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K. Patel
Arrcus
R. Fernando
Cisco Systems
J. Scudder
J. Haas
Juniper Networks

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Notification Message Support for BGP Graceful Restart

Abstract

The BGP Graceful Restart mechanism defined in RFC 4724 limits the usage of BGP Graceful Restart to BGP messages other than BGP NOTIFICATION messages. This document updates RFC 4724 by defining an extension that permits the Graceful Restart procedures to be performed when the BGP speaker receives a BGP NOTIFICATION message or the Hold Time expires. This document also defines a new subcode for BGP Cease NOTIFICATION messages; this new subcode requests a full session restart instead of a Graceful Restart.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at https://www.rfc-editor.org/info/rfc8538.

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1. Introduction

For many classes of errors, BGP must send a NOTIFICATION message and reset the peering session to handle the error condition. The BGP Graceful Restart mechanism defined in [RFC4724] requires that normal BGP procedures defined in [RFC4271] be followed when a NOTIFICATION message is sent or received. This document defines an extension to BGP Graceful Restart that permits the Graceful Restart procedures to be performed when the BGP speaker receives a NOTIFICATION message or the Hold Time expires. This permits the BGP speaker to avoid flapping reachability and continue forwarding while the BGP speaker restarts the session to handle errors detected in BGP.

At a high level, this document can be summed up as follows. When a BGP session is reset, both speakers operate as "Receiving Speakers" according to [RFC4724], meaning they retain each other's routes. This is also true for HOLDTIME expiration. The functionality can be defeated by sending a BGP Cease NOTIFICATION message with the Hard Reset subcode. If a Hard Reset is used, a full session reset is performed.

1.1. Requirements Language

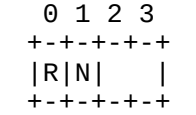
The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2. Modifications to BGP Graceful Restart Capability

The BGP Graceful Restart Capability is augmented to signal the Graceful Restart support for BGP NOTIFICATION messages. The Restart Flags field is augmented as follows (following the diagram in Section 3 of [RFC4724]).

Restart Flags:

This field contains bit flags relating to restart.



The most significant bit is defined in [RFC4724] as the Restart State ("R") bit.

The second most significant bit is defined in this document as the Graceful Notification ("N") bit. It is used to indicate Graceful Restart support for BGP NOTIFICATION messages. A BGP speaker indicates support for the procedures in this document by advertising a Graceful Restart Capability with its "N" bit set (value 1).

If a BGP speaker that previously advertised a given set of Graceful Restart parameters opens a new session with a different set of parameters, these new parameters apply once the session has transitioned into ESTABLISHED state.

3. BGP Hard Reset Subcode

This document defines a new subcode for BGP Cease NOTIFICATION messages, called the Hard Reset subcode. The value of this subcode is discussed in Section 8. In this document, a BGP Cease NOTIFICATION message with the Hard Reset subcode is referred to as a "Hard Reset message" or simply as a "Hard Reset".

When the "N" bit has been exchanged by two peers, NOTIFICATION messages other than Hard Reset messages are referred to as "Graceful", since such messages invoke Graceful Restart semantics.

3.1. Sending a Hard Reset

When the "N" bit has been exchanged, a Hard Reset message is used to indicate to the peer that the session is to be fully terminated.

When sending a Hard Reset, the data portion of the NOTIFICATION message is encoded as follows:

ErrCode is a BGP Error Code (as documented in the IANA "BGP Error (Notification) Codes" registry) that indicates the reason for the Hard Reset. Subcode is a BGP Error Subcode (as documented in the IANA "BGP Error Subcodes" registry) as appropriate for the ErrCode. Similarly, Data is as appropriate for the ErrCode and Subcode. In short, the Hard Reset encapsulates another NOTIFICATION message in its data portion.

3.2. Receiving a Hard Reset

Whenever a BGP speaker receives a Hard Reset, the speaker MUST terminate the BGP session following the standard procedures in [RFC4271].

4. Operation

A BGP speaker that is willing to receive and send BGP NOTIFICATION messages according to the procedures of this document MUST advertise the "N" bit using the Graceful Restart Capability as defined in [RFC4724].

When such a BGP speaker has received the "N" bit from its peer, and receives from that peer a BGP NOTIFICATION message other than a Hard Reset, it MUST follow the rules for the Receiving Speaker mentioned in Section 4.1. The BGP speaker generating the BGP NOTIFICATION message MUST also follow the rules for the Receiving Speaker.

When a BGP speaker resets its session due to a HOLDTIME expiry, it should generate the relevant BGP NOTIFICATION message as mentioned in [RFC4271] but subsequently MUST follow the rules for the Receiving Speaker mentioned in Section 4.1.

A BGP speaker SHOULD NOT send a Hard Reset to a peer from which it has not received the "N" bit. We note, however, that if it did so, the effect would be as desired in any case because, according to [RFC4271] and [RFC4724], any NOTIFICATION message, whether recognized or not, results in a session reset. Thus, the only negative effect to be expected from sending the Hard Reset to a peer that hasn’t advertised compliance to this specification would be that the peer would be unable to properly log the associated information.

Once the session is re-established, both BGP speakers SHOULD set their Forwarding State bit to 1. If the Forwarding State bit is not set, then, according to the procedures in Section 4.2 of [RFC4724], the relevant routes will be flushed, defeating the goals of this specification.

4.1. Rules for the Receiving Speaker

Section 4.2 of [RFC4724] defines rules for the Receiving Speaker. This document modifies those rules as follows:

The sentence "To deal with possible consecutive restarts, a route (from the peer) previously marked as stale MUST be deleted" only applies when the "N" bit has not been exchanged with the peer:

OLD: When the Receiving Speaker detects termination of the TCP session for a BGP session with a peer that has advertised the Graceful Restart Capability, it MUST retain the routes received from the peer for all the address families that were previously received in the Graceful Restart Capability and MUST mark them as stale routing information. To deal with possible consecutive restarts, a route (from the peer) previously marked as stale MUST be deleted. The router MUST NOT differentiate between stale and other routing information during forwarding.

NEW: When the Receiving Speaker detects termination of the TCP session for a BGP session with a peer that has advertised the Graceful Restart Capability, it MUST retain the routes received from the peer for all the address families that were previously received in the Graceful Restart Capability and MUST mark them as stale routing information. The router MUST NOT differentiate between stale and other routing information during forwarding. If the "N" bit has not been exchanged with the peer, then to deal with possible consecutive restarts, a route (from the peer) previously marked as stale MUST be deleted.

The stale timer is given a formal name and made mandatory:

OLD: To put an upper bound on the amount of time a router retains the stale routes, an implementation MAY support a (configurable) timer that imposes this upper bound.

NEW: To put an upper bound on the amount of time a router retains the stale routes, an implementation MUST support a (configurable) timer, called the "stale timer", that imposes this upper bound. A suggested default value for the stale timer is 180 seconds. An implementation MAY provide the option to disable the timer (i.e., to provide an infinite retention time) but MUST NOT do so by default.

5. Use of Hard Reset

5.1. When to Send a Hard Reset

Although when to send a Hard Reset is an implementation-specific decision, we offer some advice. Many Cease NOTIFICATION subcodes represent permanent or long-term, rather than transient, session termination. Because of this, it's appropriate to use Hard Reset with them. As of publication of this document, subcodes 1-9 have been defined for Cease. The following table lists each of these subcodes along with suggested behavior.

Value	Name	Suggested Behavior
1	Maximum Number of Prefixes Reached	Hard Reset
2	Administrative Shutdown	Hard Reset
3	Peer De-configured	Hard Reset
4	Administrative Reset	Provide user control
5	Connection Rejected	Graceful Cease
6	Other Configuration Change	Graceful Cease
7	Connection Collision Resolution	Graceful Cease
8	Out of Resources	Graceful Cease
9	Hard Reset	Hard Reset

These suggestions are only that -- suggestions, not requirements. It's the nature of BGP implementations that the mapping of internal states to BGP NOTIFICATION codes and subcodes is not always perfect. The guiding principle for the implementor should be that if there is no realistic hope that forwarding can continue or that the session will be re-established within the deadline, Hard Reset should be used.

For all NOTIFICATION codes other than Cease, use of Hard Reset does not appear to be indicated.

5.2. Interaction with Other Specifications

"BGP Administrative Shutdown Communication" [RFC8203] specifies use of the data portion of the Administrative Shutdown or Administrative Reset subcodes to convey a short message. When [RFC8203] is used in conjunction with Hard Reset, the subcode of the outermost Cease MUST be Hard Reset, with the Administrative Shutdown or Administrative Reset subcodes encapsulated within. The encapsulated message MUST subsequently be processed according to [RFC8203].

6. Management Considerations

When reporting a Hard Reset to network management, the error code and subcode reported MUST be Cease and Hard Reset, respectively. If the network management layer in use permits it, the information carried in the Data portion SHOULD be reported as well.

7. Operational Considerations

Note that long (or infinite) retention time may cause operational issues and should be enabled with care.

8. IANA Considerations

IANA has assigned subcode 9 ("Hard Reset") in the "BGP Cease NOTIFICATION message subcodes" registry.

IANA has created a sub-registry called "BGP Graceful Restart Flags" under the "Border Gateway Protocol (BGP) Parameters" registry. The registration procedure is Standards Action [RFC8126]; this document and [RFC4724] are listed as references. The initial values are as follows:

Bit Position	Name	Short Name	Reference
0	Restart State	R	RFC 4724
1	Notification	N	RFC 8538
2-3	Unassigned		

IANA has created a sub-registry called "BGP Graceful Restart Flags for Address Family" under the "Border Gateway Protocol (BGP) Parameters" registry. The registration procedure is Standards Action; this document and [RFC4724] are listed as references. The initial values are as follows:

Bit Position	Name	Short Name	Reference
0	Forwarding State	F	RFC 4724
1-7	Unassigned		

9. Security Considerations

This specification doesn't change the basic security model inherent in [RFC4724], with the exception that the protection against repeated resets is relaxed. To mitigate the consequent risk that an attacker could use repeated session resets to prevent stale routes from ever being deleted, we make the stale timer mandatory (in practice, it is already ubiquitous). To the extent [RFC4724] might be said to help defend against denials of service by making the control plane more resilient, this extension may modestly increase that resilience; however, there are enough confounding and deployment-specific factors that no general claims can be made.

10. References

10.1. Normative References

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[RFC4271] Rekhter, Y., Ed., Li, T., Ed., and S. Hares, Ed., "A Border Gateway Protocol 4 (BGP-4)", RFC 4271, DOI 10.17487/RFC4271, January 2006, <https://www.rfc-editor.org/info/rfc4271>.

[RFC4724] Sangli, S., Chen, E., Fernando, R., Scudder, J., and Y. Rekhter, "Graceful Restart Mechanism for BGP", RFC 4724, DOI 10.17487/RFC4724, January 2007, <https://www.rfc-editor.org/info/rfc4724>.

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10.2. Informative References

[RFC8126] Cotton, M., Leiba, B., and T. Narten, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 8126, DOI 10.17487/RFC8126, June 2017, <https://www.rfc-editor.org/info/rfc8126>.

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Authors' Addresses

Keyur Patel
Arrcus

Email: keyur@arrcus.com

Rex Fernando
Cisco Systems
170 W. Tasman Drive
San Jose, CA 95134
United States of America

Email: rex@cisco.com

John Scudder
Juniper Networks
1194 N. Mathilda Ave
Sunnyvale, CA 94089
United States of America

Email: jgs@juniper.net

Jeff Haas
Juniper Networks
1194 N. Mathilda Ave
Sunnyvale, CA 94089
United States of America

Email: jhaas@juniper.net