic is not transmitted to H1. |

**Possible Problems:**

- None

## Group 5: IPsec Security for OSPF

### Overview

The goal of this section is to confirm OSPF Security through OSPF with IPsec and OSPF Authentication Trailer.

### OSPFv3.IO.5.1: IPsec Security

**Purpose:** Test the functionality of OSPF when IPsec ESP is used to ensure the authentication, confidentiality, and integrity of the neighbor.

**References:**

- [OSPF IPv6] – 2.6
- [OSPF IPsec]
- [IPsec]
- [ESP]

**Test Setup:** All Routers follow [common configuration](#).

- Utilize the necessary IPsec Manual Key Security association between TR1 and TR2 on Link2 using the keys and algorithms specified below to secure the OSPFv3 packets.



| SA1                      |   |
|--------------------------|---|
| SPI                      | 0x1000  |
| Encryption Algorithm     | ENCR_AES_CBC (128-bit)  |
| Encryption Key           | ipv6ospfaescbc01<br>0x697076366F7370666165736362633031  |
| Authentication Algorithm | AUTH_HMAC_SHA2_256_128  |
| Authentication Key       | ipv6ospfv3usgv6ipsecsha2256sa001<br>0x697076366F7370666763375736776366970736563736861323235367361303031 |

| SA2                      |   |
|--------------------------|---|
| SPI                      | 0x2000  |
| Encryption Algorithm     | ENCR_AES_CBC (128-bit)  |
| Encryption Key           | ipv6ospfaescbc02<br>0x697076366F7370666165736362633032  |
| Authentication Algorithm | AUTH_HMAC_SHA2_256_128  |
| Authentication Key       | ipv6ospfv3usgv6ipsecsha2256sa002<br>0x697076366F7370666763375736776366970736563736861323235367361303032 |

**Procedure:**

**Part A: Security enabled**

| Step | Action                          | Expected Result |
|------|---------------------------------|-----------------|
| 1.   | Shutdown OSPFv3 on all Routers. |                 |



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|    |   |   |
|----|---|---|
| 2. | On both TR1 and TR2, configure OSPFv3 with IPsec using SA-1 between TR1 and TR2 on Link2. |   |
| 3. | Enable OSPFv3 on all routers.   |   |
| 4. | Wait for adjacency to form in state Full.   | OSPFv3 Packets are Encrypted.                                   |
| 5. | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link3<br>5 H2 |

Part B: Discard unprotected OSPF Packets

| Step | Action   | Expected Result  |
|------|--|--|
| 6.   | Shutdown OSPFv3 on all Routers.  |  |
| 7.   | On TR1 only, configure OSPFv3 with IPsec using SA-1 between TR1 and TR2 on Link2. TR2 does not have OSPFv3 Security Enabled.     |  |
| 8.   | Enable OSPFv3 on all routers.  |  |
| 9.   | Wait at least RouterDeadInterval.  | OSPFv3 Packets from TR1 are Encrypted. OSPFv3 Packets from TR2 are not protected with ESP. |
| 10.  | Transmit Traffic from H1 to H2.  | Traffic is not transmitted from H1 to H2.  |
| 11.  | On TR2 only, configure OSPFv3 with IPsec using SA-1 between TR1 and TR2 on Link2. TR1 continues to have OSPFv3 Security Enabled. |  |
| 12.  | Wait for adjacency to form in state Full.  | OSPFv3 Packets are Encrypted.  |
| 13.  | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link3<br>5 H2                            |

Part C: Rekeying

| Step | Action                          | Expected Result |
|------|---------------------------------|-----------------|
| 14.  | Shutdown OSPFv3 on all Routers. |                 |

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|     |   |  |
|-----|---|--|
| 15. | On both TR1 and TR2, configure OSPFv3 with IPsec using SA-1 between TR1 and TR2 on Link2.         |  |
| 16. | Enable OSPFv3 on all routers.   |  |
| 17. | Wait for adjacency to form in state Full.   | OSPFv3 Packets are Encrypted utilizing SA-1.   |
| 18. | Transmit Traffic from H1 to H2. Traffic continues to be transmitted for the duration of the test. | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link3<br>5 H2  |
| 19. | On both TR1 and TR2, configure OSPFv3 with IPsec using SA-2 between TR1 and TR2 on Link2.         | OSFPv3 Packets are Encrypted utilizing SA-2. Traffic Transmitted between H1 and H2 is not disrupted. OSFPv3 Adjacency is not lost or rebuilt during the configuration of the new SA. |

**Possible Problems:**

- If any of the routers is not able to utilize the given encryption algorithm, NULL Encryption may be used instead.
- If any of the routers is not able to utilize the given authentication algorithm, AUTH\_HMAC\_SHA1\_96 Authentication may be used instead.
- The keys specified may be substituted with different ASCII keys, or keys in HEX format.

### OSPFv3.IO.5.2: IPsec Security with Virtual Link

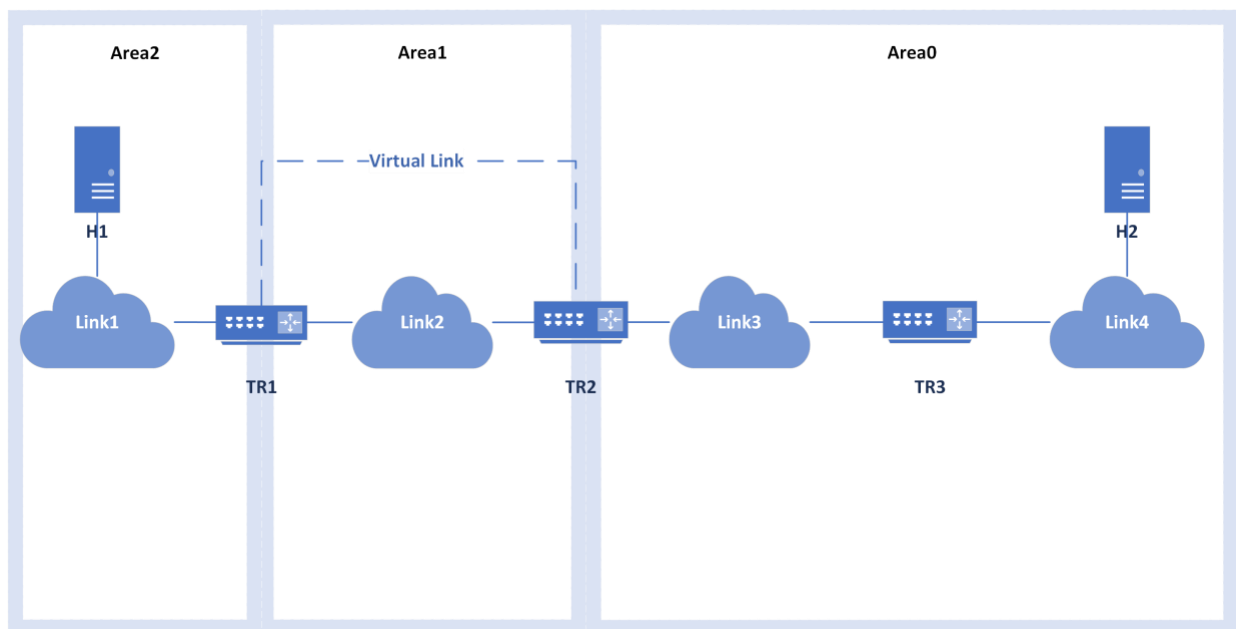
**Purpose:** Test the functionality of OSPF when IPsec ESP over an OSPFv3 Virtual Link is used to ensure the authentication, confidentiality, and integrity of the neighbor.

**References:**

- [OSPFv2] – 5, 16
- [OSPF IPv6] – 4.7
- [OSPF IPsec]
- [IPsec]
- [ESP]

**Test Setup:** All Routers follow [common configuration](#).

- Area Assignments
  - TR1
    - Link1: Area 2
    - Link2: Area 1
  - TR2
    - Link2: Area 1
    - Link3: Area 0
  - TR3
    - Link3: Area 0
    - Link4: Area 0
- Utilize the necessary IPsec Manual Key Security association between TR1 and TR2 on Link2 using the keys and algorithms specified below to secure the OSPFv3 Virtual Link.



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| SA1                      |  |
|--------------------------|--|
| SPI                      | 0x1000   |
| Encryption Algorithm     | ENCR_AES_CBC (128-bit)   |
| Encryption Key           | ipv6ospfaescbc01<br>0x697076366F7370666165736362633031   |
| Authentication Algorithm | AUTH_HMAC_SHA2_256_128   |
| Authentication Key       | ipv6ospfv3usgv6ipsecsa2256sa001<br>0x697076366F7370666763375736776366970736563736861323235367361303031 |

**Procedure:**

Part A: Virtual Link Security Enabled

| Step | Action   | Expected Result  |
|------|--|--|
| 1.   | Shutdown OSPFv3 on all Routers.  |  |
| 2.   | Configure a Virtual Link between TR1 and TR2.  |  |
| 3.   | On both TR1 and TR2, configure OSPFv3 with IPsec, for the previously configured Virtual Link, using SA-1 between TR1 and TR2 on Link2. |  |
| 4.   | Enable OSPFv3 on all routers.  |  |
| 5.   | Wait for adjacency to form in state Full.  | OSPFv3 Virtual Link Packets are Encrypted.                                 |
| 6.   | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link3<br>5 Link4<br>6 H2 |

Part B: Discard Unprotected Virtual Link Packets

| Step | Action   | Expected Result |
|------|--|-----------------|
| 7.   | Shutdown OSPFv3 on all Routers.  |                 |
| 8.   | Configure a Virtual Link between TR1 and TR2.  |                 |
| 9.   | On TR1 only, configure OSPFv3 with IPsec, for the previously configured Virtual Link, using SA-1 between TR1 and TR2 on Link2. |                 |
| 10.  | Enable OSPFv3 on all routers.  |                 |

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|     |  |  |
|-----|--|--|
| 11. | Wait at least RouterDeadInterval.  | The Virtual Link and adjacency are not established.                        |
| 12. | Transmit Traffic from H1 to H2.  | Traffic is not transmitted from H1 to H2.                                  |
| 13. | On TR2 only, configure OSPFv3 with IPsec, for the previously configured Virtual Link, using SA-1 between TR1 and TR2 on Link2. |  |
| 14. | Wait for adjacency to form in state Full.  | OSPFv3 Virtual Link Packets are Encrypted.                                 |
| 15. | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link3<br>5 Link4<br>6 H2 |

**Possible Problems:**

- If any of the routers is not able to utilize the given encryption algorithm, NULL Encryption may be used instead.
- If any of the routers is not able to utilize the given authentication algorithm, AUTH\_HMAC\_SHA1\_96 Authentication may be used instead.
- The keys specified may be substituted with different ASCII keys, or keys in HEX format.

### OSPFv3.IO.5.3: IPsec Algorithms and Keys

**Purpose:** Test the functionality of OSPF when IPsec ESP is used with different algorithms and key formats to ensure the authentication, confidentiality, and integrity of the neighbor.

**References:**

- [OSPF IPv6] – 2.6
- [OSPF IPsec]
- [IPsec]
- [ESP]

**Test Setup:** All Routers follow [common configuration](#).

- Utilize the necessary IPsec Manual Key Security association between TR1 and TR2 on Link2 using the keys and algorithms specified below to secure the OSPFv3 packets.



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| SA1  |  |
|------|--|
| Part | Algorithm / Key  |
| A    | ENCR_AES_CBC (128-bit)   |
|      | ipv6ospfaescbc01   |
|      | AUTH_HMAC_SHA2_256_128   |
|      | ipv6ospfv3usgv6ipsecsha2256sa001                                 |
| B    | ENCR_NULL  |
|      |  |
|      | AUTH_HMAC_SHA2_256_128   |
|      | ipv6ospfv3usgv6ipsecsha2256sa001                                 |
| C    | ENCR_AES_CBC (128-bit)   |
|      | ipv6ospfaescbc01   |
|      | AUTH_HMAC_SHA1_96  |
|      | ipv6ospfv3usgv6sha01   |
| D    | ENCR_NULL  |
|      |  |
|      | AUTH_HMAC_SHA1_96  |
|      | ipv6ospfv3usgv6sha01   |
| E    | ENCR_AES_CBC (128-bit)   |
|      | 0102030405060708090A0B0C0D0E0F10                                 |
|      | AUTH_HMAC_SHA2_256_128   |
|      | 0102030405060708090A0B0C0D0E0F101112131415161718191A1B1C1D1E1F20 |

*A SPI of 0x1000 is used for all parts. This may be substituted.*

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**Procedure:**

All Parts: Algorithms and Keys

| Step | Action  | Expected Result   |
|------|---|---|
| 1.   | Shutdown OSPFv3 on all Routers.   |   |
| 2.   | On both TR1 and TR2, configure OSPFv3 with IPsec using SA-1 between TR1 and TR2 on Link2. |   |
| 3.   | Enable OSPFv3 on all routers.   |   |
| 4.   | Wait for adjacency to form in state Full.   | OSPFv3 Packets are Encrypted.                                   |
| 5.   | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link3<br>5 H2 |

**Possible Problems:**

- Parts A-D: Keys may be substituted for these test cases in either ASCII or HEX format. Algorithms may **not** be substituted. An ASCII key formatted as hexadecimal is acceptable.
- Part E: Algorithms may be substituted for this test part, and the key may be lengthened or shortened as needed.
  - The format of the key may **not** be substituted.
  - A hexadecimal key (that is not limited to the subset of ASCII characters) **must** be used. An ASCII key formatted as hexadecimal is **not** acceptable. For example, should SHA1 be substituted as algorithm, the following key (represented as bytes) is acceptable: **0102030405060708090A0B0C0D0E0F1011121314** , the following key is unacceptable (byte-encoded ASCII string): **697076366F737066763375736776367368613031**



## Group 6: Authentication Trailer for OSPF

### Overview

The goal of this section is to confirm OSPF Security through OSPF with OSPF Authentication Trailer.

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### OSPFv3.IO.6.1: Authentication Trailer with HMAC-SHA-256

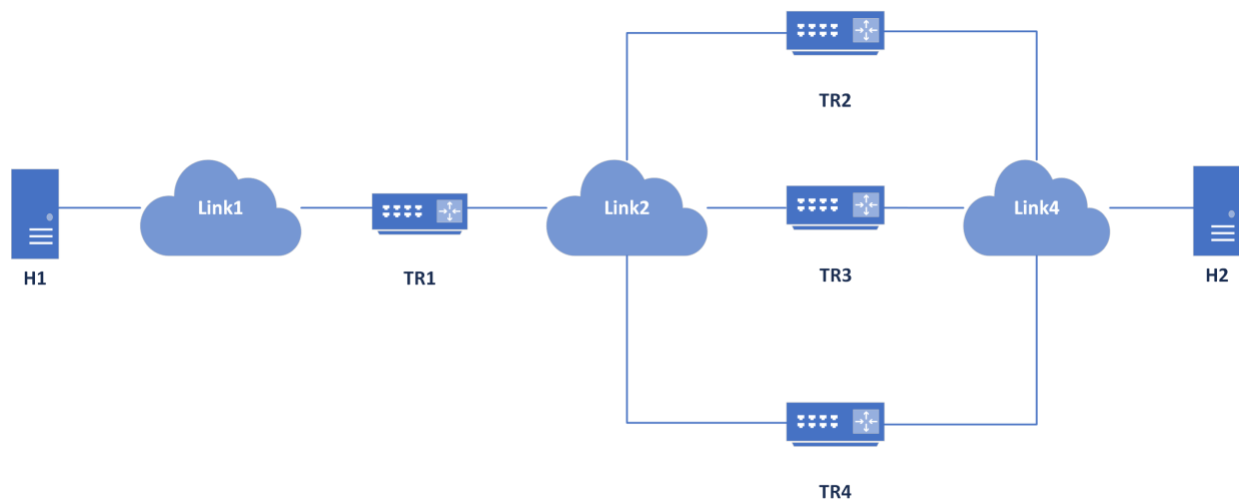
**Purpose:** Test the functionality of OSPF when OSPFv3 Authentication Trailer is used to ensure the authentication of the OSPFv3 neighbor.

**References:**

- [OSPF IPv6]
- [OSPF Auth]

**Test Setup:** All Routers follow [common configuration](#).

- Utilize the necessary OSPFv3 Security Associations between TR1 and TR2 on Link2 using the keys and algorithms specified below



| OSPFv3 Key Chain         |                                       |
|--------------------------|---------------------------------------|
| Authentication Key Chain | Key #1 (Unless modified by Procedure) |

| Key #1 (Expires First)   |                 |
|--------------------------|-----------------|
| Key ID                   | 1               |
| Authentication Algorithm | HMAC-SHA-256    |
| Authentication Key       | ospfv3authkey01 |
| KeyStartAccept           | Immediately     |
| KeyStartGenerate         | Immediately     |
| KeyStopGenerate          | Now + 5 Minutes |
| KeyStopAccept            | Now + 6 Minutes |

| Key #2 (Expires Last)    |              |
|--------------------------|--------------|
| Key ID                   | 2            |
| Authentication Algorithm | HMAC-SHA-256 |

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|                    |                  |
|--------------------|------------------|
| Authentication Key | ospfv3authkey02  |
| KeyStartAccept     | Immediately      |
| KeyStartGenerate   | Immediately      |
| KeyStopGenerate    | Now + 60 Minutes |
| KeyStopAccept      | Now + 65 Minutes |

| Key #3 (Expires Last, Highest Key ID) |                  |
|---------------------------------------|------------------|
| Key ID                                | 3                |
| Authentication Algorithm              | HMAC-SHA-256     |
| Authentication Key                    | ospfv3authkey03  |
| KeyStartAccept                        | Immediately      |
| KeyStartGenerate                      | Immediately      |
| KeyStopGenerate                       | Now + 60 Minutes |
| KeyStopAccept                         | Now + 65 Minutes |

**Procedure:**

**Part A: Authentication Trailer TR2**

| Step | Action  | Expected Result   |
|------|---|---|
| 1.   | Shutdown OSPFv3 on all Routers.   |   |
| 2.   | On both TR1 and TR2, configure OSPFv3 with Authentication Trailer using only Key #1 in the Key Chain. |   |
| 3.   | Enable OSPFv3 on TR1 and TR2.   |   |
| 4.   | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 5.   | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

**Part B: Authentication Trailer TR3**

| Step | Action  | Expected Result                                    |
|------|---|--|
| 6.   | Shutdown OSPFv3 on all Routers.   |  |
| 7.   | On both TR1 and TR3, configure OSPFv3 with Authentication Trailer using only Key #1 in the Key Chain. |  |
| 8.   | Enable OSPFv3 on TR1 and TR3.   |  |
| 9.   | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer. |
| 10.  | Transmit Traffic from H1 to H2.   | Traffic Route:                                     |

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|  |  |   |
|--|--|---|
|  |  | 1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
|--|--|---|

Part C: Authentication Trailer TR4

| Step | Action  | Expected Result   |
|------|---|---|
| 11.  | Shutdown OSPFv3 on all Routers.   |   |
| 12.  | On both TR1 and TR4, configure OSPFv3 with Authentication Trailer using only Key #1 in the Key Chain. |   |
| 13.  | Enable OSPFv3 on TR1 and TR4.   |   |
| 14.  | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 15.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

Part D: Prefer Key that Expires Last TR2

| Step | Action   | Expected Result   |
|------|--|---|
| 16.  | Shutdown OSPFv3 on all Routers.  |   |
| 17.  | On both TR1 and TR2, configure OSPFv3 with Authentication Trailer using both Key #1 and Key #2 in the Key Chain. |   |
| 18.  | Enable OSPFv3 on TR1 and TR2.  |   |
| 19.  | Wait for adjacency to form in state Full.  | OSPFv3 Packets include the Authentication Trailer.              |
| 20.  | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

Part E: Prefer Key that Expires Last TR3

| Step | Action  | Expected Result |
|------|---|-----------------|
| 21.  | Shutdown OSPFv3 on all Routers.                                   |                 |
| 22.  | On both TR1 and TR3, configure OSPFv3 with Authentication Trailer |                 |

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|     |  |   |
|-----|--|---|
|     | using both Key #1 and Key #2 in the Key Chain. |   |
| 23. | Enable OSPFv3 on TR1 and TR3.                  |   |
| 24. | Wait for adjacency to form in state Full.      | OSPFv3 Packets include the Authentication Trailer.              |
| 25. | Transmit Traffic from H1 to H2.                | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

Part F: Prefer Key that Expires Last TR4

| Step | Action   | Expected Result   |
|------|--|---|
| 26.  | Shutdown OSPFv3 on all Routers.  |   |
| 27.  | On both TR1 and TR4, configure OSPFv3 with Authentication Trailer using both Key #1 and Key #2 in the Key Chain. |   |
| 28.  | Enable OSPFv3 on TR1 and TR4.  |   |
| 29.  | Wait for adjacency to form in state Full.  | OSPFv3 Packets include the Authentication Trailer.              |
| 30.  | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

Part G: Prefer Highest Key ID TR2

| Step | Action   | Expected Result                                    |
|------|--|--|
| 31.  | Shutdown OSPFv3 on all Routers.  |  |
| 32.  | On both TR1 and TR2, configure OSPFv3 with Authentication Trailer using Key #1, Key #2, and Key #3 in the Key Chain. |  |
| 33.  | Enable OSPFv3 on TR1 and TR2.  |  |
| 34.  | Wait for adjacency to form in state Full.  | OSPFv3 Packets include the Authentication Trailer. |
| 35.  | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2       |

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|  |  |                 |
|--|--|-----------------|
|  |  | 4 Link4<br>5 H2 |
|--|--|-----------------|

Part H: Prefer Highest Key ID TR3

| Step | Action   | Expected Result   |
|------|--|---|
| 36.  | Shutdown OSPFv3 on all Routers.  |   |
| 37.  | On both TR1 and TR3, configure OSPFv3 with Authentication Trailer using Key #1, Key #2, and Key #3 in the Key Chain. |   |
| 38.  | Enable OSPFv3 on TR1 and TR3.  |   |
| 39.  | Wait for adjacency to form in state Full.  | OSPFv3 Packets include the Authentication Trailer.              |
| 40.  | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

Part I: Prefer Highest Key ID TR4

| Step | Action   | Expected Result   |
|------|--|---|
| 41.  | Shutdown OSPFv3 on all Routers.  |   |
| 42.  | On both TR1 and TR4, configure OSPFv3 with Authentication Trailer using Key #1, Key #2, and Key #3 in the Key Chain. |   |
| 43.  | Enable OSPFv3 on TR1 and TR4.  |   |
| 44.  | Wait for adjacency to form in state Full.  | OSPFv3 Packets include the Authentication Trailer.              |
| 45.  | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

**Possible Problems:**

Routers may not support overlapping keys in their keychain.

OSPFv3.IO.6.2: Key Changes

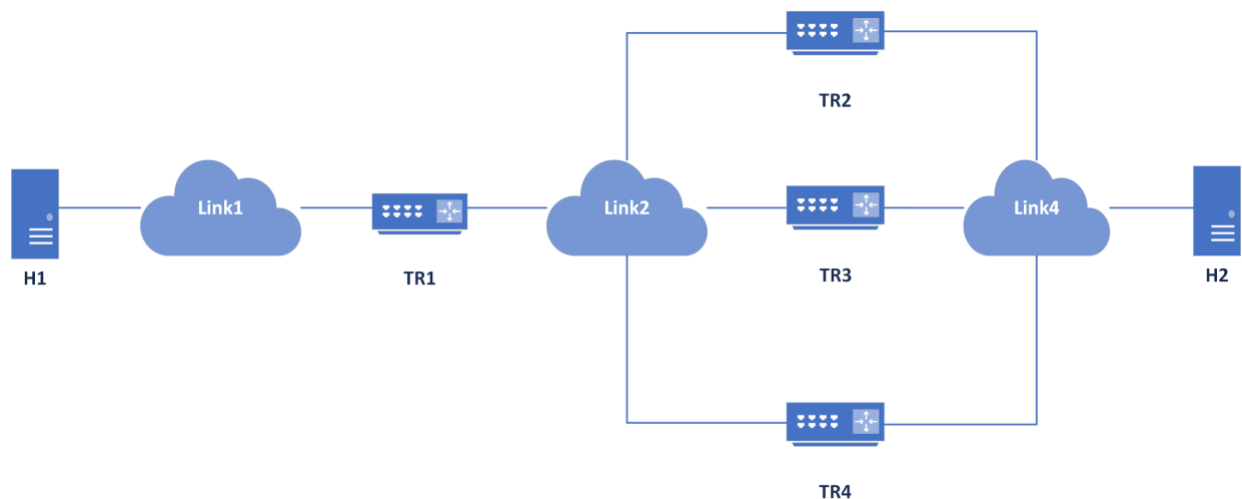
**Purpose:** Test the functionality of OSPF when OSPFv3 Authentication Trailer is used to ensure the authentication of the neighbor under key change scenarios.

**References:**

- [OSPF IPv6]
- [OSPF Auth]

**Test Setup:** All Routers follow [common configuration](#).

- Utilize the necessary OSPFv3 Security Associations between TR1 and TR2 on Link2 using the keys and algorithms specified below



| OSPFv3 Key Chain         |                                       |
|--------------------------|---------------------------------------|
| Authentication Key Chain | Key #1 (Unless modified by Procedure) |

| Key #1 (Expires First)   |                 |
|--------------------------|-----------------|
| Key ID                   | 1               |
| Authentication Algorithm | HMAC-SHA-256    |
| Authentication Key       | ospfv3authkey01 |
| KeyStartAccept           | Immediately     |
| KeyStartGenerate         | Immediately     |
| KeyStopGenerate          | Now + 4 Minutes |
| KeyStopAccept            | Now + 5 Minutes |

| Key #2 |   |
|--------|---|
| Key ID | 2 |

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|                          |                  |
|--------------------------|------------------|
| Authentication Algorithm | HMAC-SHA-256     |
| Authentication Key       | ospfv3authkey02  |
| KeyStartAccept           | Now + 2 Minutes  |
| KeyStartGenerate         | Now + 3 Minutes  |
| KeyStopGenerate          | Now + 10 Minutes |
| KeyStopAccept            | Now + 10 Minutes |

| Key #3                   |                 |
|--------------------------|-----------------|
| Key ID                   | 3               |
| Authentication Algorithm | HMAC-SHA-256    |
| Authentication Key       | ospfv3authkey03 |
| KeyStartAccept           | Immediately     |
| KeyStartGenerate         | Immediately     |
| KeyStopGenerate          | Now + 2 Minutes |
| KeyStopAccept            | Now + 3 Minutes |

| Key #4 TR1               |                    |
|--------------------------|--------------------|
| Key ID                   | 4                  |
| Authentication Algorithm | HMAC-SHA-256       |
| Authentication Key       | ospfv3authkey04tr1 |
| KeyStartAccept           | Now + 2 Minutes    |
| KeyStartGenerate         | Now + 3 Minutes    |
| KeyStopGenerate          | Now + 10 Minutes   |
| KeyStopAccept            | Now + 10 Minutes   |

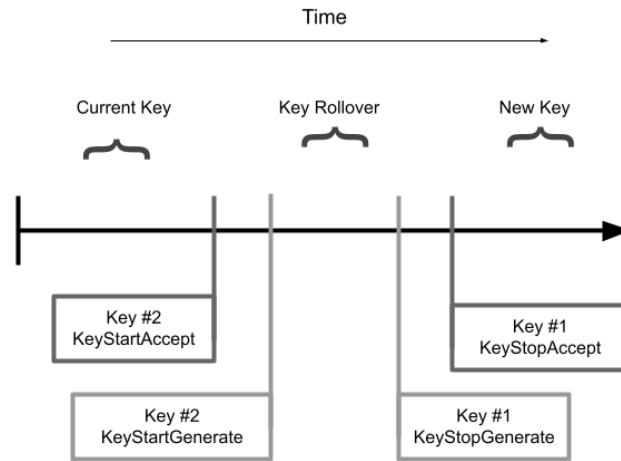
| Key #4 TR2, TR3 & TR4    |                  |
|--------------------------|------------------|
| Key ID                   | 4                |
| Authentication Algorithm | HMAC-SHA-256     |
| Authentication Key       | ospfv3authkey04  |
| KeyStartAccept           | Now + 2 Minutes  |
| KeyStartGenerate         | Now + 3 Minutes  |
| KeyStopGenerate          | Now + 10 Minutes |
| KeyStopAccept            | Now + 10 Minutes |

| Key #5                   |                 |
|--------------------------|-----------------|
| Key ID                   | 5               |
| Authentication Algorithm | HMAC-SHA-256    |
| Authentication Key       | ospfv3authkey01 |
| KeyStartAccept           | Immediately     |
| KeyStartGenerate         | Immediately     |



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|                 |                 |
|-----------------|-----------------|
| KeyStopGenerate | Now + 4 Minutes |
| KeyStopAccept   | Now + 5 Minutes |



**Procedure:**

**Part A: Key Rollover TR2**

| Step | Action  | Expected Result   |
|------|---|---|
| 1.   | Shutdown OSPFv3 on all Routers.   |   |
| 2.   | On both TR1 and TR2, configure OSPFv3 with Authentication Trailer using Key #1 and Key #2 in the Key Chain. |   |
| 3.   | Enable OSPFv3 on TR1 and TR2.   |   |
| 4.   | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 5.   | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 6.   | Wait approximately 5 Minutes.   |   |
| 7.   | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

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Part B: Key Rollover TR3

| Step | Action  | Expected Result   |
|------|---|---|
| 8.   | Shutdown OSPFv3 on all Routers.   |   |
| 9.   | On both TR1 and TR3, configure OSPFv3 with Authentication Trailer using Key #1 and Key #2 in the Key Chain. |   |
| 10.  | Enable OSPFv3 on TR1 and TR3.   |   |
| 11.  | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 12.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 13.  | Wait approximately 5 Minutes.   |   |
| 14.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

Part C: Key Rollover TR4

| Step | Action  | Expected Result   |
|------|---|---|
| 15.  | Shutdown OSPFv3 on all Routers.   |   |
| 16.  | On both TR1 and TR4, configure OSPFv3 with Authentication Trailer using Key #1 and Key #2 in the Key Chain. |   |
| 17.  | Enable OSPFv3 on TR1 and TR4.   |   |
| 18.  | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 19.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 20.  | Wait approximately 5 Minutes.   |   |
| 21.  | Transmit Traffic from H1 to H2.   | Traffic Route:  |

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|  |  |   |
|--|--|---|
|  |  | 1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
|--|--|---|

Part D: Key Expiry TR2

| Step | Action  | Expected Result   |
|------|---|---|
| 22.  | Shutdown OSPFv3 on all Routers.   |   |
| 23.  | On both TR1 and TR2, configure OSPFv3 with Authentication Trailer using only Key #3 in the Key Chain. |   |
| 24.  | Enable OSPFv3 on TR1 and TR2.   |   |
| 25.  | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 26.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 27.  | Wait approximately 5 Minutes.   |   |
| 28.  | Transmit Traffic from H1 to H2.   | Traffic is not transmitted from H1 to H2.                       |

Part E: Key Expiry TR3

| Step | Action  | Expected Result   |
|------|---|---|
| 29.  | Shutdown OSPFv3 on all Routers.   |   |
| 30.  | On both TR1 and TR3, configure OSPFv3 with Authentication Trailer using only Key #3 in the Key Chain. |   |
| 31.  | Enable OSPFv3 on TR1 and TR3.   |   |
| 32.  | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 33.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 34.  | Wait approximately 5 Minutes.   |   |
| 35.  | Transmit Traffic from H1 to H2.   | Traffic is not transmitted from H1 to H2.                       |

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Part F: Key Expiry TR4

| Step | Action  | Expected Result   |
|------|---|---|
| 36.  | Shutdown OSPFv3 on all Routers.   |   |
| 37.  | On both TR1 and TR4, configure OSPFv3 with Authentication Trailer using only Key #3 in the Key Chain. |   |
| 38.  | Enable OSPFv3 on TR1 and TR4.   |   |
| 39.  | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 40.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 41.  | Wait approximately 5 Minutes.   |   |
| 42.  | Transmit Traffic from H1 to H2.   | Traffic is not transmitted from H1 to H2.                       |

Part G: Key Mismatch causes Discard TR2

| Step | Action   | Expected Result   |
|------|--|---|
| 43.  | Shutdown OSPFv3 on all Routers.  |   |
| 44.  | On both TR1 and TR2, configure OSPFv3 with Authentication Trailer using Key #1 and Key #4 in the Key Chain. Note that TR1 and TR2 use different keys for Key #4. |   |
| 45.  | Enable OSPFv3 on TR1 and TR2.  |   |
| 46.  | Wait for adjacency to form in state Full.  | OSPFv3 Packets include the Authentication Trailer.              |
| 47.  | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 48.  | Wait approximately 5 Minutes.  |   |
| 49.  | Transmit Traffic from H1 to H2.  | Traffic is not transmitted from H1 to H2.                       |

Part H: Key Mismatch causes Discard TR3

| Step | Action                          | Expected Result |
|------|---------------------------------|-----------------|
| 50.  | Shutdown OSPFv3 on all Routers. |                 |

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|     |  |   |
|-----|--|---|
| 51. | On both TR1 and TR3, configure OSPFv3 with Authentication Trailer using Key #1 and Key #4 in the Key Chain. Note that TR1 and TR3 use different keys for Key #4. |   |
| 52. | Enable OSPFv3 on TR1 and TR3.  |   |
| 53. | Wait for adjacency to form in state Full.  | OSPFv3 Packets include the Authentication Trailer.              |
| 54. | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 55. | Wait approximately 5 Minutes.  |   |
| 56. | Transmit Traffic from H1 to H2.  | Traffic is not transmitted from H1 to H2.                       |

Part I: Key Mismatch causes Discard TR4

| Step | Action   | Expected Result   |
|------|--|---|
| 57.  | Shutdown OSPFv3 on all Routers.  |   |
| 58.  | On both TR1 and TR4, configure OSPFv3 with Authentication Trailer using Key #1 and Key #4 in the Key Chain. Note that TR1 and TR4 use different keys for Key #4. |   |
| 59.  | Enable OSPFv3 on TR1 and TR4.  |   |
| 60.  | Wait for adjacency to form in state Full.  | OSPFv3 Packets include the Authentication Trailer.              |
| 61.  | Transmit Traffic from H1 to H2.  | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 62.  | Wait approximately 5 Minutes.  |   |
| 63.  | Transmit Traffic from H1 to H2.  | Traffic is not transmitted from H1 to H2.                       |

Part J: SA ID Mismatch causes Discard TR2

| Step | Action                          | Expected Result |
|------|---------------------------------|-----------------|
| 64.  | Shutdown OSPFv3 on all Routers. |                 |

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|     |  |   |
|-----|--|---|
| 65. | On TR1, configure OSPFv3 with Authentication Trailer using only Key #1 in the Key Chain. |   |
| 66. | On TR2, configure OSPFv3 with Authentication Trailer using only Key #5 in the Key Chain. |   |
| 67. | Enable OSPFv3 on TR1 and TR2.  |   |
| 68. | Wait approximately RouterDeadInterval.   |   |
| 69. | Transmit Traffic from H1 to H2.  | Traffic is not transmitted from H1 to H2. |

Part K: SA ID Mismatch causes Discard TR3

| Step | Action   | Expected Result                           |
|------|--|---|
| 70.  | Shutdown OSPFv3 on all Routers.  |   |
| 71.  | On TR1, configure OSPFv3 with Authentication Trailer using only Key #1 in the Key Chain. |   |
| 72.  | On TR3, configure OSPFv3 with Authentication Trailer using only Key #5 in the Key Chain. |   |
| 73.  | Enable OSPFv3 on TR1 and TR3.  |   |
| 74.  | Wait approximately RouterDeadInterval.   |   |
| 75.  | Transmit Traffic from H1 to H2.  | Traffic is not transmitted from H1 to H2. |

Part L: SA ID Mismatch causes Discard TR4

| Step | Action   | Expected Result                           |
|------|--|---|
| 76.  | Shutdown OSPFv3 on all Routers.  |   |
| 77.  | On TR1, configure OSPFv3 with Authentication Trailer using only Key #1 in the Key Chain. |   |
| 78.  | On TR4, configure OSPFv3 with Authentication Trailer using only Key #5 in the Key Chain. |   |
| 79.  | Enable OSPFv3 on TR1 and TR4.  |   |
| 80.  | Wait approximately RouterDeadInterval.   |   |
| 81.  | Transmit Traffic from H1 to H2.  | Traffic is not transmitted from H1 to H2. |

Possible Problems:

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- Routers may not support overlapping keys in their keychain. Therefore, the router **MUST** be able to set the new keys KeyStartGenerate time equal to the KeyStopGenerate time of the old key.

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### OSPFv3.IO.6.3: Sequence Number Across Reboot

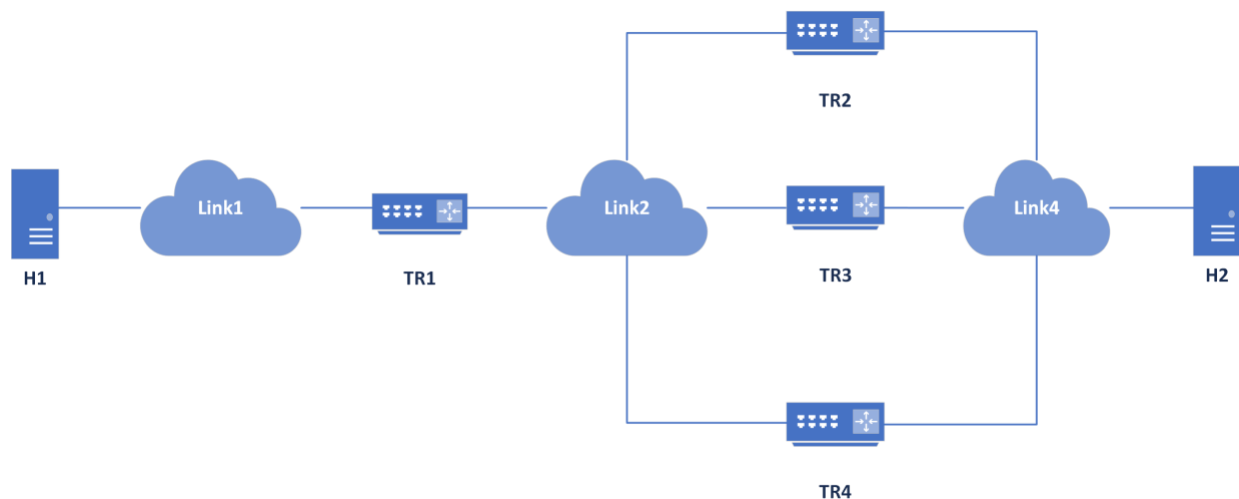
**Purpose:** Test the functionality of OSPF when OSPFv3 Authentication Trailer is used and a device undergoes a reboot.

**References:**

- [OSPF IPv6]
- [OSPF Auth]

**Test Setup:** All Routers follow [common configuration](#).

- Utilize the necessary OSPFv3 Security Associations between TR1 and TR2 on Link2 using the keys and algorithms specified below



| OSPFv3 Key Chain         |                                       |
|--------------------------|---------------------------------------|
| Authentication Key Chain | Key #1 (Unless modified by Procedure) |

| Key #1 (Expires First)   |                  |
|--------------------------|------------------|
| Key ID                   | 1                |
| Authentication Algorithm | HMAC-SHA-256     |
| Authentication Key       | ospfv3authkey01  |
| KeyStartAccept           | Immediately      |
| KeyStartGenerate         | Immediately      |
| KeyStopGenerate          | Now + 60 Minutes |
| KeyStopAccept            | Now + 60 Minutes |

**Procedure:**

**Part A: Reboot With TR2**

| Step | Action | Expected Result |
|------|--------|-----------------|
|------|--------|-----------------|



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|    |   |   |
|----|---|---|
| 1. | Shutdown OSPFv3 on all Routers.   |   |
| 2. | On both TR1 and TR2, configure OSPFv3 with Authentication Trailer using only Key #1 in the Key Chain. |   |
| 3. | Enable OSPFv3 on TR1 and TR2.   |   |
| 4. | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 5. | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 6. | Reboot TR1 or cause a cold reset.   |   |
| 7. | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 8. | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

**Part B: Reboot With TR3**

| Step | Action  | Expected Result   |
|------|---|---|
| 9.   | Shutdown OSPFv3 on all Routers.   |   |
| 10.  | On both TR1 and TR3, configure OSPFv3 with Authentication Trailer using only Key #1 in the Key Chain. |   |
| 11.  | Enable OSPFv3 on TR1 and TR3.   |   |
| 12.  | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 13.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 14.  | Reboot TR1 or cause a cold reset.   |   |
| 15.  | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 16.  | Transmit Traffic from H1 to H2.   | Traffic Route:  |

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|  |  |   |
|--|--|---|
|  |  | 1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
|--|--|---|

Part C: Reboot With TR4

| Step | Action  | Expected Result   |
|------|---|---|
| 17.  | Shutdown OSPFv3 on all Routers.   |   |
| 18.  | On both TR1 and TR4, configure OSPFv3 with Authentication Trailer using only Key #1 in the Key Chain. |   |
| 19.  | Enable OSPFv3 on TR1 and TR4.   |   |
| 20.  | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 21.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |
| 22.  | Reboot TR1 or cause a cold reset.   |   |
| 23.  | Wait for adjacency to form in state Full.   | OSPFv3 Packets include the Authentication Trailer.              |
| 24.  | Transmit Traffic from H1 to H2.   | Traffic Route:<br>1 H1<br>2 Link1<br>3 Link2<br>4 Link4<br>5 H2 |

Possible Problems:

- None

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## Modification Record

| Version | Date               | Editor                              | Modification   |
|---------|--------------------|-------------------------------------|--|
| 2.1     | December 2021      | Christopher Brown                   | <ul style="list-style-type: none"><li>• Updated section 6 topology and test cases by adding TR3 and TR4</li><li>• Added possible problem for section 5.2</li><li>• Added possible problem for section 6.2</li></ul>  |
| 2.0     | August 2021        | Christopher Brown<br>Timothy Carlin | <ul style="list-style-type: none"><li>• Incorporated Tests and Updates from IPv6 OSPFv3 IOT Test Suite (Chunghwa Telecom and NIST v.1.3)</li><li>• Added TR4</li><li>• Added Tests Parts for Intra and Inter Area Routes and Virtual Link</li><li>• Added Tests for Authentication Trailer</li><li>• Updates to procedure format</li><li>• Updates to Network Topology</li><li>• Updated common configuration and removed repetitive test setup procedures</li></ul> |
| 1.6     | September 9, 2008  | Timothy Winters                     | <ul style="list-style-type: none"><li>• Revised wording in test 1.5</li></ul>  |
| 1.5     | June 24, 2007      | Timothy Winters                     | <ul style="list-style-type: none"><li>• Removed test 1.4</li><li>• Removed RFC 1583 References</li><li>• Updated all tests</li><li>• Updated Table of Contents</li></ul>   |
| 1.4     | March 12, 2004     |                                     | <ul style="list-style-type: none"><li>• Modified test 1.3</li></ul>  |
| 1.3     | January 29, 2004   |                                     | <ul style="list-style-type: none"><li>• Removed Resource Requirements</li><li>• Updated Table of Contents</li></ul>  |
| 1.2     | May 31, 2002       |                                     |  |
| 1.1     | January 3, 2002    |                                     |  |
| 1.0     | September 25, 2001 |                                     |  |