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OSPFv2 Extensions for BIER
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Abstract

Bit Index Explicit Replication (BIER) is an architecture that provides multicast forwarding through a "BIER domain" without requiring intermediate routers to maintain multicast related per-flow state. Neither does BIER require an explicit tree-building protocol for its operation. A multicast data packet enters a BIER domain at a "Bit-Forwarding Ingress Router" (BFIR), and leaves the BIER domain at one or more "Bit-Forwarding Egress Routers" (BFERs). The BFIR router adds a BIER header to the packet. Such header contains a bit-string in which each bit represents exactly one BFER to forward the packet to. The set of BFERs to which the multicast packet needs to be forwarded is expressed by the according set of bits set in BIER packet header.

This document describes the OSPF [RFC2328] protocol extension required for BIER with MPLS encapsulation [RFC8296]. Support for other encapsulation types is outside thescope of this document. The use of multiple encapsulation types is outside the scope of this document.

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1. Introduction

Bit Index Explicit Replication (BIER) is an architecture that provides optimal multicast forwarding through a "BIER domain" without requiring intermediate routers to maintain any multicast related per-flow state. Neither does BIER explicitly require a tree-building protocol for its operation. A multicast data packet enters a BIER domain at a "Bit-Forwarding Ingress Router" (BFIR), and leaves the BIER domain at one or more "Bit-Forwarding Egress Routers" (BFERs). The BFIR router adds a BIER header to the packet. The BIER header contains a bit-string in which each bit represents exactly one BFER to forward the packet to. The set of BFERs to which the multicast

packet needs to be forwarded is expressed by setting the bits that correspond to those routers in the BIER header.

BIER architecture requires routers participating in BIER to exchange BIER related information within a given domain. BIER architecture permits link-state routing protocols to perform distribution of such information. This document describes extensions to OSPF necessary to advertise BIER specific information in the case where BIER uses MPLS encapsulation as described in [RFC8296].

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].

2. Flooding of the BIER Information in OSPF

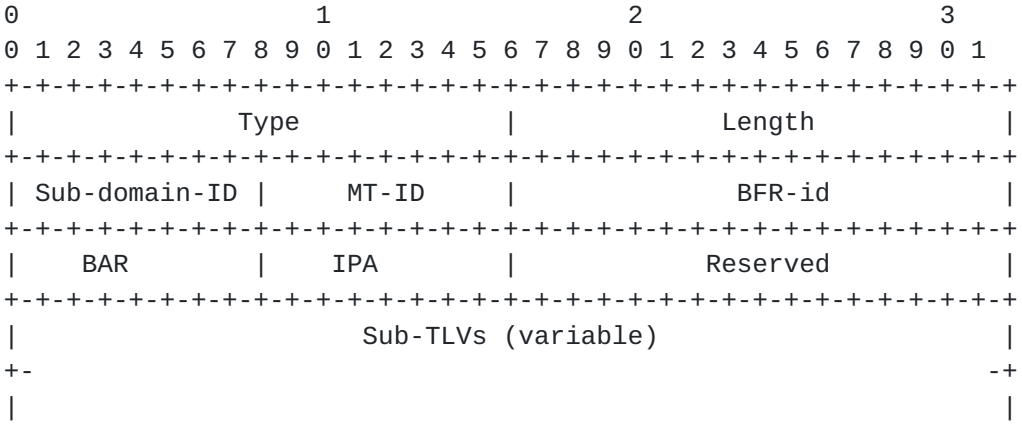
All BIER specific information that a Bit-Forwarding Router (BFR) needs to advertise to other BFRs is associated with a BFR-Prefix. A BFR prefix is a unique (within a given BIER domain) routable IP address that is assigned to each BFR as described in more detail in section 2 of [RFC8279].

Given that BIER information must be associated with a BFR prefix, the OSPF Extended Prefix Opaque LSA [RFC7684] has been chosen for advertisement.

2.1. BIER Sub-TLV

A Sub-TLV of the Extended Prefix TLV (defined in [RFC7684]) is defined for distributing BIER information. The Sub-TLV is called the BIER Sub-TLV. Multiple BIER Sub-TLVs may be included in the Extended Prefix TLV.

The BIER Sub-TLV has the following format:



Type: 9

Length: Variable, dependent on sub-TLVs.

Sub-domain-ID: Unique value identifying the BIER sub-domain within the BIER domain, as described in section 1 of [RFC8279].

MT-ID: Multi-Topology ID (as defined in [RFC4915]) that identifies the topology that is associated with the BIER sub-domain.

BFR-id: A 2 octet field encoding the BFR-id, as documented in section 2 of [RFC8279]. If the BFR is not locally configured with a valid BFR-id, the value of this field is set to 0, which is defined as illegal in [RFC8279].

BAR: Single octet BIER specific algorithm used to calculate underlay paths to reach other BFRs. Values are allocated from the "BIER Algorithm Registry" which is defined in [I-D.ietf-bier-isis-extensions].

IPA: Single octet IGP algorithm to either modify, enhance or replace the calculation of underlay paths to reach other BFRs as defined by the BAR value. Values are defined in the "IGP Algorithm Types" registry.

Each BFR sub-domain MUST be associated with one and only one OSPF topology that is identified by the MT-ID. If the association between BIER sub-domain and OSPF topology advertised in the BIER sub-TLV by other BFRs is in conflict with the association locally configured on the receiving router, the BIER Sub-TLV MUST be ignored.

If the MT-ID value is outside of the values specified in [RFC4915], the BIER Sub-TLV MUST be ignored.

If a BFR advertises the same Sub-domain-ID in multiple BIER sub-TLVs, the BFR MUST be treated as if it did not advertise a BIER sub-TLV for such sub-domain.

All BFRs MUST detect advertisement of duplicate valid BFR-IDs for a given MT-ID and Sub-domain-ID. When such duplication is detected by the BFR, it MUST behave as described in section 5 of [RFC8279].

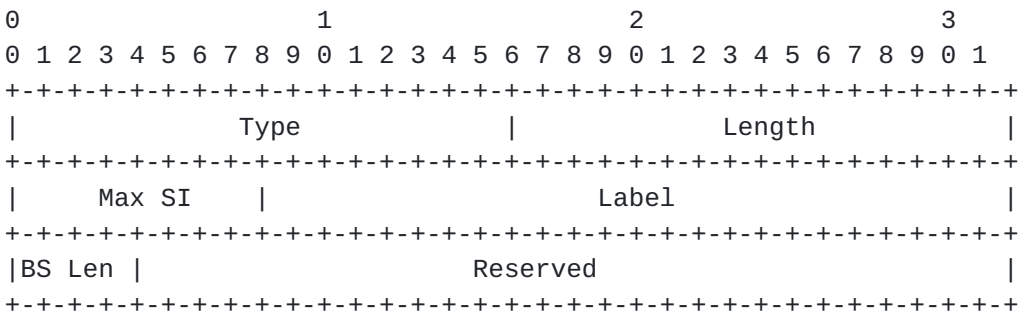
The supported BAR and IPA algorithms MUST be consistent for all routers supporting a given BFR sub-domain. A router receiving BIER Sub-TLV advertisement with a value in BAR or IPA fields which does not match the locally configured value for a given BFR sub-domain, MUST report a misconfiguration for such BIER sub-domain and MUST ignore such BIER sub-TLV.

The use of non-zero values in either the BAR field or the IPA field is outside the scope of this document.

2.2. BIER MPLS Encapsulation Sub-TLV

The BIER MPLS Encapsulation Sub-TLV is a Sub-TLV of the BIER Sub-TLV. The BIER MPLS Encapsulation Sub-TLV is used in order to advertise MPLS specific information used for BIER. It MAY appear multiple times in the BIER Sub-TLV.

The BIER MPLS Encapsulation Sub-TLV has the following format:



Type: 10

Length: 8 octets

Max SI : A 1 octet field encoding the maximum Set Identifier (section 1 of [RFC8279]), used in the encapsulation for this BIER sub-domain for this bitstring length.

Label: A 3 octet field, where the 20 rightmost bits represent the first label in the label range. The 4 leftmost bits MUST be ignored.

Bit String Length: A 4 bits field encoding the supported BitString length associated with this BFR-prefix. The values allowed in this field are specified in section 2 of [RFC8296].

Reserved: SHOULD be set to 0 on transmission and MUST be ignored on reception.

The "label range" is the set of labels beginning with the Label and ending with (Label + (Max SI)). A unique label range is allocated for each BitString length and Sub-domain-ID. These labels are used for BIER forwarding as described in [RFC8279] and [RFC8296].

The size of the label range is determined by the number of Set Identifiers (SI) (section 1 of [RFC8279]) that are used in the network. Each SI maps to a single label in the label range. The first label is for SI=0, the second label is for SI=1, etc.

If the label associated with the Maximum Set Identifier exceeds the 20 bit range, the BIER MPLS Encapsulation Sub-TLV MUST be ignored.

If the BS length is set to a value that does not match any of the allowed values specified in [RFC8296], the BIER MPLS Encapsulation Sub-TLV MUST be ignored.

If same BS length is repeated in multiple BIER MPLS Encapsulation Sub-TLV inside the same BIER Sub-TLV, the BIER sub-TLV MUST be ignored.

Label ranges within all BIER MPLS Encapsulation Sub-TLVs advertised by the same BFR MUST NOT overlap. If the overlap is detected, the advertising router MUST be treated as if it did not advertise any BIER sub-TLVs.

2.3. Flooding scope of BIER Information

The flooding scope of the OSPF Extended Prefix Opaque LSA [RFC7684] that is used for advertising the BIER Sub-TLV is set to area-local. To allow BIER deployment in a multi-area environment, OSPF must propagate BIER information between areas.

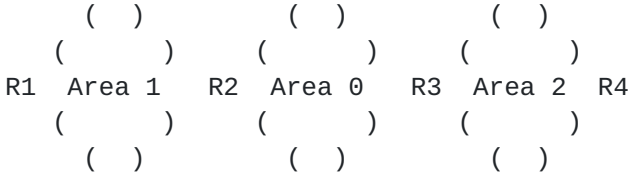


Figure 1: BIER propagation between areas

The following procedure is used in order to propagate BIER related information between areas:

When an OSPF Area Border Router (ABR) advertises a Type-3 Summary LSA from an intra-area or inter-area prefix to all its attached areas, it will also originate an Extended Prefix Opaque LSA, as described in [RFC7684]. The flooding scope of the Extended Prefix Opaque LSA type will be set to area-local. The route-type in the OSPF Extended Prefix TLV is set to inter-area. When determining

whether a BIER Sub-TLV should be included in this LSA, an OSPF ABR will:

- Examine its best path to the prefix in the source area and find the advertising router associated with the best path to that prefix.

- Determine if such advertising router advertised a BIER Sub-TLV for the prefix. If yes, the ABR will copy the information from such BIER Sub-TLV when advertising BIER Sub-TLV to each attached area.

In the Figure 1, R1 advertises a prefix 192.0.2.1/32 in Area 1. It also advertises Extended Prefix Opaque LSA for prefix 192.0.2.1/32 and includes BIER Sub-TLV in it. Area Border Router (ABR) R2 calculates the reachability for prefix 192.0.2.1/32 inside Area 1 and propagates it to Area 0. When doing so, it copies the entire BIER Sub-TLV (including all its Sub-TLVs) it received from R1 in Area 1 and includes it in the Extended Prefix Opaque LSA it generates for 192.0.2.1/32 in Area 0. ABR R3 calculates the reachability for prefix 192.0.2.1/32 inside Area 0 and propagates it to Area 2. When doing so, it copies the entire BIER Sub-TLV (including all its Sub-TLVs) it received from R2 in Area 0 and includes it in the Extended Prefix Opaque LSA it generates for 192.0.2.1/32 in Area 2.

3. Security Considerations

This document introduces new sub-TLVs for existing OSPF Extended Prefix TLV. It does not introduce any new security risks to OSPF. Existing security extensions as described in [RFC2328] and [RFC7684] apply.

It is assumed that both BIER and OSPF layer is under a single administrative domain. There can be deployments where potential attackers have access to one or more networks in the OSPF routing domain. In these deployments, stronger authentication mechanisms such as those specified in [RFC7474] SHOULD be used.

The Security Considerations section of [RFC8279] discusses the possibility of performing a Denial of Service (DoS) attack by setting too many bits in the BitString of a BIER-encapsulated packet. However, this sort of DoS attack cannot be initiated by modifying the OSPF BIER advertisements specified in this document. A BFIR decides which systems are to receive a BIER-encapsulated packet. In making this decision, it is not influenced by the OSPF control messages. When creating the encapsulation, the BFIR sets one bit in the encapsulation for each destination system. The information in the

OSPF BIER advertisements is used to construct the forwarding tables that map each bit in the encapsulation into a set of next hops for the host that is identified by that bit, but is not used by the BFIR to decide which bits to set. Hence an attack on the OSPF control plane cannot be used to cause this sort of DoS attack.

While a BIER-encapsulated packet is traversing the network, a BFR that receives a BIER-encapsulated packet with n bits set in its BitString may have to replicate the packet and forward multiple copies. However, a given bit will only be set in one copy of the packet. That means that each transmitted replica of a received packet has fewer bits set (i.e., is targeted to fewer destinations) than the received packet. This is an essential property of the BIER forwarding process as defined in [RFC8279]. While a failure of this process might cause a DoS attack (as discussed in the Security Considerations of [RFC8279]), such a failure cannot be caused by an attack on the OSPF control plane.

Implementations MUST assure that malformed TLV and Sub-TLV defined in this document are detected and do not provide a vulnerability for attackers to crash the OSPF router or routing process. Reception of malformed TLV or Sub-TLV SHOULD be counted and/or logged for further analysis. Logging of malformed TLVs and Sub-TLVs SHOULD be rate-limited to prevent a Denial of Service (DoS) attack (distributed or otherwise) from overloading the OSPF control plane.

4. IANA Considerations

The document requests two new allocations from the OSPF Extended Prefix sub-TLV registry as defined in [RFC7684].

BIER Sub-TLV: 9

BIER MPLS Encapsulation Sub-TLV: 10

5. Acknowledgments

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