ROUTING CONSORTIUM TEST SUITE

Border Gateway Protocol 4+
Over Internet Protocol Version 6
Multi-System Interoperability Test Suite

Technical Document

Version 2.1

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MODIFICATION RECORD

Version 2.1 June 22, 2010

- Added a third interoperability partner to test case 1.1 and 1.2.
- Traceroutes only needed to test transit and non-transit. Removed extraneous traceroutes.
- Added test cases to 1.2 for non-transit test cases.
- Changed focus of 1.3 to External and Internal BGP Peers.
- Changed focus of 1.4 to Internal BGP Peers.

Version 2.0 March 2, 2006

- Re-worded test procedures.
- Re-numbered test 2.1 and test 2.2 to test 1.3 and test 1.4 respectively
- Changed the RUT to be in AS 1 in test 1.2 and test 1.4

Version 1.1 June 17, 2005

- Re-worded test procedures.
- Re-ordered observable results.
- Changed TR3 to be TR2 in step 6 of test 2.2

Version 1.0 March 14, 2005

- Removed TR5 from Test 2.1, and 2.2
- Added updated pictures to the Test Suite.
- Changed the names of the Test Routers and Test Nodes in all tests.

Version 0.2 June 10, 2004

- Tests 2.1 and 2.2, added configuration on the RUT to include setting next-hop to self for internal peers.

Version 0.1 August 7, 2003

- Initial Version

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Ethan Burns	University of New Hampshire
Eric Barrett	University of New Hampshire
Andrew Gadzik	University of New Hampshire
Sagun Shakya	University of New Hampshire
Timothy Winters	University of New Hampshire
Fanny Xu	University of New Hampshire

INTRODUCTION

Overview

The University of New Hampshire's InterOperability Laboratory (UNH-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 BGP4+ based products. This test suite has been designed to test interoperability of the device under test with other BGP4+ 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 BGP4+ standard but they are designed as interoperability tests. These tests provide one method to isolate problems within the BGP4+ 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 BGP4+ capable devices. However, these tests do provide a reasonable level of confidence that the RUT will function well in most BGP4+ environment.

Abbreviations and Acronyms

Acronyms used in this Test Suite:

N: **N**etwork
RUT: **R**outer **U**nder **T**est
TR: **T**esting **R**outer
TN: **T**esting **N**ode
AS: **A**utonomous **S**ystem
ASN: Autonomous System Number

When several entities of the same type are present in a test configuration, a number is appended to the acronym to yield a label for each entity. For example, if there were three testing routers in the test configuration, they would be labeled TR1, TR2 and TR3.

Drawing conventions

External BGP connection:

Internal BGP connection:

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 by concatenating the short test suite name, the group number, and the test number within the group, separated by periods. The **Test Number** is the group and test number, also separated by a period. So, test label BGP4+_INTEROP.1.2 refers to the second test of the first test group in the BGP4+ InterOperability suite. The test number is 1.2.

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 for that parameter.

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 packet 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:

- [RFC 4760] "Multiprotocol Extensions for BGP-4", Request for Comments 4760

Test BGP4+_INTEROP.1.1: Transit-AS, External BGP peers

Purpose: To verify that a transit-AS BGP4+ router correctly communicates routes to other external BGP4+ router peers.

References:

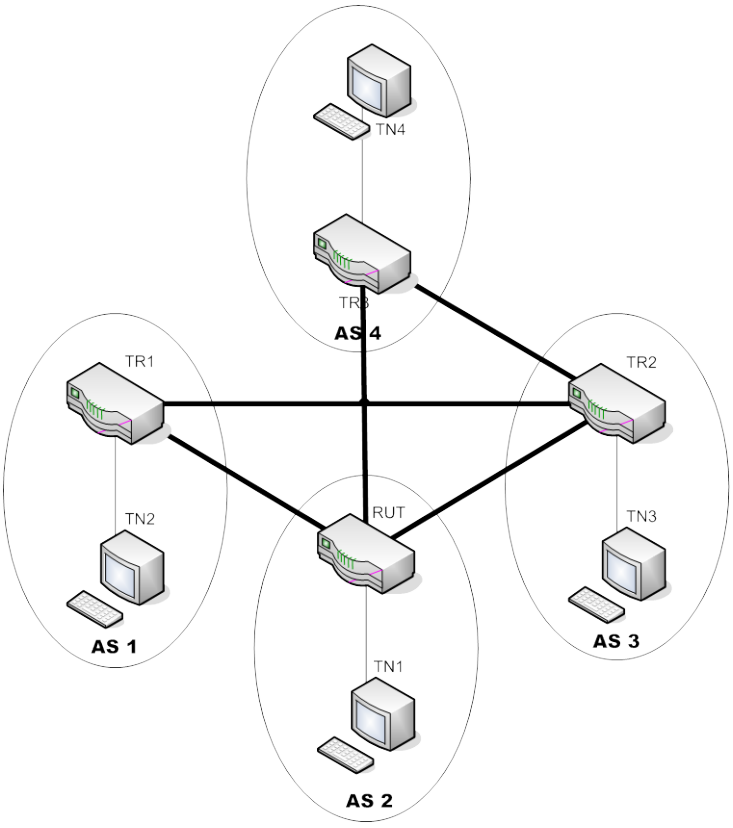
- [RFC 4760] – Section 3

Resource Requirements:

- Utility Program: traceroute

Discussion: This test verifies that the RUT can successfully communicate route information to other external BGP4+ router peers. An AS is called transit if it carries any traffic that neither originates nor terminates at that AS, while an AS is called non-transit if it only carries traffic that either originates or terminates at that AS. The RUT resides in a transit AS since the AS carries transit traffic in some cases.

Test Setup: Configure the RUT to be external peers with TR1, TR2 and TR3. Configure TR1 and TR2 to be external peers. Configure TR2 and TR3 to be external peers.



Procedure:
Part A: External BGP Peer Establishments

1. TR1 and TR2 are not configured as external peers.
2. TR2 and TR3 are not configured as external peers.
3. Disable TR3.
4. Perform a traceroute from TN2 to TN3.
5. Observe the traffic on all networks.
6. Enable TR3. Disable TR1.
7. Perform a traceroute from TN4 to TN3.
8. Observe the traffic on all networks.

Part B: External BGP Peer Establishment, Shorter AS Path

9. Disable TR3.
10. Perform a traceroute from TN2 to TN3.
11. Observe traffic on all networks.
12. Enable TR3. Disable TR1.
13. Perform a traceroute from TN4 to TN3.
14. Observe the traffic on all networks.

Part C: Accepting AS Path Change

15. Disable TR3.
16. Configure TR2 to prepend its own AS number three times on outgoing UPDATES to TR1.
17. Perform a traceroute from TN2 to TN3.
18. Observe the traffic on all networks.
19. Enable TR3. Disable TR1.
20. Configure TR2 to prepend its own AS number three times outgoing UPDATES to TR3.
21. Perform a traceroute from TN4 to TN3.
22. Observe the traffic on all networks.

Part D: Advertising AS Path Change

23. Disable TR3.
24. Configure TR2 to prepend its own AS number three times on outgoing UPDATES to TR1.
25. Configure the RUT to prepend its own AS number four times on outgoing UPDATES to TR1.
26. Perform a traceroute from TN4 to TN3.
27. Observe the traffic on all networks.
28. Enable TR3. Disable TR1.
29. Configure TR2 to prepend its own AS number three times on outgoing UPDATES to TR3.
30. Configure the RUT to prepend its own AS number four times on outgoing UPDATES to TR3.
31. Perform a traceroute from TN4 to TN3.
32. Observe the traffic on all networks.

Part E: External BGP Peer Removal

33. Disable TR3.
34. Configure TR1 to disable TR2 as its peer.
35. Perform a traceroute from TN2 to TN3.
36. Observe the traffic on all networks.
37. Enable TR3. Disable TR1.
38. Configure TR3 to disable TR2 as its peer.
39. Perform a traceroute from TN4 to TN3.
40. Observe the traffic on all networks.

Part F: External BGP Peer Reestablishment

41. Disable TR3.
42. Configure TR1 to disable TR2 as its peer.
43. Perform a traceroute from TN2 to TN3.
44. Observe the traffic on all networks.

45. Configure TR1 and TR2 to be peers.
46. Perform a traceroute from TN2 to TN3.
47. Observe the traffic on all networks.
48. Enable TR3. Disable TR1.
49. Configure TR3 to disable TR2 as its peer.
50. Perform a traceroute from TN4 to TN3.
51. Observe the traffic on all networks
52. Configure TR3 and TR2 to be peers.
53. Perform a traceroute from TN4 to TN3.
54. Observe the traffic on all networks.

Observable Results:

- In Part A, traceroute results should be as follows:
  Step 5: TN2->TR1->RUT->TR2->TN3
  Step 8: TN4->TR3->RUT->TR2->TN3
- In Part B, traceroute results should be as follows:
  Step 11: TN2->TR1->TR2->TN3
  Step 14: TN4->TR3->TR2->TN3
- In Part C, traceroute results should be as follows:
  Step 18: TN2->TR1->RUT->TR2->TN3
  Step 22: TN4->TR3->RUT->TR2->TN3
- In Part D, traceroute results should be as follows:
  Step 27: TN2->TR1->TR2->TN3
  Step 32: TN4->TR3->TR2->TN3
- In Part E, traceroute results should be as follows:
  Step 36: TN2->TR1->RUT->TR2->TN3
  Step 40: TN4->TR3->RUT->TR2->TN3
- In Part F, traceroute results should be as follows:
  Step 44: TN2->TR1->RUT->TR2->TN3
  Step 47: TN2->TR1->TR2->TN3
  Step 51: TN4->TR3->RUT->TR2->TN3
  Step 54: TN4->TR3->TR2->TN3

Possible Problems:

- None

Test BGP4+_INTEROP.1.2: Non-Transit-AS, External BGP Peers

Purpose: To verify that a non-transit-AS BGP4+ router correctly communicates routes to other external BGP4+ router peers.

References:

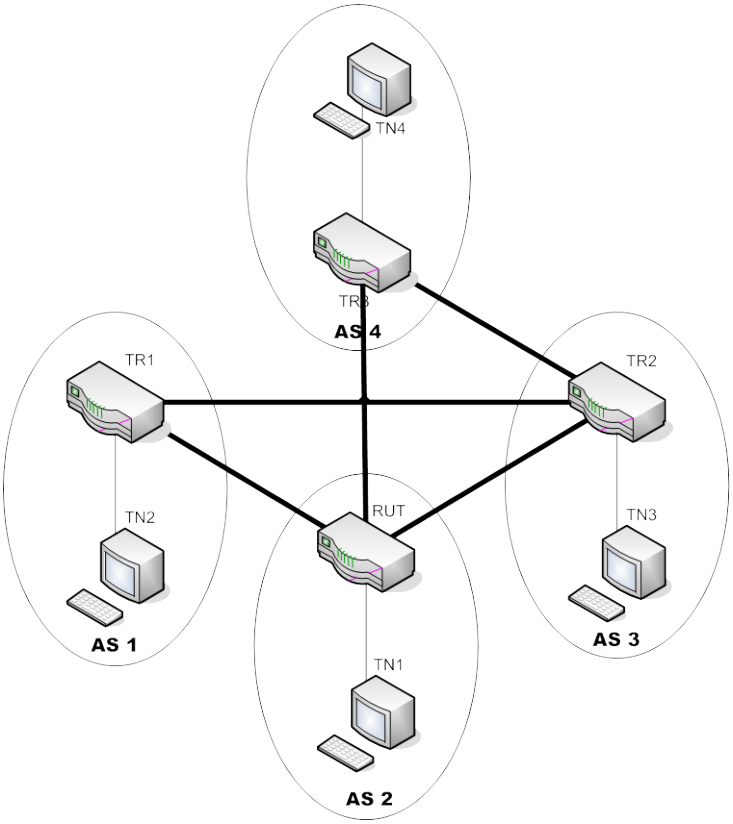
- [RFC 4760] – Section 3

Resource Requirements:

- Utility Program: traceroute

Discussion: This test verifies that the RUT can successfully communicate route information to other external BGP4+ router peers. An AS is called transit if it carries any traffic that neither originates nor terminates at that AS, while an AS is called non-transit if it only carries traffic that either originates or terminates at that AS. The RUT resides in a non-transit AS since the AS doesn't carry transit traffic in this test at all.

Test Setup: Configure the RUT to be external peers with TR1,TR2 and TR3. Configure TR1 and TR2 to be external peers. Configure TR2 and TR3 to be external peers.



Procedure:
Part A: External BGP Peer Establishments

1. Disable TR3.
2. The RUT and TR2 are not configured as external peers.
3. Perform a traceroute from TN1 to TN2.
4. Observe the traffic on all networks.
5. Perform a traceroute from TN1 to TN3.
6. Observe the traffic on all networks.
7. Enable TR3. Disable TR1.
8. Configure the RUT to be peers with TR3.
9. Configure TR3 and TR2 to be peers.
10. Perform a traceroute from TN1 to TN4.
11. Observe the traffic on all networks.
12. Perform a traceroute from TN1 to TN3.
13. Observe the traffic on all networks.

Part B: External BGP Peer Establishment, Shorter AS Path

14. Disable TR3.
15. Perform traceroute from TN1 to TN2.
16. Observe traffic on all networks.
17. Perform traceroute from TN1 to TN3.
18. Observe traffic on all networks.
19. Enable TR3. Disable TR1.
20. Perform a traceroute from TN1 to TN4.
21. Observe traffic on all networks.
22. Perform a traceroute from TN1 to TN3.
23. Observe the traffic on all networks.

Part C: Accepting AS Path Change

24. Disable TR3.
25. Configure TR1 to prepend its own AS number three times on outgoing UPDATES to the RUT.
26. Perform a traceroute from TN1 to TN2.
27. Observe the traffic on all networks.
28. Perform a traceroute from TN1 to TN3.
29. Observe the traffic on all networks.
30. Enable TR3. Disable TR1.
31. Configure TR3 to prepend its own AS number three times on outgoing UPDATES to the RUT.
32. Perform a traceroute from TN1 to TN4.
33. Observe the traffic on all networks.
34. Perform a traceroute from TN1 to TN3.
35. Observe the traffic on all networks.

Part D: Advertising AS Path Change

36. Disable TR3.
37. Configure RUT to prepend its own AS number three times on outgoing UPDATES to TR1.
38. Perform a traceroute from TN2 to TN1.
39. Observe the traffic on all networks.
40. Perform a traceroute from TN3 to TN1.
41. Observe the traffic on all networks.
42. Enable TR3. Disable TR1.
43. Configure RUT to prepend its own AS number three times on outgoing UPDATES to TR3.
44. Perform a traceroute from TN4 to TN1.
45. Observe the traffic on all networks.
46. Perform a traceroute from TN3 to TN1.

47. Observe the traffic on all networks.

Part E: External BGP Peer Removal

48. Disable TR3.
49. Perform a traceroute from TN1 to TN2.
50. Observe the traffic on all networks.
51. Configure TR1 to disable RUT as its peer.
52. Perform a traceroute from TN1 to TN2.
53. Observe the traffic on all networks.
54. Perform a traceroute from TN1 to TN3.
55. Observe the traffic on all networks.
56. Enable TR3. Disable TR1.
57. Configure TR3 to be peers with the RUT.
58. Perform a traceroute from TN1 to TN4.
59. Observe the traffic on all networks.
60. Configure TR3 to disable RUT as its peer.
61. Perform a traceroute from TN1 to TN4.
62. Observe the traffic on all networks.
63. Perform a traceroute from TN1 to TN3.
64. Observe the traffic on all networks.

Part F: External BGP Peer Reestablishment

65. Disable TR3.
66. Configure RUT to disable TR1 as its peer.
67. Perform a traceroute from TN1 to TN2.
68. Observe the traffic on all networks.
69. Perform a traceroute from TN1 to TN3.
70. Observe the traffic on all networks.
71. Configure the RUT and TR1 to be peers.
72. Perform a traceroute from TN1 to TN2.
73. Observe the traffic on all networks.
74. Perform a traceroute from TN1 to TN3.
75. Observe the traffic on all networks.
76. Enable TR3. Disable TR1.
77. Configure RUT to disable TR3 as its peer.
78. Perform a traceroute from TN1 to TN4.
79. Observe the traffic on all networks.
80. Perform a traceroute from TN1 to TN3.
81. Observe the traffic on all networks.
82. Configure the RUT and TR1 to be peers.
83. Perform a traceroute from TN1 to TN4.
84. Observe the traffic on all networks.
85. Perform a traceroute from TN1 to TN3.
86. Observe the traffic on all networks.

Observable Results:

- In Part A, traceroute results are as follows:
  Step 4: TN1->RUT->TR1->TN2.
  Step 6: TN1->RUT->TR1->TR2->TN3.
  Step 11: TN1->RUT->TR3->TN4.

Step 13: TN1->RUT->TR3->TR2->TN3.

- In Part B, traceroute results are as follows:
  Step 16: TN1->RUT->TR1->TN2.
  Step 18: TN1->RUT->TR2->TN3.
  Step 21: TN1->RUT->TR3->TN4.
  Step 23: TN1->RUT->TR2->TN3.
- In Part C, traceroute results are as follows:
  Step 27: TN1->RUT->TR2->TR1->TN2.
  Step 29: TN1->RUT->TR2->TN3.
  Step 33: TN1->RUT->TR2->TR3->TN4.
  Step 35: TN1->RUT->TR2->TN3.
- In Part D, traceroute results are as follows:
  Step 39: TN2->TR1->TR2->RUT->TN1.
  Step 41: TN3->TR2->RUT->TN1.
  Step 45: TN4->TR3->TR2->RUT->TN1.
  Step 47: TN3->TR2->RUT->TN1.
- In Part E, traceroute results are as follows:
  Step 50: TN1->RUT->TR1->TN2.
  Step 53: TN1->RUT->TR2->TR1->TN2.
  Step 55: TN1->RUT->TR2->TN3.
  Step 59: TN1->RUT->TR3->TN4.
  Step 62: TN1->RUT->TR2->TR3->TN4.
  Step 64: TN1->RUT->TR2->TN3.
- In Part F, traceroute results are as follows:
  Step 68: TN1->RUT->TR2->TR1->TN2.
  Step 70: TN1->RUT->TR2->TN3.
  Step 73: TN1->RUT->TR1->TN2.
  Step 75: TN1->RUT->TR2->TN3.
  Step 79: TN1->RUT->TR2->TR3->TN4.
  Step 81: TN1->RUT->TR2->TN3.
  Step 84: TN1->RUT->TR3->TN4.
  Step 86: TN1->RUT->TR2->TN3.

Possible Problems:

- None

Test BGP4+_INTEROP.1.3: Internal and External BGP Peers

Purpose: To verify that a BGP4+ router correctly communicates routes to other external and internal BGP4+ router peers.

References:

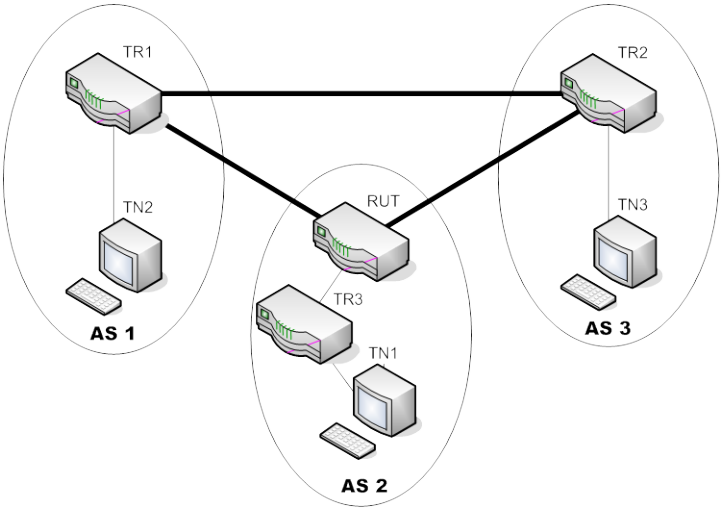
- [RFC 4760] – Section 3

Resource Requirements:

- Utility Program: traceroute

Discussion: This test verifies that the RUT can successfully communicate route information to other internal and external BGP4+ router peers. An AS is called transit if it carries any traffic that neither originates nor terminates at that AS, while an AS is called non-transit if it only carries traffic that either originates or terminates at that AS. The RUT resides in a transit AS since the AS carries transit traffic in some cases.

Test Setup: Configure the following configurations for Parts B thru E. The RUT should be configured as next-hop self for all neighbors. Configure the RUT to be external peers with TR1 and TR2. Configure the TR1 and TR2 to external peers.



Procedure:

Part A: Internal and External BGP Peer Establishments

1. The RUT and TR2 are not configured as external peers.
2. Perform a traceroute from TN1 to TN2.
3. Observe the traffic on all networks.
4. Perform a traceroute from TN1 to TN3.
5. Observe the traffic on all networks.

Part B: External BGP Peer Establishment, Shorter AS Path

6. Perform a traceroute from TN1 to TN2.
7. Observe the traffic on all networks.
8. Perform a traceroute from TN1 to TN3.
9. Observe the traffic on all networks.

Part C: Advertising AS Path Change

10. Configure the RUT to prepend its own AS number three times on outgoing UPDATES to TR2.
11. Perform a traceroute from TN2 to TN1.
12. Observe the traffic on all networks.
13. Perform a traceroute from TN3 to TN1.
14. Observe the traffic on all networks.

Part D: Accepting AS Path Change

15. Configure TR2 to prepend its own AS number three times on outgoing UPDATES to RUT.
16. Perform a traceroute from TN1 to TN2.
17. Observe the traffic on all networks.
18. Perform a traceroute from TN1 to TN3.
19. Observe the traffic on all networks.

Part E: External BGP Peer Removal

20. Configure RUT to disable TR2 as its peer.
21. Perform a traceroute from TN1 to TN2.
22. Observe the traffic on all networks.
23. Perform a traceroute from TN1 to TN3.
24. Observe the traffic on all networks.

Observable Result:

- In Part A, traceroute results are as follows:
  TN1->TR3->RUT->TR1->TN2
  TN1->TR3->RUT->TR1->TR2->TN3
- In Part B, traceroute results are as follows:
  TN1->TR3->RUT->TR1->TN2
  TN1->TR3->RUT->TR2->TN3
- In Part C, traceroute results are as follows:
  TN2->TR1->RUT->TR3->TN1
  TN3->TR2->TR1->RUT->TR3->TN1
- In Part D, traceroute results are as follows:
  TN1->TR3->RUT->TR1->TN2
  TN1->TR3->RUT->TR1->TR2->TN3
- In Part E, traceroute results are as follows:
  TN1->TR3->RUT->TR1->TN2
  TN1->TR3->RUT->TR2->TN3

Possible Problems:

- None

Test BGP4+_INTEROP.1.4: Internal BGP Peers

Purpose: To verify that a BGP4+ router correctly communicates routes to other internal BGP4+ router peers.

References:

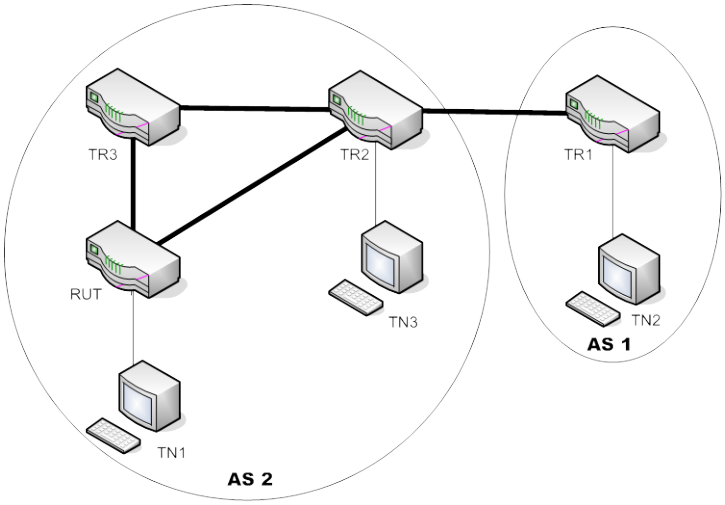
- [RFC 4760] – Section 3

Resource Requirements:

- Utility Program: traceroute

Discussion: This test verifies that the RUT can successfully communicate route information to other internal and external BGP4+ router peers. An AS is called transit if it carries any traffic that neither originates nor terminates at that AS, while an AS is called non-transit if it only carries traffic that either originates or terminates at that AS. The RUT resides in a non-transit AS since the AS doesn't carry transit traffic in this test at all.

Test Setup: Configure the RUT to be internal peers with TR3 and TR2. Configure TR3 and TR2 to be internal peers. Configure TR1 and TR2 to external peers.



Procedure:

Part A: Internal BGP Peer Establishments

1. Perform a traceroute from TN1 to TN3.
2. Observe the traffic on all networks.

Part B: Internal to External

3. Perform a traceroute from TN1 to TN2.
4. Observe the traffic on all networks.

Observable Results:

- In Part A, traceroute results are as follows:
  TN1->RUT->TR2->TN3

- In Part B, traceroute results are as follows:
  TN1->RUT->TR2->TR1->TN2

Possible Problems:

- None