            Advertisement of Multiple Paths in BGP: Implementation Report
                  draft-retana-idr-add-paths-implementation-00

Abstract

   This document reports the results of an ADD-PATH implementation
   survey. The survey had 22 questions about implementations' support
   for advertising multiple paths in BGP. After a brief summary of the
   results, each response is listed. This document contains responses
   from three implementers who completed the survey (Cumulus Networks,
   Cisco Systems and Exa Networks).

   The editor did not use external means to verify the accuracy of the
   information submitted by the respondents. The respondents are
   considered experts on the products they reported on.

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1. Introduction

   This document reports results from a survey of implementations of the
   Advertisement of Multiple Paths in BGP [I-D.ietf-idr-add-paths],
   where a BGP [RFC4271] extension that allows the advertisement of
   multiple paths for the same address prefix without the new paths
   implicitly replacing any previous ones is defined. The essence of
   the extension is that each path is identified by a path identifier in
   addition to the address prefix.

   The ADD-PATH implementation survey had 22 detailed questions about
   compliance with [I-D.ietf-idr-add-paths]. Three implementers
   (Cumulus Networks, Cisco Systems and Exa Networks) completed the
   survey. Section 4 provides a compilation of the results.
   Section 3.1 provides an overview of the differences between the
   implementations. Section 3.3 provides interoperability information.

2. Requirements Language

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in [RFC2119].

3. Results of the Survey

   The respondents replied "Yes" or "No" to the survey's questions to
   indicate whether their implementation supports the Functionality/
   Description of the [RFC2119] language in [I-D.ietf-idr-add-paths].
   The respondents replied "Other" to indicate an alternate behavior and
   had the opportunity to provide comments in all cases. Some questions
   were informative.

3.1. Overview of Differences

   This section provides the reader with a shortcut to the points where
   the implementations differ.

   The following questions were not answered "Yes" by all respondents
   (Note that the question numbers correspond to the subsection numbers
   of Section 4):

      MUST

      4.1.3, 4.1.4, 4.4.6

   Question 4.1.3 asks about the ability of the implementation to
   uniquely identify a path. This question is linked to 4.1.2 in which
   the mechanism used to assigned Path Identifiers is explained. The

vendor that did not answer "Yes" to 4.1.3 lets the user assign Path Identifiers; the response to 4.1.3 was "Other: This is left to the user of the application to do."

Question 4.1.4 asks about the generation of Path Identifiers when re-advertising a route. All responded chose "Other" -- I believe that there was some misinterpretation on the intent of re-advertisement.

Question 4.4.6 asks about using the encoding defined when generating an Update. One vendor replied "Other"; in their case, transmitting Updates hasn't been implemented.

3.2. Implementation Identification

3.3.1. Cumulus

Company/Organization Name: Cumulus Networks

Implementation Name/Version: quagga

Date: 11/3/2014

Contact Name: Daniel Walton

Contact e-mail: dwalton@cumulusnetworks.com

3.3.2. Cisco

Company/Organization Name: Cisco Systems

Implementation Name/Version: IOS-XE

Date: 11/03/2014

Contact Name: Mohammed Mirza

Contact e-mail: mohamirz@cisco.com

3.3.3. Exa

Company/Organization Name: Exa Networks

Implementation Name/Version: ExaBGP

Date: 01/11/2014

Contact Name: Thomas Mangin

Contact e-mail: thomas.mangin@exa-networks.co.uk

3.3. Implementations and Interoperability

```
+---------+---------+-------+-----+-------+
|         | Cumulus | Cisco | Exa | Other |
| Cumulus |         | Yes   |     | Bird  |
| Cisco   |         | Yes   |     |       |
| Exa     |         | Yes   |     |       |
+---------+---------+-------+-----+-------+
```

4. Implementation Report

For every item listed, the respondents indicated whether their
implementation supports the Functionality/Description or not (Yes/No)
according to the [RFC2119] language indicated. Any respondent
comments are included. If appropriate, the respondents indicated
with "Other" the fact that the support is neither Yes/No (an
alternate behavior, for example). Refer to the appropriate sections
in [I-D.ietf-idr-add-paths] for additional details.

4.1. Section 2: How to Identify a Path

4.1.1. Base Behavior

Functionality/Description: Is your implementation compatible with the
use of the Path Identifier as described in this section?

[RFC2119]: N/A

```
        Implementation Yes/No/Other Comments
        -------------- ------------ --------
        Cumulus        Yes
        Cisco          Yes
        Exa            Yes
```

4.1.2. Path Identifier Assignment

Functionality/Description: Explain how Path Identifiers are assigned
in your implementation.

[RFC2119]: N/A

Implementation Comments
-------------- ---
Cumulus   quagga is RX only for now so this is not an issue
Cisco   Each net has unique path-id per paths under it. The
               path ids that are withdrawn can get assigned to the
               newer paths.
Exa   By the user

4.1.3. Path Identifier Assignment (2)

Functionality/Description: "...the Path Identifier MUST be assigned
in such a way that the BGP speaker is able to use the (prefix, path
identifier) to uniquely identify a path advertised to a neighbor."

Can your implementation uniquely identify an advertised path based on
the (prefix, path identifier) pair?

[RFC2119]: MUST

Implementation Yes/No/Other Comments
-------------- ------------ --
Cumulus   Yes
Cisco   Yes
Exa   Other   This is left to the user of the
                            application to do.

4.1.4. Route Re-advertisement

Functionality/Description: "A BGP speaker that re-advertises a route
MUST generate its own Path Identifier to be associated with the re-
advertised route."

Does your implementation generate a new Path Identifier when re-
advertising a route?

[RFC2119]: MUST

Implementation Yes/No/Other Comments
-------------- ------------ --
Cumulus   Other   Comments quagga does not support TX yet
Cisco   Other   Once a BGP speaker advertises a path-id
                            it has to also withdraw it. In case it
                            has to readvertise, it either updates the
                            older path-id path or creates a new path
                            with a new unique id.
Exa   Other   ExaBGP does not re-advertise routes

4.1.5. Received Path Identifier

   Functionality/Description: "A BGP speaker that receives a route
   SHOULD NOT assume that the identifier carries any particular
   semantics; it SHOULD be treated as an opaque value."

   Does your implementation treat a received Path Identifier as an
   opaque value?

   [RFC2119]: SHOULD NOT

                 Implementation Yes/No/Other Comments
                 -------------- ------------ --------
                 Cumulus   Yes
                 Cisco   Yes
                 Exa   Yes

4.2. Section 3: Extended NLRI Encodings

4.2.1. Base Behavior

   Functionality/Description: Does your implementation use the encodings
   specified in this section?

   [RFC2119]: N/A

                 Implementation Yes/No/Other Comments
                 -------------- ------------ --------
                 Cumulus   Yes
                 Cisco   Yes
                 Exa   Yes

4.3. Section 4: ADD-PATH Capability

4.3.1. Base Behavior

   Functionality/Description: Is your implementation able to send and
   receive the ADD-PATH Capability as described in this section?

   [RFC2119]: N/A

                 Implementation Yes/No/Other Comments
                 -------------- ------------ --------
                 Cumulus   Yes
                 Cisco   Yes
                 Exa   Yes

4.4. Section 5: Operation

4.4.1. Base Behavior

   Functionality/Description: Is your implementation compatible with the
   operation described in this section?

   [RFC2119]: N/A

         Implementation Yes/No/Other Comments
         -------------- ------------ --------------------------
         Cumulus   Other   RX yes, TX not implemented
         Cisco   Yes
         Exa   Yes

4.4.2. Implicit Replacement

   Functionality/Description: "...a new advertisement for a given
   address prefix and a given path identifier replaces a previous
   advertisement for the same address prefix and path identifier."

   Does your implementation replace previous advertisements with the
   same (prefix, path identifier) pair?

   [RFC2119]: N/A

         Implementation Yes/No/Other Comments
         -------------- ------------ ------------------------------
         Cumulus   Yes
         Cisco   Yes
         Exa   Other   ExaBGP does not implement a FIB

4.4.3. Silently Ignore

   Functionality/Description: "If a BGP speaker receives a message to
   withdraw a prefix with a path identifier not seen before, it SHOULD
   silently ignore it."

   Does your implementation silently ignore the withdraw of a prefix
   with a new path identifier?

   [RFC2119]: SHOULD

                 Implementation Yes/No/Other Comments
                 -------------- ------------ --------
                 Cumulus
                 Cisco
                 Exa

4.4.4. Send/Receive Logic

   Functionality/Description: "For a BGP speaker to be able to send
   multiple paths to its peer, that BGP speaker MUST advertise the ADD-
   PATH capability with the Send/Receive field set to either 2 or 3, and
   MUST receive from its peer the ADD-PATH capability with the Send/
   Receive field set to either 1 or 3, for the corresponding <AFI,
   SAFI>."

   Does your implementation follow the send/receive logic as specified
   in this section?

   [RFC2119]: MUST

                Implementation Yes/No/Other Comments
                -------------- ------------ --------
                Cumulus   Yes
                Cisco   Yes
                Exa   Yes

4.4.5. Update Procedure

   Functionality/Description: "A BGP speaker MUST follow the existing
   procedures in generating an UPDATE message for a particular <AFI,
   SAFI> to a peer unless the BGP speaker advertises the ADD-PATH
   Capability to the peer indicating its ability to send multiple paths
   for the <AFI, SAFI>, and also receives the ADD-PATH Capability from
   the peer indicating its ability to receive multiple paths for the
   <AFI, SAFI>..."

   Does your implementation follow normal procedures when generating
   UPDATES if the ADD-PATH capability is not sent and received?

   [RFC2119]: MUST

                Implementation Yes/No/Other Comments
                -------------- ------------ --------
                Cumulus   Yes
                Cisco   Yes
                Exa   Yes

4.4.6. Update Generation with Encoding

   Functionality/Description: "...in which case the speaker MUST
   generate a route update for the <AFI, SAFI> based on the combination
   of the address prefix and the Path Identifier, and use the extended
   NLRI encodings specified in this document."

If the ADD-PATH capability has been sent and received, does your implementation generate new UPDATEs using the (prefix, path identifier) pair and the encodings defined in this document?

[RFC2119]: MUST

```
        Implementation Yes/No/Other Comments
        -------------- ------------ -----------------------
        Cumulus        Other        TX is not supported yet
        Cisco          Yes
        Exa            Yes
```

4.4.7. Multiple Address Family Support

   Functionality/Description: "The peer SHALL act accordingly in
   processing an UPDATE message related to a particular <AFI, SAFI>."

   Does your implementation support the use of the ADD-PATH capability
   for multiple <AFI, SAFI> pairs?

   [RFC2119]: SHALL

```
          Implementation Yes/No/Other Comments
          -------------- ------------ --------
          Cumulus        Yes
          Cisco          Yes
          Exa            Yes
```

4.4.8. Multiple Address Family Support (2)

   Functionality/Description: Which <AFI, SAFI> pairs does your
   implementation support when using the ADD-PATH capability?

   [RFC2119]: N/A

```
          Implementation Comments
          -------------- -----------------------------
          Cumulus        IPv4 unicast and IPv6 unicast
          Cisco          ipv4 unicast and ipv6 unicast
          Exa            1/1 2/1 1/4 2/4
```

4.4.9. Bestpath

   Functionality/Description: "A BGP speaker SHOULD include the bestpath
   when more than one path are advertised to a neighbor unless the
   bestpath is a path received from that neighbor."

Does your implementation include the bestpath when multiple paths are
announced to a neighbor, as described?

[RFC2119]: SHOULD

```
Implementation Yes/No/Other Comments
-------------- ------------ ----------------------------------------
Cumulus        Yes
Cisco          Yes
Exa            Other        ExaBGP does not have a FIB, this is user
                            controlled.
```

4.4.10. Path Identifier Persistency

Functionality/Description: "As the Path Identifiers are locally
assigned, and may or may not be persistent across a control plane
restart of a BGP speaker..."

Are the path identifiers persistent across control plane restarts in
your implementation?

[RFC2119]: N/A

```
Implementation Yes/No/Other Comments
-------------- ------------ ----------------------------------------
Cumulus        No
Cisco          No           XE-BGP-ADD-Paths need to have HA
                            enhancements
Exa            Other        User controlled
```

4.4.11. Graceful Restart

Functionality/Description: "...an implementation SHOULD take special
care so that the underlying forwarding plane of a "Receiving Speaker"
as described in [RFC4724] is not affected during the graceful restart
of a BGP session."

Please explain how your implementation addresses Graceful Restart.

[RFC2119]: SHOULD

```
Implementation Comments
-------------- ---------------------------------------------------------
Cumulus        Quagga has partial GR support (it is GR aware for
               other restarting nodes) but does not maintain the
               forwarding plane during a restart.
Cisco          XE-BGP-ADD-Paths need to have HA enhancements
Exa            No FIB, not relevant
```

4.5. Section 6: Applications

4.5.1. Applications

   Functionality/Description: Please list or explain which applications
   that require the propagation of multiple paths are supported by your
   implementation.

   [RFC2119]: N/A

   Implementation Comments
   -------------- --
   Cumulus   None yet....RX onlys
   Cisco   1. RR client to RR use cases for ipv4 and ipv6. 2. RR
                  to RR clients(could be ASBRs) use cases for ipv4 and
                  ipv6.
   Exa   N/A

4.6. Section 7: Deployment Considerations

4.6.1. Deployment Experience

   Functionality/Description: Please comment on deployment experience
   with your implementation.

   [RFC2119]: N/A

   Implementation Comments
   -------------- --
   Cumulus
   Cisco
   Exa   Cisco routers exporting ADD-PATH routes to ExaBGP,
                  routes are then stored in a distributed Database. A
                  complex best path selection (including latency) is
                  performed on the stored routes, and the best routes
                  are then re-injected in the core via ExaBGP.

5. Security Considerations

   This document reports the results of an ADD-PATH implementation
   survey. As such, it does not iintroduce any security risks.

6. IANA Considerations

   This document has no IANA actions.

7. Acknowledgements

   The editor would like to thank Daniel Walton, Mohammed Mirza and
   Thomas Mangin.

8. References

8.1. Normative References

   [I-D.ietf-idr-add-paths]
             Walton, D., Retana, A., Chen, E., and J. Scudder,
             "Advertisement of Multiple Paths in BGP", draft-ietf-idr-
             add-paths-10 (work in progress), October 2014.

   [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate
             Requirement Levels", BCP 14, RFC 2119, March 1997.

8.2. Informative References

   [RFC4271] Rekhter, Y., Li, T., and S. Hares, "A Border Gateway
             Protocol 4 (BGP-4)", RFC 4271, January 2006.

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