ROUTING CONSORTIUM

Border Gateway Protocol 4 (BGP)

Multi-System Interoperability Test Suite

Technical Document

Revision 1.0

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MODIFICATION RECORD

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- Initial Release

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The University of New Hampshire would like to acknowledge the efforts of the following individuals in the development of this test suite.

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Eric Barrett	University of New Hampshire
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Andrew Gadzik	University of New Hampshire
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INTRODUCTION

Overview

The University of New Hampshire's InterOperability Laboratory (IOL) is an institution designed to improve the interoperability of standards based products by providing an environment where a product can be tested against other implementations of a standard. This suite of tests has been developed to help implementers evaluate the functioning of their Border Gateway Protocol 4 (from now on referred to as BGP) products. This test suite has been designed to test interoperability of a device under test with other BGP based products. 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 BGP specification, but they are designed as interoperability tests. These tests provide one method to isolate problems within the BGP 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 BGP capable devices. However, these tests do provide a reasonable level of confidence that the RUT will function well in most BGP environments.

Abbreviations and Acronyms

Acronyms used in this Test Suite:

N: **N**etwork
RUT: **R**outer **U**nder **T**est
TR: **T**esting **R**outer
AS: **A**utonomous **S**ystem
ASN: **A**utonomous **S**ystem **N**umber

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 BGP_INTEROP.1.2 refers to the second test of the first test group in the BGP 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.

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 4271] "A Border Gateway Protocol 4 (BGP-4)", Request for Comments 4271

Test BGP_INTEROP.1.1: Transit-AS, External BGP peers

Purpose: To verify that a transit-AS BGP router correctly communicates routes to other external BGP router peers, sends packets via the shortest path based on shortest AS path, and routes packets correctly when a neighboring external BGP router peer is removed from the configuration.

References:

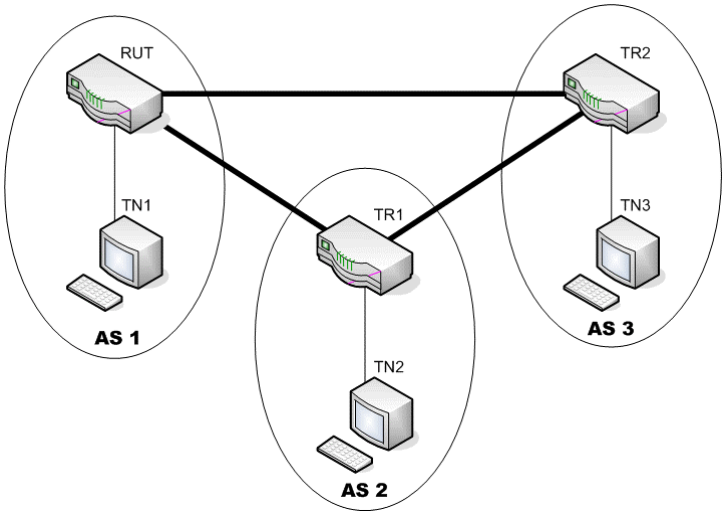
- [RFC 4271] – Section 9.1

Resource Requirements:

- Utility Program: traceroute

Discussion: This test verifies that the RUT can successfully communicate route information to other external BGP 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:



Procedure:

Part A: External BGP Peer Establishments

1. Configure the RUT and TR1 to be peers.
2. Configure TR1 and TR2 to be peers.
3. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part B: External BGP Peer Establishment, Shorter AS Path

4. Configure the RUT and TR2 to be peers.
5. Perform traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part C: Advertising AS Path Change

6. Configure the RUT to prepend its own AS number three times on outgoing UPDATES to TR2.
7. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part D: Accepting AS Path Change

8. Configure the RUT to prepend its own ASN only once on outgoing UPDATES to TR2.
9. Configure TR2 to prepend its own AS number three times on outgoing UPDATES to the RUT.
10. Perform traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part E: External BGP Peer Removal

11. Configure TR1 to disable TR2 as its peer.
12. Configure TR2 to prepend its own AS number three times on outgoing UPDATES to the RUT.
13. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part F: External BGP Peer Reestablishment

14. Configure the TR1 and TR2 to be peers.
15. Configure TR2 to prepend its own AS number three times on outgoing UPDATES to the RUT.
16. Perform traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part G: BGP Router Removal

17. Disable BGP on TR1.
18. Perform traceroute from TN1 to TN3, and TN3 to TN1.

Observable Results:

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

- In Part E, traceroute results should be as follows:
  TN1->RUT->TR1->TN2
  TN1->RUT->TR2->TN3
  TN2->TR1->RUT->TN1
  TN2->TR1->RUT->TR2->TN3
  TN3->TR2->RUT->TN1
  TN3->TR2->RUT->TR1->TN2
- In Part F, traceroute results should be as follows:
  TN1->RUT->TR1->TN2
  TN1->RUT->TR1->TR2->TN3
  TN2->TR1->RUT->TN1
  TN2->TR1->TR2->TN3
  TN3->TR2->RUT->TN1
  TN3->TR2->TR1->TN2
- In Part G, traceroute results should be as follows:
  TN1->RUT->TR2->TN3
  TN3->TR2->RUT->TN1

Possible Problems:

- None

Test BGP_INTEROP.1.2: Non-Transit-AS, External BGP Peers

Purpose: To verify that a non-transit-AS BGP router correctly communicates routes to other external BGP router peers, sends packets via the shortest path based on shortest AS path, and routes packets correctly when neighboring external BGP router peer is removed from the configuration.

References:

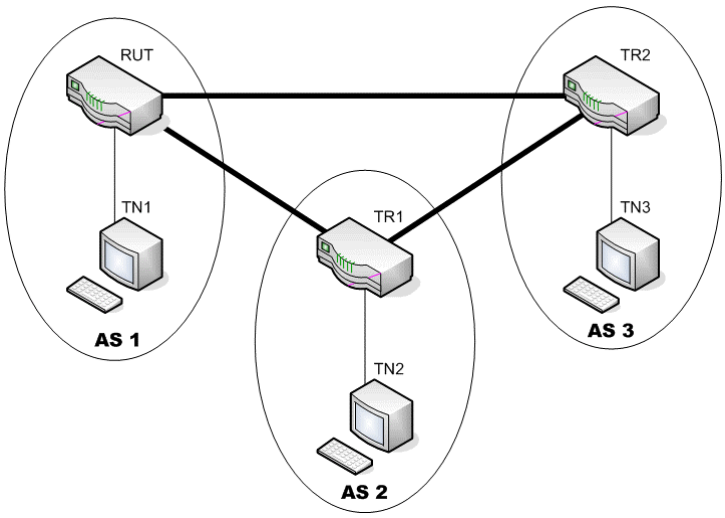
- [RFC 4271] – Section 9.1

Resource Requirements:

- Utility Program: traceroute

Discussion: This test verifies that the RUT can successfully communicate route information to other external BGP 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:



Procedure:

Part A: External BGP Peer Establishments

1. Configure the RUT and TR1 to be peers.
2. Configure the RUT and TR2 to be peers.
3. Configure the TR1 and TR2 to be peers.
4. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part B: External BGP Peer Removal

5. Configure the RUT to disable TR2 as its peer.
6. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Observable Results:

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

Possible Problems:

- None

Test BGP_INTEROP.1.3: Transit-AS, Internal and External BGP Peers

Purpose: To verify that a transit-AS BGP router correctly communicates routes to other external and internal BGP router peers, sends packets via the shortest path based on shortest AS path, and routes packets correctly when a neighboring external BGP router is removed from the configuration.

References:

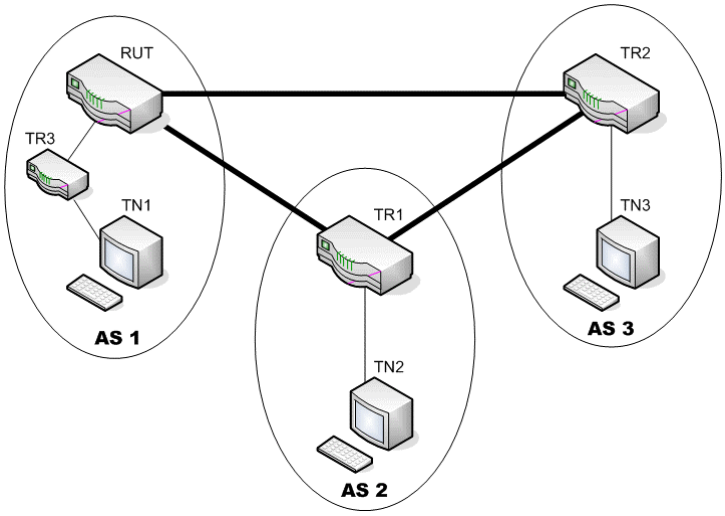
- [RFC 4271] – Section 9.1

Resource Requirements:

- Utility Program: traceroute

Discussion: This test verifies that the RUT can successfully communicate route information to other internal and external BGP 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:



Procedure:

Part A: Internal and External BGP Peer Establishments

1. Configure the RUT and TR3 to be peers.
2. Configure the RUT as next-hop-self
3. Configure the RUT and TR1 to be peers.
4. Configure the TR1 and TR2 to be peers.
5. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part B: External BGP Peer Establishment, Shorter AS Path

6. Configure the RUT and TR2 to be peers.
7. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part C: Advertising AS Path Change

8. Configure the RUT to prepend its own AS number three times on outgoing UPDATES to TR2.
9. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part D: Accepting AS Path Change

10. Configure the RUT to prepend its own AS number only once on outgoing UPDATES to TR2.
11. Configure TR2 to prepend its own AS number three times on outgoing UPDATES to the RUT.
12. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part E: External BGP Peer Removal

13. Configure TR1 to disable TR2 as its peer.
14. Configure TR2 to prepend its own AS number three times on outgoing UPDATES to the RUT.
15. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Observable Result:

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

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

Possible Problems:

- None

Test BGP_INTEROP.1.4: Non-Transit-AS, Internal and External BGP Peers

Purpose: To verify that a non-transit-AS BGP router correctly communicates routes to other external and internal BGP router peers, sends packets via the shortest path based on shortest AS path, and routes packets correctly when a neighboring external BGP router is removed from the configuration.

References:

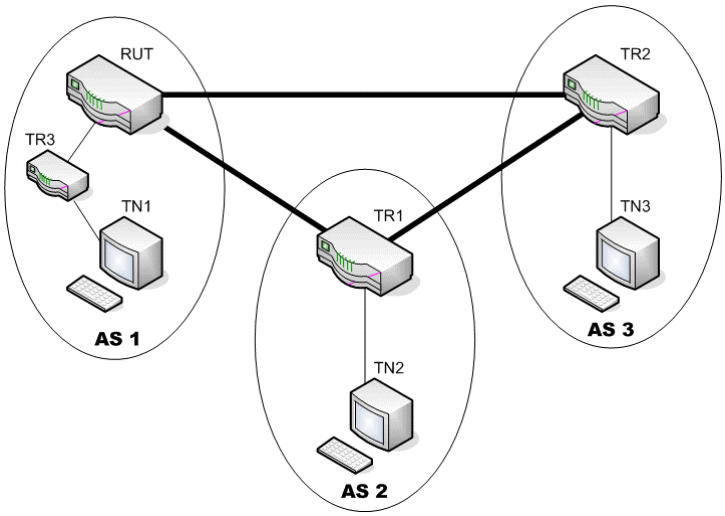
- [RFC 4271] – Section 9.1

Resource Requirements:

- Utility Program: traceroute

Discussion: This test verifies that the RUT can successfully communicate route information to other internal and external BGP 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:



Procedure:

Part A: Internal and External BGP Peer Establishments

1. Configure the RUT and TR3 to be peers.
2. Configure the RUT as next-hop-self
3. Configure the RUT and TR1 to be peers.
4. Configure the RUT and TR2 to be peers.
5. Configure the TR1 and TR2 to be peers.
6. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Part B: External BGP Peer Removal

7. Configure the RUT to disable TR2 as its peer.
8. Perform Traceroute from TN1 to TN2, TN1 to TN3, TN2 to TN1, TN2 to TN3, TN3 to TN1, and TN3 to TN2.

Observable Results:

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

Possible Problems:

- None