BIER
Internet-Draft
Updates: 8401, 8444 (if approved)
Intended status: Standards Track
Expires: 14 October 2022

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12 April 2022

BIER Underlay Path Calculation Algorithm and Constraints
draft-ietf-bier-bar-ipa-12

Abstract

This document specifies general rules for the interaction between the BIER Algorithm (BAR) and the IGP Algorithm (IPA) used for underlay path calculation. The semantics defined in this document update RFC8401 and RFC8444.

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.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on 14 October 2022.

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1. Introduction

In the Bit Index Explicit Replication (BIER) architecture [RFC8279], packets with a BIER encapsulation header are forwarded to the neighbors on the underlay paths towards Bit-Forwarding Egress Routers (BFERs) that are represented by bits set in the BIER header's BitString. The paths are calculated in the underlay topology for each sub-domain following a calculation algorithm specific to the sub-domain. The topology or algorithm may or may not be congruent with unicast. The algorithm could be a generic IGP algorithm (e.g. SPF) or could be a BIER specific one.

In [RFC8401] and [RFC8444], an 8-bit BAR (BIER Algorithm) field and 8-bit IPA (IGP Algorithm) field are defined to signal the BIER specific algorithm and generic IGP Algorithm respectively and only value 0 is allowed for both fields in those two documents.

This document specifies general rules for the interaction between the BIER Algorithm (BAR) and the IGP Algorithm (IPA) used for underlay path calculation when other BAR and/or IPA values are used. The semantics defined in this document update [RFC8401], [RFC8444].

2. Updated Definition for BAR and IPA Fields

The definition for the BAR and IPA fields in [RFC8401] and [RFC8444] are updated as follows.

IPA: IGP Algorithm. Specifies a generic Routing Algorithm (RA) and related Routing Constraints (RC) to calculate underlay paths to reach other Bit-Forwarding Routers (BFRs). Values are from the "IGP Algorithm Types" registry [RFC8665]. One Octet.

BAR: BIER Algorithm. Specifies a BIER-specific Algorithm (BA) and BIER-specific Constraints (BC) used to either modify, enhance, or replace the calculation of underlay paths to reach other BFRs as defined by the IPA value. Values are allocated from the "BIER Algorithm" registry [RFC8401]. One Octet.

When a BAR value is defined, the corresponding BA and BC semantics SHOULD be specified. For an IGP Algorithm to be used as a BIER IPA, its RA and RC semantics SHOULD be specified.

None of the components of the BAR or IPA can be unknown. If any of the components is not specified, it is interpreted as "NULL" algorithm or constraint. For example, the IGP Algorithm 0 defined in [RFC8665] is treated as having a NULL RC, i.e., no constraints.

If a BAR value is not specified in a RFC but only privately used for a deployment, it MUST be within the "240-254 Experimental Use" range of the registry.

3. General Rules for the BAR and IPA Interaction

For a particular sub-domain, all BFRs MUST be provisioned with and signal the same BAR and IPA values. If a BFR discovers another BFR advertising different BAR or IPA value for a sub-domain, it MUST treat the advertising router as incapable of supporting BIER for that sub-domain (one way of handling incapable routers is documented in Section 6.9 of [RFC8279] and additional methods may be defined in the future).

For a particular topology X that a sub-domain is associated with, a router MUST calculate the underlay paths according to its BAR and IPA values in the following way:

1. Apply the BIER constraints, resulting in BC(X).

2. Apply the routing constraints, resulting in RC(BC(X)).

3. Select the algorithm AG as following:

   a. If BA is NULL, AG is set to RA.

   b. If BA is not NULL, AG is set to BA.

4. Run AG on RC(BC(X)).

It's possible that the resulting AG is not applicable to BIER, In that case, no BIER paths will be calculated and it is a network design issue that an operator needs to avoid when choosing BAR/IPA.

3.1. When BAR Is Not Used

BAR value 0 is defined as "No BIER-specific algorithm is used" [RFC8401]. This value indicates NULL BA and BC. Following the rules defined above, the IPA value alone identifies the calculation algorithm and constraints to be used for a particular sub-domain.

3.2. Exceptions/Extensions to the General Rules

Exceptions or extensions to the above general rules may be specified in the future for specific BAR and/or IPA values. When that happens, compatibility with defined BAR and/or IPA values and semantics need to be specified.

4. Examples

As an example, one may define a new BAR with a BIER specific constraint of "excluding BIER incapable routers". No BIER specific algorithm is specified, and the BIER specific constraint can go with any IPA - whatever RC defined by the IPA is augmented with "excluding BIER incapable routers", i.e., routers that do not support BIER are not considered when applying the IGP Algorithm.

If the BC and RC happen to conflict and lead to an empty topology, then no BIER forwarding path will be found. For example, the BC could be "exclude BIER-incapable routers" and the RC could be "include green links only". If all the green links are associated with BIER-incapable routers, it results in an empty topology. That is a network design issue that an operator needs to avoid when choosing BAR/IPA.

In another example, a BAR value can be specified to use Steiner Tree algorithm and used together with IPA 0 (which uses SPF algorithm). According to the general rules, the BIER specific algorithm takes precedence so SPF is not used.

5. IANA Considerations

No IANA Consideration is requested in this document.

6. Security Considerations

This document specifies general rules for the interaction between the BIER Algorithm (BAR) and the IGP Algorithm (IPA) used for underlay path calculation. It does not change the security aspects as discussed in [RFC8279], [RFC8401], [RFC8444].

7. Acknowledgements

The authors thank Alia Atlas, Eric Rosen, Senthil Dhanaraj and many others for their suggestions and comments. In particular, the BC/BA/RC/RA representation for the interaction rules is based on Alia's write-up.

8. Normative References

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