BGP Testing: Why Be So Negative?

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NANOG 30
February 10, 2004
No one is immune to bugs in code. -Hank

Henry Kilmer writes:
>Yes. And it wasn't the configs that were wrong. It was a BGP related
   {Vendor name removed} bug.

That's the best way to find these sorts of things -- in test...
Perry
Negative BGP Conditions in Networks

• **BGP Update message errors** – Software crash may occur if improperly handled. NLRI’s may be incorrectly advertised.

• **BGP Route Explosion** – Out-of-Memory condition may occur, which could force router reboot

• **BGP Processing** – High CPU Utilization may persist on router, which could cause BGP sessions to flap and lead to more network instability

• **Incorrect BGP Path Selection Process** – Could produce routing loop or route oscillation

• **Stuck Routes** – Could produce routing loop
Negative Testing

• Negative Testing=
  Tests designed to verify that the router under test correctly responds to error conditions in the network

• Negative Testing different from functionality, conformance, and interoperability testing
  – These verify correct operation with known expected behavior

• Negative Testing more difficult to define because number of error conditions is boundless
Hey folks, Does anyone have a script or a series thereof to do large-scale BGP testing? I'm looking for scripts that will generate and nail down several hundred networks of varying sizes, and/or fake peering relationships with a similar purpose, and/or do things that don't meet the BGP protocol standards, etc. Thanks for any responses. Tim
IETF BMWG Routing Benchmarking

• BMWG Benchmarks single device Performance, not Conformance and not Negative Testing
• Current Routing Benchmarks cover FIB Scaling, Forwarding Performance, and Convergence that are fundamentals of Negative Testing:
  – Terminology for Forwarding Information Base (FIB) based Router Performance (RFC 3222)
  – Terminology for Benchmarking BGP Device Convergence in the Control Plane (draft-ietf-bmwg-conterm-05.txt)
  – Benchmarking Terminology and Methodology for IGP Data Plane Route Convergence (draft-ietf-bmwg-igp-dataplane-conv-term [and meth]-02.txt)
• http://www.ietf.org/html.charters/bmwg-charter.html
Negative Testing of BGP UPDATE Errors

• AS Path List
  – Routing Loop
  – Maximum AS Path Length

• Missing/Incorrect/Errored Attributes
  – EBGP, IBGP, RR, Confeds

• NLRI with incorrect next hop
  – Receiving router is next hop
  – NLRI is next-hop
  – Unreachable Next-Hop

• Interoperability negotiating capabilities
  – UPDATE message includes parameter that wasn't agreed upon
Negative Testing of BGP Resources

- **BGP Route Explosion** -
  - Force Out-of-Memory condition
  - Advertise NLRI's until no memory available
  - Advertise additional NLRI's and observed router behavior

- **BGP Processing** -
  - High CPU Utilization
  - Remove EBGP Peering Session from which most FIB routes learned
  - Force Convergence Event during a Convergence Event

- **Redistribute BGP into IGP**
BGP Convergence Tests

Test Setup

DUT

Preferred Egress Interface

Next-Best Egress Interface

Tester

Convergence Events

Link Failure
- Local Interface Failure
- Neighbor Interface Failure
- Remote Interface Failure

Layer 2 Failure (PPP, GigE)
IGP Adjacency Failure
Route Withdrawal
Cost Change

Test Procedure

- DUT has two paths (via Link 1 and Link 2) to reach destinations
- Tester sends traffic to DUT to all destinations in FIB
- DUT by default prefers lower cost path via Link 1
- Convergence Event reroutes traffic to Link 2
- Observe recovery to forwarding at line rate and Calculate Convergence Time
Negative Testing of BGP Functionality

• Path Decision Process
  – advertise same NLRI from multiple neighbors
  – cause each step of the decision process to be used
  – Use different IGP next-hops
  – force execution of entire Process

• Invalid peering
  – MD-5 Authentication with invalid password/keys
  – Incorrect AS number
Negative Testing of BGP Configuration

• BGP stability/scaling testing can be impacted by the configuration of the following:

• Hello/Keepalive Timer
  - Some routers exhibit degraded behavior when using a setting of 30 seconds / 90 seconds instead of the default 60 seconds / 180 seconds

• Update Rate
  - Some routers exhibit degraded behavior when increasing to 5K NLRI/s/second or higher
  - Routers tend to be stable at 2K

• Peer-Groups
  - Use of Peer-Groups can improve memory utilization to increase the number of peers and routes
Test Tools for BGP Negative Testing

- Routing Protocol emulation from commercial router test equipment has become very advanced in past year:
  - Ability to emulate iBGP or eBGP
  - Ability to emulate IGP on same test port
  - User Configuration of Update Rate and Timers
  - Feature to load external route table for building Update messages
  - These tests may be scripted
  - Test Vendors: Need canned script for Selection Process!

- Freeware emulators can be extended via scripts to generate negative conditions:
  - Python Routing Toolkit from Sprint labs
  - bgpsim, which is part of MRT from Merit, is available at http://www.sourceforge.com
Summary

• Negative Testing is a critical component of router evaluation prior to deployment.
• Some BGP implementations have caused network instability because of lack of Negative Testing
• BGP Negative Testing should drive High Memory and CPU Utilization
• IETF BMWG is addressing FIB Scaling and Convergence
• Additional BGP Negative Testing should include:
  – BGP Update Messages
  – Route Convergence
  – Path Selection Process
  – Peering
  – Configuration
• Sophisticated Test Tools are commercially available today perform this negative testing
Comments?