IPv4 CONSORTIUM

BGP Operations Test Report Revision 3.4

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Mr(s). Vendor,

Enclosed are the results from the Border Gateway Protocol Version 4(BGP-4) testing performed on:

RUT HERE. Identified as “SHORT RUT HERE” MAC Address 01-02-03-04-05-06 s/n 1234567. Console “system” command reports software version 1.2.3.

This testing pertains to a set of BGP-4 requirements and extensions, put forth in RFC 4271 and RFCs for the corresponding BGP-4 extensions. The tests performed are part of the BGP-4 Test Suite, which is available on the UNH InterOperability Lab’s website:

ftp://public.iol.unh.edu/pub/ipv4/testsuites/BGP_Description.pdf

During the testing process, the following issues were uncovered:

Test #	Result
Test BGP_CONF.3.6 c	The RUT installs the UPDATE message from TR1.
Test BGP_CONF.4.8 a	The RUT sends a BGP message of type 6 (UNKNOWN) to TR1.

As always, we welcome any comments regarding this Test Suite. If you have any questions about the test procedures or results, please feel free to contact me via e-mail at techniciana@iol.unh.edu or by phone at +1-603-862-3941.

Regards,

Technician A

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The following table contains the test results and their meanings.

Result	Interpretation
PASS	The RUT was observed to exhibit conformant behavior.
FAIL	The RUT was observed to exhibit non-compliant behavior.
PASS with Comments	The RUT was observed to exhibit conformant behavior, however this behavior deviated from previous compliant results. An additional explanation of the situation is included.
Warning	The RUT was observed to exhibit behavior that is not recommended.
NOTE	From the observations, a valid pass or fail could not be determined. An additional explanation of the situation is included.
N/S	Not Supported: The specified behavior is optional and is applicable but not implemented.
N/T	Not Tested: The specified behavior cannot be tested due to a(n) (un)related failure.

Group 1: Basic Processing

The following tests are designed to verify the basic functionality of a BGP router.

Test #		Result	
BGP_CONF.1.1	**Direct Connection**	**a**	**PASS**
		b	**PASS**
Purpose: To verify that a BGP router establishes a connection to a directly connected peer on TCP port 179.			
Comments on Test Procedure			
a. The RUT is directly connected to TR1 over network N0. The RUT and TR1 are configured as internal peers. b. The RUT is directly connected to TR1 over network N0. The RUT and TR1 are configured as external peers.			
Comments on Test Results	RFC 4271 – Sections 1 and 3		
a. The RUT makes a connection with TR1 on TCP port 179. b. The RUT makes a connection with TR1 on TCP port 179.			

Test #		Result	
BGP_CONF.1.2	**Indirect Connection**	**a**	**PASS**
		b	**PASS**
Purpose: To verify that a BGP router establishes a connection to an indirectly connected peer on TCP port 179.			
Comments on Test Procedure			
a. The RUT is connected to TR2 over network N0. TR2 is connected to TR1 over network N1. TR2 is not running BGP. The RUT and TR1 are configured as internal peers. b. The RUT is connected to TR2 over network N0. TR2 is connected to TR1 over network N1. TR2 is not running BGP. The RUT and TR1 are configured as external peers.			
Comments on Test Results	RFC 4271 – Sections 1 and 3		
a. The RUT makes a connection with TR1 on TCP port 179. b. The RUT makes a connection with TR1 on TCP port 179.			

Test #		Result	
BGP_CONF.1.5	**Keepalive Timer**	**a**	**PASS**
		b	**PASS**
		c	**PASS**

Purpose: To verify that a BGP router sends KEEPALIVE messages every Keep Alive Timer interval.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. Both the RUT and TR1 are configured with a KEEPALIVE Timer equal to 1 second.
b. The RUT is connected to TR1 as external peers. The RUT is configured with Hold Time and KEEPALIVE Timer equal to 0. TR1 is configured with a Hold Time equal to 3 seconds and KEEPALIVE equal to 1 second.
c. The RUT is connected to TR1 as external peers. The RUT is configured with a Hold Time equal to 3 seconds and KEEPALIVE Timer equal to 1 second. TR1 is configured with Hold Time and KEEPALIVE Timer equal to 0.

Comments on Test Results | RFC 4271 – Section 4.4

a. The RUT sends a KEEPALIVE message every second.
b. The RUT does not send any periodic KEEPALIVE messages. The connection remains established.
c. The RUT does not send any periodic KEEPALIVE messages. The connection remains established.

Test #		Result	
BGP_CONF.1.6	**Cease NOTIFICATION Message**	**a**	**PASS**
		b	**PASS**

Purpose: To verify that a BGP router closes a BGP connection by sending a NOTIFICATION message with the special error code Cease.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. After the routers establish the connection, the RUT closes its connection to TR1.
b. If allowed via configuration, the RUT is configured with an upper bound on the number of address prefixes it is willing to accept from TR1. Have TR1 advertise address prefixes that surpassed the limit configured on the RUT.

Comments on Test Results	RFC 4271 – Section 6.7

a. The RUT closes its connection to TR1 by sending a NOTIFICATION message with Error Code Cease.
b. The RUT discarded new address prefixes from TR1.

Test #		Result	
BGP_CONF.1.7	**Internal Update**	**a**	**PASS**

Purpose: To verify that a BGP router propagates internal updates only to external peers.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. The RUT is connected to TR2 and TR3 as internal peers. After the routers establish the connections, TR3 sends an UPDATE message to the RUT for a new route.

Comments on Test Results	RFC 4271 – Section 9.2

a. The RUT sends an UPDATE message for the new route to TR1, not TR2 or TR3.

Test #		Result	
BGP_CONF.1.8	**External Update**	**a**	**PASS**
Purpose: To verify that a BGP router propagates external updates to both internal and external peers.			
Comments on Test Procedure			
a. The RUT is connected to TR1 and TR3 as external peers (TR1 and TR3 are in different AS's). The RUT is connected to TR2 as internal peers. After the routers establish the connections, TR3 sends an UPDATE message to the RUT for a new route.			
Comments on Test Results	RFC 4271 – Section 9.2		
a. The RUT sends an UPDATE message for the new route to both TR1 and TR2.			

Test #		Result	
BGP_CONF.1.9	**Attribute Order**	**a**	**PASS**
Purpose: To verify that a BGP router properly handles path attributes that are out of order.			
Comments on Test Procedure			
a. The RUT is connected to TR1 as external peers. After the routers establish the connections, TR1 sends an UPDATE message to the RUT with the path attributes out of order.			
Comments on Test Results	RFC 4271 – Section 5		
a. The RUT accepts the route and installs it in its routing table.			

Test #		Result	
BGP_CONF.1.10	**ORIGIN Attribute**	**a**	**PASS**
		b	**PASS**
		c	**PASS**

Purpose: To verify that a BGP router properly generates the ORIGIN attribute.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. The RUT is connected to TR2 as internal peers. The RUT is connected to TR3 as OSPF peers. The RUT is configured to propagate OSPF learned routes to BGP. After the routers establish the connections, TR3 advertises a new route to RUT via OSPF.
b. IGP is disabled on the RUT and TR3. The RUT is connected to TR3 as EGP peers. After the routers establish the connections, TR3 advertises a new route to RUT via some EGP protocol.
c. The RUT is statically configured with a new route. After the routers establish the connections, the RUT is configured to advertise the new route.

Comments on Test Results | RFC 4271 – Sections 4.3 and 5.1.1

a. The RUT sets the ORIGIN attribute to 0 (IGP) in the UPDATE message when advertising it to its peers.
b. The RUT sets the ORIGIN attribute to 1 (EGP) in the UPDATE message when advertising it to its peers.
c. The RUT sets the ORIGIN attribute to 2 (INCOMPLETE) in the UPDATE message when advertising it to its peers.

Test #		Result	
BGP_CONF.1.11	**AS_PATH Attribute**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**PASS**

Purpose: To verify that a BGP router properly handles the AS_PATH attribute.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. The RUT is connected to TR2 as internal peers. After the routers establish the connections, the RUT is configured to advertise a new route to TR2.
b. The RUT is configured to advertise a new route to TR1.
c. TR1 sends an UPDATE message for a new route to the RUT.
d. TR2 sends an UPDATE message for a new route to the RUT.
e. TR2 is moved to another autonomous system AS3. TR2 sends an UPDATE message for a new route to the RUT.
f. TR2 sends an UPDATE message for a new route to RUT with the AS_PATH attribute set to (AS_SET/AS3, AS4).

Comments on Test Results	RFC 4271 – Sections 4.3 and 5.1.2

a. The RUT sends an UPDATE message to TR2 with an empty AS_PATH attribute.
b. The RUT sends an UPDATE message to TR1 with the AS_PATH attribute set to (AS_SEQUENCE/AS2).
c. The RUT sends an UPDATE message to TR2 with the AS_PATH attribute set to (AS_SEQUENCE/AS1).
d. The RUT sends an UPDATE message to TR1 with the AS_PATH attribute set to (AS_SEQUENCE/AS2).
e. The RUT sends an UPDATE message to TR1 with the AS_PATH attribute set to (AS_SEQUENCE/AS2, AS3).
f. The RUT sends an UPDATE message to TR1 with the AS_PATH attribute set to (AS_SEQUENCE/AS2) followed by (AS_SET/AS3, AS4).

Test #		Result	
BGP_CONF.1.12	**NEXT_HOP Attribute**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**PASS**

Purpose: To verify that a BGP router properly handles the NEXT_HOP attribute.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers over network N0. TR3 is a router in network N0 that is not running BGP. The RUT is configured to advertise a new route with the NEXT_HOP attribute set to TR3.
b. The RUT is connected to TR2 as internal peers over network N1. The RUT is configured to advertise a new route NEXT_HOP attribute set to TR3.
c. TR2 sends an UPDATE message for a new route to the RUT with the NEXT_HOP attribute set to itself.
d. TR1 sends an UPDATE message for a route to some network N2. The NEXT_HOP attribute is set to TR3's IP Address on N0.
e. The RUT is configured to advertise the new route to TR2 with the NEXT_HOP attribute set to itself.
f. TR2 no longer advertises a static route. The RUT is configured to advertise a static route with TR1's IP Address on N0 as the next hop.

Comments on Test Results | RFC 4271 – Sections 4.3 and 5.1.2

a. The RUT sends an UPDATE message for the new route to TR1. Inside the UPDATE message, the NEXT_HOP attribute is set to TR3's IP address on N0.
b. The RUT sends an UPDATE message for the new route to TR2. Inside the UDPATE message, the NEXT_HOP attribute is set to TR3's IP address on N0.
c. The RUT sends an UPDATE message for the new route to TR1. Inside the UPDATE message, the NEXT_HOP attribute is set to an IP address on N0.
d. The RUT sends an UPDATE message for the new route to TR2. Inside the UPDATE message, the NEXT_HOP attribute is set to TR3's IP address on N0.
e. The RUT sends an UPDATE message for the new route to TR2. Inside the UPDATE message, the NEXT_HOP attribute is set to the RUT's IP address on N1.
f. The RUT does not send an UPDATE message to TR1 listing TR1 as the NEXT_HOP.

Test #		Result	
BGP_CONF.1.13	**MULTI_EXIT_DISC Attribute**	**a**	**PASS**
		b	**PASS**
		c	**PASS**

Purpose: To verify that a BGP router properly handles the MULTI_EXIT_DISC attribute.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. The RUT is connected to TR2 as internal peers. The RUT is configured to advertise a new route with MED.
b. TR1 sends an UPDATE message for a new route with MED to the RUT.
c. TR2 is connected to TR3 as external peers. TR3 sends an UPDATE message for a new route to TR2. TR2 propagates the UPDATE message to the RUT.

Comments on Test Results	RFC 4271 – Sections 4.3 and 5.1.4

a. The RUT sends an UPDATE message for the new route TR1 and TR2. Inside the UPDATE message to TR1, the MED attribute is set to the configured value.
b. The RUT propagates the UPDATE message for the new route to TR2 with the MED attribute.
c. The RUT propagates the UPDATE message for the new route to TR1. The UPDATE message does not contain the MED attribute received from TR2.

Test #		Result	
BGP_CONF.1.14	**LOCAL_PREF Attribute**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**

Purpose: To verify that a BGP router properly handles the LOCAL_PREF attribute.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. The RUT is connected to TR2 as internal peers. TR1 sends an UPDATE message for a new route to the RUT.
b. TR2 sends an UPDATE message to the RUT for a new route with the LOCAL_PREF attribute.
c. The RUT is configured to advertise a new route.
d. TR1 sends an UPDATE message to the RUT for a new route with the LOCAL_PREF attribute.

Comments on Test Results | RFC 4271 – Sections 4.3 and 5.1.5

a. The RUT propagates the UPDATE message for the new route to TR2. Inside the UPDATE message, the LOCAL_PREF attribute is set to the value configured on the RUT.
b. The RUT propagates the UPDATE message for the new route to TR1. The UPDATE message does not contain the LOCAL_PREF attribute.
c. The RUT propagates the UDPATE message to TR1 for the new route without the LOCAL_PREF attribute, and it propagates the UPDATE message to TR2 for the new route with the LOCAL_PREF attribute set to the value configured on the RUT.
d. The RUT propagates the UDPATE message to TR2 for the new route. Inside the UPDATE message, the LOCAL_PREF attribute is set to the value configured on the RUT.

Test #		Result	
BGP_CONF.1.15	**ATOMIC_AGGREGATE Attribute**	**a**	**PASS**
		b	**PASS**
		c	**PASS**

Purpose: To verify that a BGP router properly handles the ATOMIC_AGGREGATE attribute.

Comments on Test Procedure

a. The RUT is connected to TR1, TR2 and TR3 as external peers (TR1 and TR2 are in the same AS whereas TR3 is in a different AS than TR1 and TR2). The RUT is configured not to aggregate overlapping routes. TR1 sends an UPDATE message for 192.0.0.0/8. TR2 sends an UPDATE message for 192.1.0.0/16.
b. The RUT is configured to aggregate overlapping routes under 192.0.0.0/8. TR1 sends an UPDATE message for routes to 192.0.0.0/8 and 192.1.0.0/16.
c. The RUT and TR2 are no longer peers. The RUT is configured to aggregate overlapping routes under 192.0.0.0/8. TR1 sends an UPDATE message for 192.0.0.0/8 with the ATOMIC_AGGREGATE and the AGGREGATOR attributes to the RUT.

Comments on Test Results | RFC 4271 – Sections 4.3, 5.1.6, and 9.1.4

a. The RUT sends an UPDATE message to TR3 for 192.0.0.0/8 and 192.1.0.0/16. The RUT installs both routes in its routing table. The UDPATE message does not contain the ATOMIC_AGGREGATE or the AGGREGATOR attributes.
b. The RUT installs the aggregated route 192.0.0.0/8 or both the component routes 192.0.0.0/8 and 192.1.0.0/16. The RUT sends an UPDATE message to TR3 for 192.0.0.0/8.
c. The RUT sends an UPDATE message to TR3 with the ATOMIC_AGGREGATE and AGGREGATOR attributes received from TR1.

Test #		Result	
BGP_CONF.1.16	**Aggregation Path Attributes**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**PASS**
		g	**PASS**
		h	**PASS**

Purpose: To verify the correct handling of path attributes when a BGP router aggregates routes.

Comments on Test Procedure

a. The RUT is connected to TR1, TR2, and TR3 as external peers (TR1 and TR2 are in the same AS whereas TR3 is in a different AS than TR1 and TR2). The RUT is configured to aggregate routes below 192.1.0.0/16. TR1 sends an UPDATE message to the RUT for 192.1.1.0/24 with the NEXT_HOP attribute set to itself, TR2 sends an UPDATE message to the RUT for 192.1.2.0/24 with the NEXT_HOP attribute set to itself.
b. TR1 sends an UPDATE message to the RUT for 192.1.1.0/24 with the MED attribute set to 1. TR2 sends an UPDATE message to the RUT for 192.1.2.0/24 with the MED attribute set to 2. The NEXT_HOP attributes are identical for the rest of this test.
c. TR1 sends an UPDATE message to the RUT for 192.1.1.0/24 with the ORIGIN attribute set to INCOMPLETE. TR2 sends an UPDATE message to the RUT for 192.1.2.0/24 with the ORIGIN attribute set to IGP. The MED attributes are identical for the rest of this test.
d. TR1 sends an UPDATE message to the RUT for 192.1.1.0/24 with the ORIGIN attribute set to EGP. TR2 sends an UPDATE message to the RUT for 192.1.2.0/24 with the ORIGIN attribute set to IGP.
e. TR1 sends an UPDATE message to the RUT for 192.1.1.0/24 with the AS_PATH attribute set to (AS_SEQUENCE/AS1-AS11). TR2 sends an UPDATE message to the RUT for 192.1.2.0/24 with the AS_PATH attribute set to (AS_SEQUENCE/AS1-AS11).
f. TR1 sends an UPDATE message to the RUT for 192.1.1.0/24 with the AS_PATH attribute set to (AS_SEQUENCE/AS1, AS11). TR2 peers with TR4 in AS12. TR4 sends an UPDATE message to TR2 for 192.1.2.0/24. TR2 propagates the UPDATE message received from TR4 to the RUT, with the AS_PATH attribute set to (AS_SEQUENCE/AS1, AS12).
g. TR2 closes its session with TR4 and moves to AS4. TR1 sends an UPDATE message to the RUT for 192.1.1.0/24 with the AS_PATH attribute set to (AS_SEQUENCE/AS1). TR2 sends an UPDATE message to the RUT for 192.1.2.0/24 with the AS_PATH attribute set to (AS_SEQUENCE/AS4).
h. TR1 is moved back to AS1. TR1 sends an UPDATE message to the RUT for 192.1.1.0/24 with the ATOMIC_AGGREGATE and AGGREGATOR attributes. TR2 sends an UPDATE message to the RUT for 192.1.2.0/24.

Comments on Test Results | RFC 4271 – Section 9.2.2.2

a. The RUT sends an UPDATE message to TR3 for 192.1.0.0/16 with the NEXT_HOP attribute set to itself.
b. The RUT does not aggregate 192.1.1.0/24 and 192.1.2.0/24. The RUT propagates the two UPDATE messages to TR3.
c. The RUT sends an UPDATE message to TR3 for 192.1.0.0/16 with the ORIGIN attribute set to INCOMPLETE.
d. The RUT sends an UPDATE message to TR3 for 192.1.0.0/16 with the ORIGIN attribute set to EGP.
e. The RUT sends an UPDATE to TR3, for 192.1.0.0/16, with AS_PATH set to (AS_SEQUENCE/AS2-AS1-AS11).
f. The RUT sends an UPDATE message to TR3 for 192.1.0.0/16 with the AS_PATH attribute set to (AS_SEQUENCE/AS2, AS1) followed by (AS_SET/AS11, AS12).

g. The RUT sends an UPDATE message to TR3 for 192.1.0.0/16 with the AS_PATH attribute set to (AS_SEQUENCE/AS2) followed by (AS_SET/AS1, AS4).
h. The RUT sends an UPDATE message to TR3 for 192.1.0.0/16 with the ATOMIC_AGGREGATE attribute. The UPDATE message also contains the AGGREGATOR attribute set by the RUT.

Test #		Result	
BGP_CONF.1.17	**Optional Attributes**	**a**	**PASS**
		b	**PASS**
		c	**PASS**

Purpose: To verify the correct handling of unrecognized optional attributes.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. The RUT is connected to TR2 as external peers. TR1 sends an UPDATE message with an optional non-transitive attribute, Type Code 33.
b. TR1 sends an UPDATE message with an optional transitive attribute, Type Code 33 that has the Partial Bit clear.
c. TR1 sends an UPDATE message with an optional transitive attribute, Type Code 33 that has the Partial Bit set.

Comments on Test Results	RFC 4271 – Section 9

a. The RUT propagates the received UPDATE message to TR2 without the optional attribute.
b. The RUT propagates the received UPDATE message to TR2 with the modified optional attribute.
c. The RUT propagates the received UPDATE message to TR2 with the optional attribute unmodified.

Test #		Result	
BGP_CONF.1.18	**Route Selection**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**PASS**
		g	**PASS**
		h	**PASS**
		i	**PASS**

Purpose: To verify the route selection "tie breaking" algorithm implemented by a BGP router.

Comments on Test Procedure

a. The RUT is connected to TR1 and TR2 as external peers. The RUT is configured to assign a higher degree of preference to routes received from TR1 than those received from TR2. TR1 and TR2 each send an UPDATE message to the RUT for 192.1.1.0/24 with NEXT_HOP set to itself for the rest of this test. The other path attributes are identical.
b. The RUT is configured to assign the same degree of preference to routes received from TR1 and TR2. TR1 sends an UPDATE message to RUT for 192.1.1.0/24 with AS_PATH set to (AS_SEQUENCE /AS1, AS11), and NEXT_HOP set to itself. TR2 send an UPDATE for 192.1.1.0/24, with AS_PATH set to (AS_SEQUENCE/AS1), and NEXT_HOP set to itself.
c. TR1 and TR2 are configured to set the NEXT_HOP to itself. TR1 sends an UDPATE message to the RUT for 192.1.1.0/24 with ORIGIN = 0. TR2 sends an UPDATE message to the RUT for 192.1.1.0/24 with ORIGIN = 2.
d. The RUT is configured to assign the same degree of preference to routes received from TR1 and TR2. TR1 sends an UPDATE message to the RUT for 192.1.1.0/24 with MED=20. TR2 sends an UPDATE message to the RUT for 192.1.1.0/24 with MED=10.
e. TR1 sends an UPDATE message to the RUT for 192.1.1.0/24 without MED. TR2 sends an UPDATE message to the RUT for 192.1.1.0/24 with MED=10.
f. TR2 moves to AS2. TR1 and TR2 each send an UDPATE message to the RUT for 192.1.1.0/24.
g. TR1 moves to AS2. The RUT is connected to N0, TR1 is connected to N1 and TR2 is connected to N2. The RUT has a static route configured to N1 with a cost of 20 and a static route to N2 with a cost of 10. Both TR1 and TR2 send an UPDATE message to the RUT for 192.1.1.0/24.
h. TR1 is configured with a BGP Identifier of 1.1.1.1. TR2 is configured with a BGP Identifier of 2.2.2.2. TR1 and TR2 each send an UPDATE message to the RUT for 192.1.1.0/24.
i. BGP is stopped on TR2. The RUT and TR1 are configured as IBGP peers on N0 and N1. TR1's IP Address on N0 is lower than its IP Address on N1. TR1 sends an UPDATE for 192.1.1.0/24 on both N0 and N1.

Comments on Test Results | RFC 4271 – Sections 9.1.2 and 9.1.2.2

a. The RUT installs 192.1.1.0/24 with TR1 as the next hop in its routing table.
b. The RUT installs 192.1.1.0/24, with TR2 as next hop in its routing table.
c. The RUT installs 192.1.1.0/24, with TR1 as next hop in its routing table.
d. The RUT installs 192.1.1.0/24 with TR2 as the next hop in its routing table.
e. The RUT installs 192.1.1.0/24 with TR1 as the next hop in its routing table.
f. The RUT installs 192.1.1.0/24 with TR1 as the next hop in its routing table.
g. The RUT installs 192.1.1.0/24 with TR2 as the next hop in its routing table.
h. The RUT installs 192.1.1.0/24 with TR1 as the next hop in its routing table.
i. The RUT installs 192.1.1.0/24 with TR1 on N0 as the next hop in its routing table.

Group 2: BGP Finite State Machine

The following tests are designed to verify the correct functioning of the BGP finite state machine.

Test #		Result	
BGP_CONF.2.1	**Idle State**	**a**	**PASS**
		b	**PASS**
		c	**PASS**

Purpose: To verify the correct functionality of a BGP router in the Idle state.

Comments on Test Procedure

a. The RUT is configured to peer with TR1 as external peers.
b. TR1 is unplugged. The RUT no longer has TR1's MAC Address in its ARP table. The RUT is restarted.
c. TR1 is plugged in. BGP is restarted on the RUT. Before the RUT sends BGP packets to initiate a connection, TR1 sends a NOTIFICATION message to the RUT.

Comments on Test Results | RFC 4271 – Section 8.2.2

a. The RUT sends a TCP SYN segment to TR1 and transitions to Connect state.
b. The RUT does not send a TCP SYN segment and transitions to Active state.
c. The RUT remains in state Idle

Test #		Result	
BGP_CONF.2.2	**Connect State**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**PASS**
		g	**PASS**
		h	**PASS**
		i	**PASS**

Purpose: To verify the correct functionality of a BGP router in state Connect.

Comments on Test Procedure

a. The RUT is configured to peer with TR1 as external peers. The Delay Open Flag is set on the RUT with a Delay Open Timer of n seconds. The RUT sends a TCP SYN and TR1 responds by sending a TCP SYN/ACK. TR1 does not send an OPEN message.
b. The RUT waits n seconds.
c. BGP is restarted on the RUT and TR1. The Delay Open Flag is still set on the RUT.
d. BGP is restarted on the RUT and TR1. The Delay Open Flag is not set. The RUT sends a TCP SYN and TR1 responds by sending a TCP SYN/ACK.
e. BGP is restarted on the RUT and TR1. The Delay Open Flag is set. Before the Delay Open Timer expires, BGP is stopped on the RUT.
f. The Delay Open Flag is set on the RUT with the Open Delay Timer set to n seconds. BGP is restarted on the RUT and TR1. TR1 sends a TCP SYN/ACK in response to the RUT's TCP SYN. Before the Open Delay Timer expires, TR1 sends a TCP FIN.
g. The Delay Open Timer is no longer set on the RUT. The RUT's ARP table is statically configured with TR1's IP address. TR1 is unplugged and the RUT is restarted.
h. The RUT is configured with a peer that is not on the network.
i. The RUT is configured to peer with TR1 once again. The Delay Open Flag is set on the RUT. Before the Delay Open Timer expires, TR1 sends an UPDATE message to the RUT.

Comments on Test Results | RFC 4271 – Section 8.2.2

a. The RUT acknowledges the TCP SYN/ACK segment from TR1, and remains in state Connect.
b. The RUT waits n seconds before sending an OPEN message to TR1 and transitioning to state OpenSent.
c. The RUT sends an OPEN message and transitions to state OpenConfirm.
d. The RUT acknowledges the TCP SYN/ACK segment from TR1, sends an OPEN message, and transitions to OpenSent state.
e. The RUT transitions to state Idle.
f. The RUT transitions to state Active.
g. The RUT transitions to state Idle when the TCP retransmission timer expires.
h. The RUT sends TCP SYN, which is not acknowledged, sends another TCP SYN segment when ConnectRetry timer expires, and remains in state Connect.
i. The RUT transitions to state Idle.

Test #		Result	
BGP_CONF.2.3	**Active State**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**PASS**
		g	**PASS**

Purpose: To verify the correct functionality of a BGP router in state Active.

Comments on Test Procedure

a. The RUT and TR1 are configured as external peers. The Delay Open Flag is set on the RUT with the Delay Open Timer set to n seconds. The RUT transitions to state Active before completing a TCP connection with TR1. TR1 does not send an OPEN message.
b. The RUT waits n seconds.
c. BGP is restarted on the RUT and TR1. The Delay Open Flag is still set on the RUT with the Delay Open Timer set to n seconds. The RUT transitions to state Active before completing a TCP connection with TR1. TR1 sends an OPEN message before the Delay Open Timer expires.
d. While the RUT is in Active state, TR1 sends a TCP SYN segment.
e. The RUT is restarted. After the RUT transitions to state Active, BGP is stopped.
f. TR1 is unplugged. The RUT is restarted and transitions to state Active.
g. The RUT is restarted and transitions to state Active. TR1 sends a TCP SYN immediately followed by a TCP FIN segment.

Comments on Test Results | RFC 4271 – Section 8.2.2

a. The RUT remains in state Active.
b. The RUT sends an OPEN message and transitioning to state OpenSent.
c. The RUT sends an OPEN message and transitions to state OpenConfirm.
d. The RUT completes the connection initiated by TR1, sends an OPEN message and transitions to state Open-Sent.
e. The RUT transitions to state Idle.
f. The RUT sends a TCP SYN, which is not acknowledged, transitions to Active state. When the ConnectRetry timer times out, it transitions to state Connect.
g. The RUT transitions to state Idle.

Test #		Result	
BGP_CONF.2.4	**OpenSent State**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**PASS**
		g	**PASS**

Purpose: To verify the correct functionality of a BGP router in state OpenSent.

Comments on Test Procedure

a. The RUT is configured to peer with TR1 as external peers. After the RUT sends an OPEN message, TR1 responds by sending an OPEN message.
b. The RUT is restarted. After the RUT sends an OPEN message, TR1 responds by sending an erroneous OPEN message.
c. The RUT is restarted. After the RUT sends an OPEN message, TR1 sends a TCP FIN segment.
d. The RUT is restarted. After the RUT sends an OPEN message, TR1 does not respond.
e. The RUT is restarted. After the RUT sends an OPEN message, TR1 sends a NOTIFICATION message with a version error.
f. The RUT is restarted. After the RUT sends an OPEN message, stop BGP on the RUT.
g. The RUT is restarted. After the RUT sends an OPEN message, TR1 sends an UPDATE message.

Comments on Test Results | RFC 4271 – Section 8.2.2

a. The RUT sends a KEEPALIVE message and transitions to state OpenConfirm.
b. The RUT sends a NOTIFICATION message and transitions to state Idle.
c. The RUT transitions to state Active.
d. The RUT sends a NOTIFICATION message with Error Code Hold Timer Expired and transitions to state Idle.
e. The RUT closes connection with TRI, and transitions to state Idle.
f. The RUT sends a NOTIFICATION message to TR1 with Error Code Cease and transitions to state Idle.
g. The RUT sends a NOTFICATION message with Error Code Finite State Machine Error, and transition to the state Idle.

Test #		Result	
BGP_CONF.2.5	**OpenConfirm State**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**PASS**
		g	**PASS**

Purpose: To verify the correct functionality of a BGP router in state OpenConfirm.

Comments on Test Procedure

a. The RUT is configured to peer with TR1 as external peers. After the RUT sends the first KEEPALIVE message, TR1 responds by sending a KEEPALIVE message.
b. The RUT is restarted. After the RUT sends a KEEPALIVE message, TR1 does not respond within the Hold Timer interval.
c. The RUT is restarted. After the RUT sends a KEEPALIVE message, TR1 does not respond within the Keep Alive Timer interval.
d. The RUT is restarted. After the RUT sends a KEEPALIVE message, TR1 sends a NOTIFICATION message.
e. The RUT is restarted. After the RUT sends a KEEPALIVE message, TR1 sends a TCP FIN segment.
f. The RUT is restarted. After the RUT sends a KEEPALIVE message, BGP is disabled on the RUT.
g. The RUT is restarted. After the RUT sends a KEEPALIVE message, TR1 sends an UPDATE packet.

Comments on Test Results | RFC 4271 – Section 8.2.2

a. The RUT transitions to state Established.
b. The RUT sends a NOTIFICATION message to TR1 with Error Code Hold Timer Expired and transitions to state Idle.
c. The RUT sends a KEEPALIVE message and remains in state OpenConfirm.
d. The RUT transitions to state Idle.
e. The RUT transitions to state Idle.
f. The RUT sends a NOTIFICATION message to TR1 with Error Code Cease and transitions to state Idle.
g. The RUT sends a NOTFICATION message with Error Code Finite State Machine Error, and transition to the state Idle.

Test #		Result	
BGP_CONF.2.6	**Established State**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**PASS**
		g	**PASS**

Purpose: To verify the correct functionality of a BGP router in state Established.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. After RUT and TR1 establish the connection, TR1 sends a NOTIFICATION message to the RUT.
b. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends an incorrect UPDATE message to RUT.
c. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends a TCP FIN segment to RUT.
d. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 does not send a KEEPALIVE message.
e. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 does not send a KEEPALIVE message within the KeepAlive interval.
f. The RUT is restarted. After the RUT and TR1 establish the connection, BGP is disabled on the RUT.
g. The RUT is restarted. After the RUT and TR1 establish the connection. TR1 sends an OPEN message.

Comments on Test Results | RFC 4271 – Section 8.2.2

a. The RUT transitions to state Idle.
b. The RUT sends a NOTIFICATION message and transitions to state Idle.
c. The RUT transitions to state Idle.
d. The RUT sends a NOTIFICATION message with Error Code Hold Timer Expired and transitions to state Idle.
e. The RUT does not send a NOTIFICATION message and remains in state Established.
f. The RUT sends a NOTIFICATION and transitions to state Idle.
g. The RUT sends a NOTIFICATION message with Error Code Finite State Machine Error and transitions to state Idle.

Group 3: Error Handling

The following tests are designed to verify the correct handling of erroneous conditions.

Test #		Result	
BGP_CONF.3.1	**Header Error**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**PASS**
		g	**PASS**
		h	**PASS**
		i	**PASS**

Purpose: To verify the correct handling of errors in the BGP packet header.

Comments on Test Procedure

a. The RUT is configured to peer with TR1 as external peers. TR1 sends an OPEN message with the Marker field in the Message Header different than "all ones".
b. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends a KEEPALIVE message with the Marker field in the Message Header different than "all ones".
c. The RUT is restarted. TR1 sends an OPEN message with the Length field in the Message Header set less than 29.
d. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the Length field in the Message Header set less than 23.
e. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends a KEEPALIVE message with the Length field in the Message Header set less than 19.
f. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends a KEEPALIVE message with the Length field in the Message Header set greater than 19.
g. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends a NOTIFICATION message with the Length field in the Message Header set less than 21.
h. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends a KEEPALIVE message with the Length field in the Message Header set greater than 4096.
i. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends a message with the Type field in the Message Header set to an undefined value.

Comments on Test Results | RFC 4271 – Section 6.1

a. The RUT sends a NOTIFICATION message with Error Code Message Header Error and Error Subcode Connection Not Synchronized.
b. The RUT sends a NOTIFICATION message with Error Code Message Header Error and Error Subcode Connection Not Synchronized.
c. The RUT sends a NOTIFICATION message with Error Subcode Bad Message Length. The Data field contains the erroneous Length field.
d. The RUT sends a NOTIFICATION message with Error Subcode Bad Message Length. The Data field contains the erroneous Length field.
e. The RUT sends a NOTIFICATION message with Error Subcode Bad Message Length. The Data field contains the erroneous Length field.
f. The RUT sends a NOTIFICATION message with Error Subcode Bad Message Length. The Data field contains the erroneous Length field.

g. The RUT sends a NOTIFICATION message with Error Subcode Bad Message Length. The Data field contains the erroneous Length field.
h. The RUT sends a NOTIFICATION message with Error Subcode Bad Message Length. The Data field contains the erroneous Length field.
i. The RUT sends a NOTIFICATION message with Error Subcode Bad Message Type. The Data field contains the erroneous Type field.

Test #		Result	
BGP_CONF.3.2	**OPEN Message Error**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**

Purpose: To verify the correct handling of errors in OPEN messages.

Comments on Test Procedure

a. The RUT is configured to peer with TR1 as external peers. TR1 sends an OPEN message with the Version field set to an undefined value.
b. The RUT is restarted. TR1 sends an OPEN message with the Autonomous System field set to an unacceptable value.
c. The RUT is restarted. TR1 sends an OPEN message with the Hold Time field set to 2 seconds. The RUT is restarted again. TR1 sends an OPEN message with the Hold Time field set to 1 second.
d. The RUT is restarted. TR1 sends an OPEN message with the BGP Identifier field set to a syntactically incorrect IP address.
e. The RUT is restarted. TR1 sends an OPEN message with the Parameter Type field in the Optional Parameters set to an undefined value.

Comments on Test Results | RFC 4271 – Section 6.2

a. The RUT sends a NOTIFICATION message with Error Code OPEN Message Error and Error Subcode Unsupported Version Number. The Data field is set to the largest version number supported by RUT.
b. The RUT sends a NOTIFICATION message with Error Subcode Bad Peer AS.
c. The RUT sends a NOTIFICATION message with Error Subcode Unacceptable Hold Time.
d. The RUT sends a NOTIFICATION message with Error Subcode Bad BGP Identifier.
e. The RUT sends a NOTIFICATION message with Error Subcode Unsupported Optional Parameters.

Test #		Result	
BGP_CONF.3.3	**UPDATE Message Length Error**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**

Purpose: To verify the correct handling of length errors in UPDATE messages.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the Unfeasible Routes Length set to 4090.
b. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the Total Attribute Length set to 4090.
c. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the high-order bit of the Attribute Flags for the ORIGIN attribute set to 1.
d. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with a conflicting Attribute Length/Attribute Type.

Comments on Test Results | RFC 4271 – Section 6.3

a. The RUT sends a NOTIFICATION message with Error Code UPDATE Message Error and Error Subcode Malformed Attribute List.
b. The RUT sends a NOTIFICATION message with Error Code UPDATE Message Error and Error Subcode Malformed Attribute List.
c. The RUT sends a NOTIFICATION message with Error Subcode Attribute Flags Error. The Data field contains the erroneous attribute.
d. The RUT sends a NOTIFICATION message with Error Subcode Attribute Length Error. The Data field contains the erroneous attribute.

Test #		Result	
BGP_CONF.3.4	**Well-Known Attribute Error**	**a**	**PASS**
		b	**PASS**

Purpose: To verify the correct handling of well-known attribute errors in UPDATE messages.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message without the ORIGIN attribute.
b. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the high-order bit of the Attribute Flags field set to 0 (denoting a well-known attribute) and Attribute Type Code set to 11.

Comments on Test Results	RFC 4271 – Section 6.3

a. The RUT sends a NOTIFICATION message with Error Subcode Missing Well-known Attribute. The Data field contains the missing attribute.
b. The RUT sends a NOTIFICATION message with Error Subcode Unrecognized Well-known Attribute. The Data field contains the unrecognized attribute.

Test #		Result	
BGP_CONF.3.5	**ORIGIN Attribute Error**	**a**	**PASS**

Purpose: To verify the correct handling of ORIGIN attribute errors in UPDATE messages.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the ORIGIN attribute set to an undefined value.

Comments on Test Results	RFC 4271 – Section 6.3

a. The RUT sends a NOTIFICATION message with Error Subcode Invalid ORIGIN Attribute. The Data field contains the invalid attribute.

Test #		Result	
BGP_CONF.3.6	**NEXT_HOP Attribute Error**	**a**	**PASS**
		b	**PASS**
		c	**FAIL**

Purpose: To verify the correct handling of NEXT_HOP attribute errors in UPDATE messages.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the NEXT_HOP attribute set to 224.0.0.5.
b. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the NEXT_HOP attribute set to an address that is not on the common subnet shared by the two routers.
c. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the NEXT_HOP attribute set to RUT's address on the common subnet.

Comments on Test Results | RFC 4271 – Section 6.3

a. The RUT sends a NOTIFICATION message with Error Subcode Invalid NEXT_HOP Attribute. The Data field contains the incorrect value.
b. The RUT does not send a NOTIFICATION message and the connection remains open.
c. The RUT does not send a NOTIFICATION message, and the connection remains open. However, the RUT installs the UPDATE message from TR1. According to draft-ietf-idr-bgp4-26 "*If a BGP router receives an UPDATE message with the NEXT_HOP attribute set to a semantically incorrect IP address, it should log the error and ignore the route. No NOTIFICATION message should be sent.*" Therefore, the RUT should not install the UPDATE message from TR1.

Test #		Result	
BGP_CONF.3.7	**AS_PATH Attribute Error**	**a**	**PASS**
		b	**PASS**

Purpose: To verify the correct handling of AS_PATH attribute errors in UPDATE messages.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the path segment type set to 11.
b. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the leftmost AS in its AS_PATH not set to its own Autonomous system.

Comments on Test Results | RFC 4271 – Section 6.3

a. The RUT sends a NOTIFICATION message with Error Subcode Malformed AS_PATH.
b. The RUT sends a NOTIFICATION message with error code UPDATE Message Error and error subcode Malformed AS_PATH.

Test #		Result	
BGP_CONF.3.8	**NLRI Field Error**	**a**	**PASS**
		b	**PASS**
Purpose: To verify the correct handling of NLRI field errors in UPDATE messages.			
Comments on Test Procedure			
a. The RUT is connected to TR1 as external peers. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with the NLRI field set to 224.0.0.5. b. The RUT is restarted. After the routers establish connection, TR1 sends an UPDATE message without the NLRI field.			
Comments on Test Results	RFC 4271 – Section 6.3		
a. The RUT does not send a NOTIFICATION message, just ignores the UPDATE message. b. The RUT accepts the UPDATE message from TR1.			

Test #		Result	
BGP_CONF.3.9	**Miscellaneous Attribute Errors**	**a**	**PASS**
Purpose: To verify the correct handling of miscellaneous errors in UPDATE messages.			
Comments on Test Procedure			
a. The RUT is connected to TR1 as external peers. After the RUT and TR1 establish the connection, TR1 sends an UPDATE message with multiple instances of the ORIGIN attribute.			
Comments on Test Results	RFC 4271 – Section 6.3		
a. The RUT sends a NOTIFICATION message with error code UPDATE Message Error and error subcode Malformed Attribute List.			

Test #		Result	
BGP_CONF.3.10	**Hold Timer Expired**	**a**	**PASS**
Purpose: To verify a BGP router's behavior when event Hold Timer Expired occurs.			
Comments on Test Procedure			
a. The RUT is connected to TR1 as external peers. After the RUT and TR1 establish the connection, TR1 is removed from the network.			
Comments on Test Results	RFC 4271 – Section 6.5		
a. The RUT sends a NOTIFICATION message with Error Code Hold Timer Expired when Hold Timer expires.			

Test #		Result	
BGP_CONF.3.11	**Connection Collision Detection**	**a**	**PASS**
		b	**PASS**
		c	**PASS**

Purpose: To verify that, in the case of a connection collision, a BGP router properly closes one of the connections or accepts connection closure.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. The RUT is configured with a BGP Identifier higher than that of TR1. The RUT initiates a connection to TR1. While the RUT is in state OpenConfirm, TR1 initiates a connection to the RUT.
b. The RUT is configured with a BGP Identifier lower than that of TR1. The RUT initiates a connection to TR1. While the RUT is in state OpenConfirm, TR1 initiates a connection to the RUT.
c. The RUT is restarted. After the RUT and TR1 establish the connection, TR1 initiates a connection to the RUT.

Comments on Test Results | RFC 4271 – Section 6.8

a. The RUT closes the connection initiated by TR1 and continues to use the connection it initiated.
b. The RUT closes the connection initiated by itself, and accepts the connection initiated by TR1.
c. The RUT closes the new connection initiated by TR1.

Group 4: Extensions

The following tests are designed to verify the behavior of BGP routers that implement the following extensions:

Confederations, Route Reflection, Communities, Capabilities Negotiation, Multiprotocol Extensions and Carrying Label Information.

Test #		Result	
BGP_CONF.4.1	**Confederations (Propagating an UPDATE)**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**PASS**
		g	**PASS**

Purpose: To verify the correct behavior of a BGP router participating in an AS confederation, when it propagates an UPDATE.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers in AS1. The RUT is connection to TR2 as internal peers in AS2. After the routers establish the connections, TR1 sends an UPDATE message for a new route to the RUT.
b. The routers are configured so that AS1 and AS2 are part of a confederation with confederation identifier 11. After the routers establish the connections, TR2 sends an UPDATE message for a new route to the RUT.
c. TR2 is moved to AS3. AS3 is part of confederation 11. After the routers establish the connections, TR2 sends an UPDATE message for a new route to the RUT.
d. AS1 is removed from the confederation. After the routers establish the connections, TR2 sends an UPDATE message for a new route to the RUT.
e. AS3 is removed from the confederation. After the routers establish the connections, TR2 sends an UPDATE message for a new route to the RUT.
f. After the routers establish the connections, TR2 sends an UPDATE message for a new route to the RUT. The AS_PATH attribute in the UPDATE message is set to (AS_CONFED_SEQUENCE/AS3).
g. After the routers establish the connections, TR2 sends an UPDATE message for a new route to the RUT. The AS_PATH attribute in the UPDATE message is set to (AS_CONFED_SEQUENCE/AS3), (AS_SET/AS4, AS5).

Comments on Test Results | RFC 3065 – Section 6

a. The RUT sends an UPDATE message for the new route to TR2 with the same AS_PATH attribute as received from TR1.
b. The RUT sends an UPDATE message for the new route to TR1. Inside the UPDATE message, the AS_PATH attribute is set to (AS_CONFED_SEQUENCE/11).
c. The RUT sends an UPDATE message for the new route to TR1. Inside the UPDATE message, the AS_PATH attribute is set to (AS_CONFED_SEQUENCE/AS2, AS3).
d. The RUT sends an UPDATE message for the new route to TR1. Inside the UPDATE message, the AS_PATH attribute is set to (AS_SEQUENCE/11).
e. The RUT sends an UPDATE message for the new route to TR1. Inside the UPDATE message, the AS_PATH attribute is set to (AS_SEQUENCE/11, AS3).
f. The RUT sends the UPDATE message to TR1 with AS_PATH set to (AS_SEQUENCE/11).

g. The RUT sends the UPDATE message to TR1 with AS_PATH set to (AS_SEQUENCE/11), (AS_SET/AS4, AS5).

Test #		Result	
BGP_CONF.4.2	**Confederations (Originating an UPDATE)**	**a**	**PASS**
		b	**PASS**
		c	**PASS**

Purpose: To verify the correct behavior of a BGP router participating in an AS confederation, when it originates an UPDATE.

Comments on Test Procedure

a. The RUT is connected to TR1 as internal peers in AS1. AS1 is part of confederation 11. After the RUT and TR1 establish the connection, RUT is configured to advertise a new route.
b. TR1 is moved to AS2. AS2 is part of confederation 11. After the RUT and TR1 establish the connection, the RUT is configured to advertise a new route.
c. TR1 is moved to AS3. AS3 is not a part of confederation 11. After the RUT and TR1 establish the connection, the RUT is configured to advertise a new route.

Comments on Test Results | RFC 3065 – Section 6

a. The RUT sends an UPDATE message to TR1. Inside the UPDATE message, the AS_PATH attribute is empty.
b. The RUT sends an UPDATE message to TR1. Inside the UPDATE message, the AS_PATH attribute is set to (AS_CONFED_SEQUENCE/AS1).
c. The RUT sends an UPDATE message to TR1. Inside the UPDATE message, the AS_PATH attribute is set to (AS_SEQUENCE/11).

Test #		Result	
BGP_CONF.4.3	**Confederations (Attributes)**	**a**	**PASS**
		b	**PASS**

Purpose: To verify the correct behavior of a BGP router participating in an AS confederation, regarding changes in the use of some fields in BGP messages.

Comments on Test Procedure

a. The RUT (AS2) is connected to TR1 (AS1) and TR2 (AS3) as external peers. AS2 and AS3 are part of confederation 111.
b. TR1 is configured to use MED. After the routers establish the connections, TR1 sends an UPDATE message for a new route to the RUT.

Comments on Test Results | RFC 3065 – Section 7

a. The RUT sends an OPEN message to TR1 and TR2. In the OPEN message to TR1, the My Autonomous System field is set to 111. In the OPEN message to TR2, the My Autonomous System field is set to AS2.
b. The RUT sends an UPDATE message to TR2. Inside the UPDATE message, the NEXT_HOP attribute is unchanged, the MED attribute is unchanged, and also contains the LOCAL_PREF attribute computed by the RUT.

Test #		Result	
BGP_CONF.4.4	**Route Reflector**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**

Purpose: To verify the correct behavior of a BGP router when it is configured as a route reflector.

Comments on Test Procedure

a. The RUT is connected to TR1, TR2, and TR3 as internal peers. The RUT is configured as a route reflector, with a CLUSTER_ID = 11. The client cluster is made of TR2 and TR3. After the routers establish the connections, TR1 sends an UPDATE message for a new route to the RUT.
b. After the routers establish the connections, TR2 sends an UPDATE message for a new route to the RUT.
c. TR3 is moved to another autonomous system. TR3 is configured to use MED. After the routers establish the connections, TR3 sends an UPDATE message for a new route to the RUT.
d. TR3 is moved back to the RUT's autonomous system. TR3 is not in the client cluster. After the routers establish the connections, TR3 sends an UPDATE message with a new route.
e. After the routers establish the connections, TR1 sends an UPDATE message with the ORIGINATOR_ID set to the ROUTER_ID of the RUT.

Comments on Test Results | RFC 2796

a. The RUT sends an UPDATE message for the new route to TR2 and TR3.
b. The RUT sends an UPDATE message for the new route to TR1 and TR3. In the UPDATE message to TR1, the CLUSTER_LIST attribute contains CLUSTER_ID=11. Both UPDATE messages contain the ORIGINATOR_ID attribute, set to TR2's ROUTER_ID.
c. The RUT sends an UPDATE message to TR1 and TR2. In the UPDATE messages, the NEXT_HOP and the AS_PATH should be unchanged. The MED attributes may be changed.
d. The RUT sends an UPDATE message for the new route to TR2 but not TR1. The NEXT_HOP, AS_PATH, and LOCAL_PREF attributes are unchanged. The UPDATE includes the ORIGINATOR_ID attribute set to TR3's ROUTER_ID.
e. The RUT ignores the UPDATE message from TR1.

Test #		Result	
BGP_CONF.4.5	**Route Reflector to Non-Client**	**a**	**PASS**
Purpose: To verify the correct behavior of a BGP route reflector when peered with a nonclient.			
Comments on Test Procedure			
a. The RUT is connected to TR1 and TR2 as internal peers. The RUT is configured with CLUSTER_ID 5.0.0.0. After the routers establish the connections, TR1 sends an UPDATE message for a new route to the RUT. The UPDATE message includes the CLUSTER_LIST attribute, with CLUSTER_ID 5.0.0.0.			
Comments on Test Results	RFC 2796		
a. The RUT ignores the UPDATE message. It does not install the new route, and does not propagate the UPDATE message to TR2.			

Test #		Result	
BGP_CONF.4.6	**Communities**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**
		e	**PASS**

Purpose: To verify the correct behavior of a BGP router that implements the Communities Attribute extension.

Comments on Test Procedure

a. The RUT is connected to TR1 and TR2 as external peers (TR1 and TR2 are in different AS's). After the routers establish the connections, the RUT is configured to advertise a new route as part of the NO_EXPORT community.
b. The RUT is configured to attach a communities attribute to routes it receives from TR1. After the routers establish the connections, TR1 sends an UPDATE message for a new route to the RUT. The UPDATE message carries no communities attribute.
c. The RUT is configured not to attach a communities attribute to routes it receives from TR1. After the routers establish the connections, TR1 sends an UPDATE message for a new route to the RUT. The UPDATE message carries the communities attribute NO_EXPORT.
d. AS2 and AS3 are configured in the same confederation. After the routers establish the connections, TR1 sends an UPDATE message for a new route to the RUT. The UPDATE message carries the communities attribute NO_EXPORT_SUBCONFED.
e. TR3 is moved to AS2. After the routers establish the connections, TR1 sends an UPDATE message for a new route to the RUT. The UPDATE message carries the communities attribute NO_ADVERTISE.

Comments on Test Results | RFC 1997

a. The RUT sends an UPDATE message for the new route to both TR1 and TR2. The UPDATE contains the COMMUNITIES attribute with value NO_EXPORT.
b. The RUT propagates the UPDATE message to TR2. The UPDATE contains the COMMUNITIES attribute configured on the RUT.
c. The RUT installs the route in its routing table. The RUT does not propagate the route to TR2.
d. The RUT installs the route in its routing table. The RUT does not propagate the route to TR2.
e. The RUT installs the route in its routing table. The RUT does not propagate the route to TR2.

Test #		Result	
BGP_CONF.4.7	**Capabilities Advertisement**	**a**	**PASS**
		b	**PASS**
		c	**PASS**

Purpose: To verify the correct behavior of a BGP router that implements the Capabilities Negotiation extension.

Comments on Test Procedure

a. The RUT is configured to peer with TR1 as external peers. The RUT is configured to include the Capabilities Optional Parameter in its OPEN message. TR1 does not support Capabilities Advertisement.
b. The RUT is restarted. TR1 is configured with all the Capabilities the RUT supports.
c. The RUT is restarted. TR1 is configured with all the Capabilities the RUT supports. Inside the OPEN message from TR1, one of the Capabilities is duplicated.

Comments on Test Results | draft-ietf-idr-bgp4-cap-neg-04- Sections 3 and 4

a. The RUT sends another OPEN message to TR1 without the Capabilities Optional Parameter.
b. The RUT and TR1 establish the connection normally.
c. The RUT and TR1 establish the connection normally.

Test #		Result	
BGP_CONF.4.8	**Multiprotocol**	**a**	**FAIL**
		b	**N/T**
		c	**PASS**
		d	**PASS**
		e	**PASS**
		f	**N/T**

Purpose: To verify the correct behavior of a BGP router that implements the Multiprotocol extension.

Comments on Test Procedure

a. The RUT is connected to TR1 as external peers. The RUT and TR1 supports the same protocols (AFI/SAFI). After the routers establish the connections, the RUT is configured to advertise a new route belonging to one of the supported protocols.
b. The new route is removed from the RUT.
c. After the routers establish the connections, TR1 sends an UPDATE message for a new route to the RUT. The UPDATE message contains the MP_REACH_NLRI attribute. The leftmost AS in the AS_PATH attribute is different than TR1's AS number.
d. After the routers establish the connections, TR1 sends an UPDATE message for a new route to the RUT. The UPDATE message contains the MP_REACH_NLRI attribute. The leftmost AS in the AS_PATH attribute is equal to TR1's AS number.
e. After the routers establish the connections, TR1 sends an UPDATE message for the withdrawal of a route to the RUT. The UPDATE message contains the MP_UNREACH_NLRI attribute for the previous route.
f. The RUT is connected to TR1 as internal peers. After the routers establish the connections, the RUT is configured to advertise a new route with the MP_REACH_NLRI attribute.

Comments on Test Results | RFC 2858 – Section 2

a. The RUT sends a BGP message of type 6 (UNKNOWN) to TR1. According to RFC 2858, Section 2 "*A BGP router that implements the Multiprotocol Extensions should use MP_REACH_NLRI to advertise a feasible route to a peer. The UPDATE message must also carry the ORIGIN and AS_PATH attributes.*" Therefore, the RUT should send an UPDATE message for the new route to TR1 using MP_REACH_NLRI.
b. Due to the failure in part a, this was not tested.
c. The RUT sends a NOTIFICATION message with Error Code UPDATE Message Error and Error Subcode Malformed AS_PATH to TR1.
d. The RUT accepts the UPDATE message and installs the route in its routing table.
e. The RUT accepts the UPDATE message and removes the route from Part d. from its routing table.
f. Due to the failure in part a, this was not tested.

Test #		Result	
BGP_CONF.4.9	**Basic MD5 Authentication**	**a**	**PASS**
		b	**PASS**
		c	**PASS**

Purpose: To verify that a router can perform basic MD5 authentication processing functionality.

Comments on Test Procedure

a. The RUT is not configured to perform TCP MD5 authentication. TR1 sends an OPEN message with a correct MD5 authentication header.
b. The RUT is configured to perform TCP MD5 authentication, with a secret of ABCDEFGHIJKL. TR1 sends an OPEN message with a MD5 authentication header (correct digest).
c. The RUT is configured to perform TCP MD5 authentication, with a secret of ABCDEFGHIJKL. TR1 sends an OPEN message with no authentication header.

Comments on Test Results	RFC 2385 – Section 2

a. The RUT just discards the message. It does not produce any response back to the sender.
b. The RUT and TR1 establish the BGP connection normally.
c. The RUT just discards the message. It does not produce any response back to the sender.

Test #		Result	
BGP_CONF.4.10	**Processing Route Advertisements**	**a**	**PASS**
		b	**PASS**
		c	**PASS**
		d	**PASS**

Purpose: To verify the BGP router running Route Flap Damping properly processes route advertisements.

Comments on Test Procedure

a. Route Flap Dampening is enabled on the RUT with a Penalty of 1000, a Cutoff of 2000, Reuse set to 300, a Half-life of 3 min. and Maximum suppression set to 5min. The RUT is connected to TR1 and TR2 in AS1 as external peers. The RUT is connected to TR3 in AS3 as external peers. After the routers establish the connections TR1 sends an UPDATE message to the RUT for 192.1.0.0/16 with NEXT_HOP set to itself.
b. The RUT is configured to assign a higher degree of preference to routes received from TR1 than TR2. TR2 sends an UPDATE message to the RUT for 192.1.0.0/16 with NEXT_HOP set to itself. TR1's link to the RUT flaps once.
c. TR1's link to the RUT flaps two more times before the figure-of-merit decays to zero.
d. TR1's link to the RUT remains stable for approximately two minutes.

Comments on Test Results | RFC 2439 – Sections 4.8.1 and 4.8.3

a. The RUT installs 192.1.0.0/16 in its routing table and sends an UPDATE message to TR3 for the route.
b. The RUT selects TR1 as the next hop for traffic destined for 192.1.0.0/16.
c. The RUT selects TR2 as the next hop for traffic destined for 192.1.0.0/16.
d. The RUT selects TR1 as the next hop for traffic destined for 192.1.0.0/16.

Test #		Result	
BGP_CONF.4.11	**Processing Route Changes**	**a**	**PASS**

Purpose: To verify the BGP router running Route Flap Damping properly processes route changes.

Comments on Test Procedure

a. Route Flap Dampening is enabled on the RUT. The RUT is connected to TR1 in AS 1 as external peers. The RUT is connected to TR2 in AS3 as external peers. After the routers establish the connections, TR1 periodically switches between sending UPDATE messages with AS_PATH set to (AS_SEQUENCE/AS1, AS12) and (AS_SEQUENCE/AS1, AS14) to some network N3 until figure-of-merit >= cutoff threshold.

Comments on Test Results | RFC 2439 – Section 4.8.4

a. The RUT penalizes both routes and sends an UPDATE message to TR2 for the changes each time TR1 switches between the two routes.