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**Route Distinguisher Outbound Route Filter for BGP-4
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Abstract

This draft defines a new Outbound Route Filter (ORF) type, called the Route Distinguisher ORF (RD-ORF). RD-ORF is applicable in BGP/MPLS IP Virtual Private Networks and Ethernet VPN, in which the Route Reflector (RR) and Autonomous System border router (ASBR) do not maintain the VPN routes.

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Table of Contents

[1](#) 1. Introduction

[2](#) 2. Conventions used in this document

[3](#) 3. Terminology

[3](#) 4. RD-ORF Encoding

[3](#) 5. Operation

[5](#) 5.1. Application in Option B cross-domain scenario

[5](#) 5.2. Application in Option C cross-domain scenario

[8](#) 6. Security Considerations

[10](#) 7. IANA Considerations

[10](#) 8. Normative References

[10](#) Authors' Addresses

[11](#)

1. Introduction

According to the description in [[RFC4364](#)], MPLS VPN can cross-domain networking in three ways, we usually called them Option A, B and C. In Option A, an Autonomous System border router (ASBR) is attached directly to an ASBR in another AS, they act as CE/PE of each other and exchange VPN route, so they SHOULD maintain VPN route information

in Virtual Routing Forwarding (VRF). So, the route control mechanism

based on Prefix Limit can be used in Option A scenario, to prevent the number of routes transmitted by one of them from exceeding the maximum number of another's routing tables. In Option B, a ASBR is connected to another via EBGp. ASBRs only perform VPN routing forwarding, the maintenance of VRF is done by PEs. In Option C, RRs are connected each other via MP-EBGP and are responsible for VPN routing forwarding, without maintaining VRFs. Due to ASBRs and RRs do not maintain VRFs in Option B and C, the route control mechanism based on Prefix Limit does not work.

[[RFC5291](#)] defines a BGP-based mechanism called Outbound Route Filter (ORF), which allows a BGP speaker to send a set of ORFs to its BGP peers, the peers will constrain the routing information that they decide to transmit to the speaker.

This draft defines a new ORF-type, called the Route Distinguisher ORF

(RD-ORF). When the route table of a BGP speaker reaches its maximum, the BGP speaker will send a RD-ORF to its BGP peers that carry a RD. If a BGP speaker receives a RD-ORF from its BGP peer, it will filter the VPN routes it tends to send according to the RD-ORF entry.

RD-ORF is applicable in BGP/MPLS IP Virtual Private Networks [[RFC4364](#)], and BGP/MPLS Ethernet VPN (EVPN) networks [[RFC7432](#)].

2. Conventions used in this document

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. Terminology

The following terms are defined in this draft:

- o RD: Route Distinguisher, defined in [[RFC4364](#)]
- o ORF: Outbound Route Filter, defined in [[RFC5291](#)]
- o AFI: Address Family Identifier, defined in [[RFC4760](#)]
- o SAFI: Subsequent Address Family Identifier, defined in [[RFC4760](#)]
- o EVPN: BGP/MPLS Ethernet VPN, defined in [[RFC7432](#)]
- o RR: Router Reflector, provides a simple solution to the problem of IBGP full mesh connection in large-scale IBGP implementation.
- o VRF: Virtual Routing Forwarding, a virtual routing table based on VPN instance.

4. RD-ORF Encoding

In this draft, we defined a new ORF type called Route Distinguisher Outbound Route Filter (RD-ORF). The ORF entries are carried in the BGP ROUTE-REFRESH message as defined in [[RFC5291](#)]. A BGP ROUTE-REFRESH message can carry one or more ORF entries. The ROUTE-REFRESH

message which carries ORF entries contains the following fields:

- o AFI (2 octets)
- o SAFI (1 octet)
- o When-to-refresh (1 octet): the value is IMMEDIATE or DEFER
- o ORF Type (1 octet)
- o Length of ORF entries (2 octets)

A RD-ORF entry contains a common part and type-specific part. The common part is encoded as follows:

- o Action (2 bits): the value is ADD, REMOVE or REMOVE-ALL

- o Match (1 bit): the value is PERMIT or DENY
- o Reserved (5 bits)

RD-ORF also contains type-specific part. The encoding of the type-specific part is shown in Figure 1.

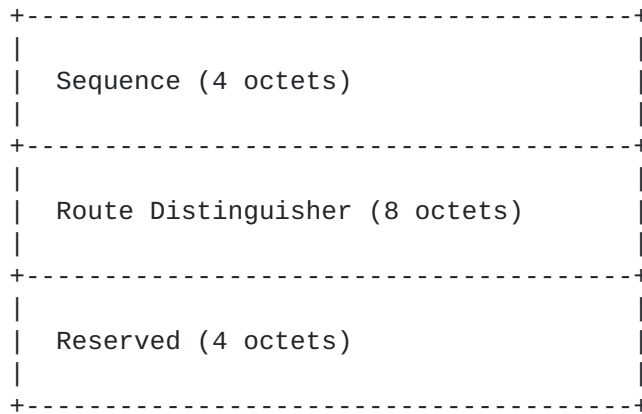


Figure 1: RD-ORF type-specific encoding

- o Sequence: identifying the order in which RD-ORF is generated
- o Route Distinguisher: distinguish the different user routes. The RD-ORF filters the VPN routes it tends to send based on Route Distinguisher.

Note that if the Action component of an ORF entry specifies REMOVE-ALL, the ORF entry does not include the type-specific part.

When the BGP ROUTE-REFRESH message carries RD-ORF entries, it must be set as follows:

- o The ORF-Type MUST be set to RD-ORF.
- o The AFI MUST be set to IPv4, IPv6, or Layer 2 VPN (L2VPN).
- o If the AFI is set to IPv4 or IPv6, the SAFI MUST be set to MPLS-labeled VPN address.
- o If the AFI is set to L2VPN, the SAFI MUST be set to BGP EVPN.
- o The Match field MUST be equal to DENY.

5. Operation

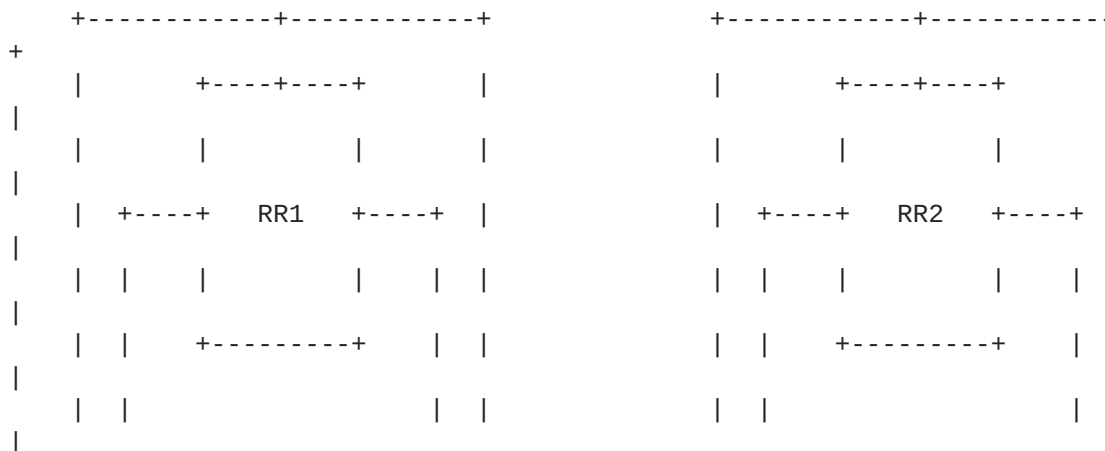
In VPN/EVPN, RD is used to distinguish different user routes. When a BGP speaker's route table reaches its maximum, it will generate a BGP ROUTE-REFRESH message contains a RD-ORF entry, and send it to its BGP peers, reminding them not to send it routes whose Type field in the BGP header is set to UPDATE (BGP UPDATE message). In the RD-ORF entry, the RD field must be set to the Route Distinguisher of the BGP speaker.

When a BGP speaker receives a ROUTE-REFRESH message that carries a RD-ORF entry, it will check whether the message violates the encoding rules or not. If the ROUTE-REFRESH message violates the rules, the BGP speaker MUST ignore it and log the event. Otherwise, the BGP speaker checks the Action field of the RD-ORF entry. If the Action field is set to ADD, the BGP speaker adds this entry to the Adj-RIB-out. The location is specified by the Sequence field. If the Action field is set to REMOVE, the BGP speaker removes the CP-ORF entry specified by the Sequence field from the Adj-RIB-out. If the Action field is set to REMOVE-ALL, the BGP speaker removes all entries in the Adj-RIB-out.

For a BGP speaker, before sending BGP routes to its peers, it checks the Adj-RIB-out to find the related strategies. If it finds a RD-ORF associated with a BGP peer in the Adj-RIB-out, it will not send any BGP UPDATE message to that peer.

5.1. Application in Option B cross-domain scenario

The Option B cross-domain scenario is shown in Figure 2:



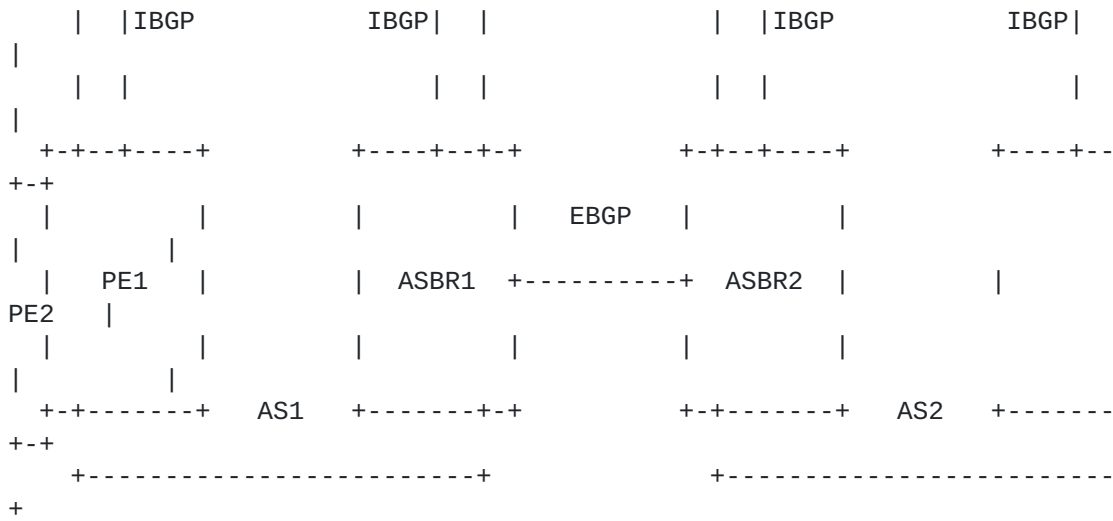


Figure 2: The Option B cross-domain scenario

In this scenario, PE1 and PE2 are responsible for maintaining VPN routing of devices in AS1 and AS2, respectively. There is a direct link between ASBR1 and ASBR2 via EBGP. In AS1, PE1 and ASBR1 establish IBGP session with RR1 to ensure the routes can be transmitted in AS1, same in AS2.

Due to the maintenance of VPN routes is only done by PEs. ASBRs cannot know whether the PEs' ability to handle VPN routes has reached the upper limit or not, so it needs the RD-ORF to control the number of routes.

Assume that PE1 and PE2 can transmit VPN routes through the network architecture shown in Figure 2. When PE1 thinks it cannot handle more VPN routes, it will send ROUTE-REFRESH message that carries a RD-ORF entry to RR1. The entry consists of the following fields:

- o AFI is set to IPv4 or IPV6
- o SAFI is set to "MPLS-labeled VPN address"
- o When-to-refresh is set to IMMEDIATE
- o Action is set to ADD
- o Match is set to DENY
- o ORF Type is set to RD-ORF
- o RD-ORF Sequence is set to 1
- o RD-ORF Route Distinguisher is set to RD1

It noted that for a RD, the sequence of the first RD-ORF is equal to 1. When a PE needs to send a second RD-ORF entry associated with the same RD, the RD-ORF sequence SHOULD increment.

When RR1 receives the ROUTE-REFRESH message, it checks the <AFI/SAFI, ORF-Type> to determine whether it is interested in the entry. Then RR1 will check the RD-ORF Route Distinguisher and sequence, find the Route Distinguisher is equal to RD1 and the sequence is equal to 1, indicating that it received the latest entry. If the above conditions are not all met, RR1 will discard the entry; otherwise, RR1 will add the RD-ORF entry into its Adj-RIB-out and stop sending VPN routes containing that RD to PE1, and transmitting this RD-ORF entry to ASBR1.

After receiving the RD-ORF entry, ASBR1 will repeat the above process

and send the entry to ASBR2. The RD-ORF entry will be transmitted toward PE2, until PE2 receives it and add it into the Adj-RIB-out.

Before sending a VPN route (the RD is equal to RD1) toward PE1, PE2 will check its Adj-RIB-out and find the RD-ORF entry prevent it from sending VPN route which carries RD1 to RR2. Then, PE2 will stop sending that VPN route.

If PE1 can re-receive the route entries, it will send a ROUTE-REFRESH

message to RR1, carrying a RD-ORF entry consists of the following fields:

- o AFI is set to IPv4 or IPv6
- o SAFI is set to "MPLS-labeled VPN address"
- o When-to-refresh is set to IMMEDIATE
- o Action is set to REMOVE
- o Match is set to DENY
- o ORF Type is set to RD-ORF
- o RD-ORF Sequence is set to 2
- o RD-ORF Route Distinguisher is set to RD1

When RR1 receives the ROUTE-REFRESH message, it checks the <AFI/
SAFI,

ORF-Type> to determine whether it is interested in the entry. Then RR1 will check the RD-ORF Route Distinguisher and sequence, find the Route Distinguisher is equal to RD1 and the sequence is equal to 2, indicating that it received the latest entry. If the above conditions are not all met, RR1 will discard the entry; otherwise, RR1 will remove the RD-ORF entry from its Adj-RIB-out and send this entry to ASBR1.

After receiving the RD-ORF entry, ASBR1 will repeat the above process

and send the entry to ASBR2. The RD-ORF entry will be transmitted toward PE2, until PE2 receives it and remove the entry from the Adj-RIB-out.

Before sending a VPN route (the RD is equal to RD1) toward PE1, PE2 will check its Adj-RIB-out and find there is no filter associated with RD1. Then, PE2 will send that VPN route.

5.2. Application in Option C cross-domain scenario

The Option C cross-domain scenario is shown in Figure 3:

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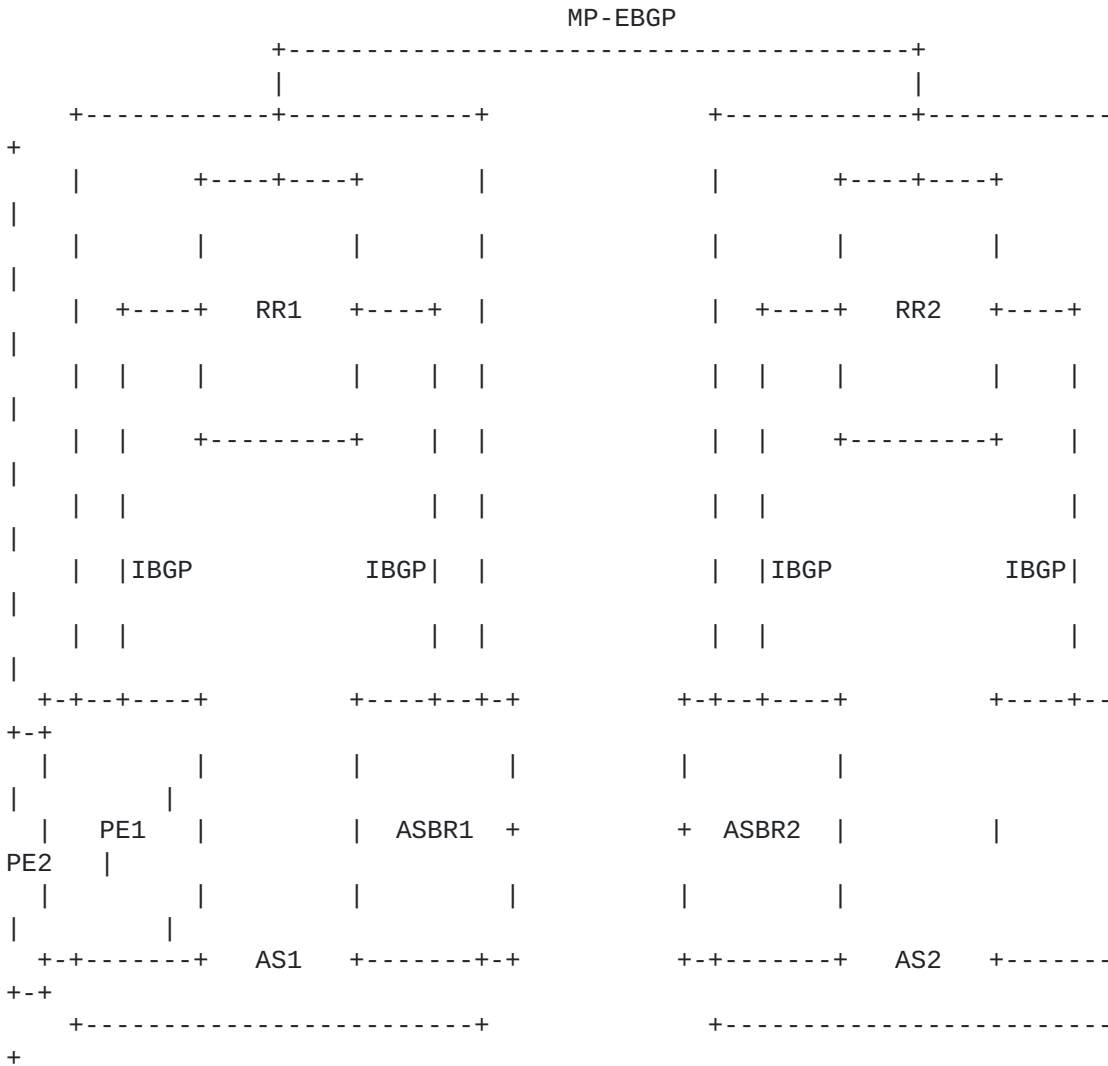


Figure 3: The Option C cross-domain scenario

In this scenario, PE1 and PE2 are responsible for maintaining VPN routing of devices in AS1 and AS2, respectively. In order to reduce the complexity that full-mesh brings to the network, RR1 and RR2 establish MP-BGP session to transmit labeled routes. In AS1, PE1 and

ASBR1 establish IBGP session with RR1 to ensure the routes can be transmitted in AS1, same in AS2.

Due to the maintenance of VPN routes is only done by PEs. RRs

cannot

know whether the PEs' ability to handle VPN routes has reached the upper limit or not, so it needs the RD-ORF to control the number of routes.

Assume that PE1 and PE2 can transmit VPN routes through the network architecture shown in Figure 3. When PE1 thinks it cannot handle more VPN routes, it will send ROUTE-REFRESH message that carries a RD-ORF entry to RR1. The entry consists of the following fields:

- o AFI is set to IPv4 or IPv6
- o SAFI is set to "BGP EVPN"

- o When-to-refresh is set to IMMEDIATE
- o Action is set to ADD
- o Match is set to DENY
- o ORF Type is set to RD-ORF
- o RD-ORF Sequence is set to 1
- o RD-ORF Route Distinguisher is set to RD1

When RR1 receives the ROUTE-REFRESH message, it checks the <AFI/
SAFI,
ORF-Type> to determine whether it is interested in the entry. Then
RR1 will check the RD-ORF Route Distinguisher and sequence, find the
Route Distinguisher is equal to RD1 and the sequence is equal to 1,
indicating that it received the latest entry. If the above
conditions are not all met, RR1 will discard the entry; otherwise,
RR1 will remove the RD-ORF entry from its Adj-RIB-out and send this
entry to ASBR1 and RR2. After receiving the RD-ORF entry, RR2 and
ASBR1 will repeat the above process, then send the entry to ASBR2
and
PE2.

Before sending a VPN route (the RD is equal to RD1) toward PE1, PE2
will check its Adj-RIB-out and find the RD-ORF entry prevent it from
sending VPN route which carries RD1 to RR2. Then, PE2 will stop
sending that VPN route.

If PE1 can re-receive the VPN routes, it will send a ROUTE-REFRESH
message to RR1, carrying RD-ORF entries consist of the following
fields:

- o AFI is set to IPv4 or IPv6
- o SAFI is set to "BGP EVPN"
- o When-to-refresh is set to IMMEDIATE
- o Action is set to REMOVE
- o Match is set to DENY
- o ORF Type is set to RD-ORF
- o RD-ORF Sequence is set to 2
- o RD-ORF Route Distinguisher is set to RD1

When RR1 receives the ROUTE-REFRESH message, it checks the <AFI/
SAFI,
ORF-Type> to determine whether it is interested in the entry. Then
RR1 will check the RD-ORF Route Distinguisher and sequence, find the
Route Distinguisher is equal to RD1 and the sequence is equal to 2,
indicating that it received the latest entry. If the above
conditions are not all met, RR1 will discard the entry; otherwise,
RR1 will remove the RD-ORF entry from its Adj-RIB-out and send this
entry to ASBR1 and RR2. After receiving the RD-ORF entry, RR2 and
ASBR1 will repeat the above process, then send the entry to ASBR2
and
PE2.

Before sending a VPN route (the RD is equal to RD1) toward PE1, PE2
will check its Adj-RIB-out and find there is no filter associated
with RD1. Then, PE2 will send that VPN route.

6. Security Considerations

A BGP speaker will maintain the RD-ORF entries in Adj-RIB-out, this
behavior consumes its memory and compute resources. To avoid the
excessive consumption of resources, [[RFC5291](#)] specifies that a BGP
speaker can only accept ORF entries transmitted by its interested
peers.

7. IANA Considerations

This document defines a new Outbound Route Filter type - Route
Distinguisher Outbound Route Filter. The code point is from the
"BGP
Outbound Route Filtering (ORF) Types". It is recommended to set the
code point of RD-ORF to 66.

8. Normative References

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