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Compressed Routing Header (CRH) Helper Option
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Abstract

   This document defines the IPv6 Compressed Routing Header (CRH) Helper
   option. When a source node sends a packet with a CRH, it can use the
   CRH Helper option to provide additional information to downstream
   nodes.

Status of This Memo

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1. Introduction

IPv6 [RFC8200] source nodes use the Compressed Routing Header (CRH)
[I-D.bonica-6man-comp-rtg-hdr] to steer packets along a delivery path
to their destination. Two CRH versions have been defined. The
CRH-16 encodes segment endpoints in 16 bits, while CRH-32, encodes
segment endpoints in 32 bits.

Both CRH versions contain the following fields:

o Next Header - Identifies the header immediately following the CRH.

o Hdr Ext Len - Length of the CRH.

o Routing Type - Identifies the Routing header variant (i.e., CRH-16
   or CRH-32).

o Segments Left - The number of segments still to be traversed
   before reaching the packet's ultimate destination.

o Segment Identifier (SID) List - Represents the delivery path as an
   ordered list of Segment Identifiers (SID). SIDs are listed in
   reverse order, with SID[0] representing the final segment, SID[1]
   representing the penultimate segment, and so forth. SIDs are
   listed in reverse order so that Segments Left can be used as an
   index to the SID List. The SID indexed by Segments Left is called
   the current SID.

As per [RFC8200], when an IPv6 node receives a packet, it examines
the packet's destination address. If the destination address
represents an interface belonging to the node, the node processes the

next header. If the next header is a CRH, it is processed as
follows:

o If Segments Left equals 0, skip over the CRH and process the next
   header in the packet.

o Decrement Segments Left.

o Query a local data structure, called the CRH Forwarding
   Information Base (CRH-FIB), searching for an entry that is indexed
   by the current SID.

o If the above-mentioned query returns a CRH-FIB entry, update the
   packet's IPv6 Destination Address and forward the packet.

In a typical CRH deployment, every segment ingress node maintains a
complete CRH-FIB and the above-mentioned query returns a CRH-FIB
entry. However, in some CRH deployments, some segment ingress nodes
maintain a complete CRH-FIB while others do not. For example, a node
that does not participate in a control plane or communicate with a
controller may not maintain a CRH-FIB.

This document defines the IPv6 CRH Helper option. When a source node
sends a packet with a CRH, it can use the IPv6 CRH Helper option to
provide CRH-FIB information to downstream nodes that do not maintain
a complete CRH-FIB.

If a segment ingress node queries its CRH-FIB, searching for an entry
that is indexed by the current SID, and that query returns nothing,
the segment ingress node can obtain the required CRH-FIB information
from the IPv6 CRH Helper option. If the segment ingress node cannot
obtain the required CRH-FIB information from either source, it
discards the packet and sends an ICMPv6 [RFC4443] Parameter Problem
message to the source node.

2. 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.

3. Option Format

The CRH Helper option contains the following fields:

   o Option Type - (8-bits) CRH Helper option. Value TBD by IANA.
      (Suggested value: 0x11). See Note below.

   o Opt Data Len - (8-bits) Length of the option, in octets, excluding
      the Option Type and Option Length fields.

   o Helper List - (Variable length) A list of Helpers.

   Each Helper contains the following fields:

   o Helper Length - (8-bits) Length of the Helper, in octets,
      excluding Helper Length. Value MUST be greater than 2 and less
      than 19.

   o Low SID - (8-bits) Index to the CRH SID List. References the
      first member of the SID List to which this Helper applies.

   o High SID - (8-bits) Index to the CRH SID List. References the
      last member of the SID List to which this Helper applies.

   o Prefix field (variable length): An IPv6 Prefix.

   NOTE : The highest-order two bits of the Option Type (i.e., the "act"
   bits) are 00. These bits specify the action taken by a destination
   node that does not recognize the option. The required action is to
   skip over this option and continue processing the header.

   The third highest-order bit of the Option Type (i.e., the "chg" bit)
   is 0. This indicates that Option Data cannot be modified along the
   path between the packet's source and its destination.

[4]. Option Processing

   When a segment endpoint node processes a CRH, it attempts to resolve
   the SID using information contained by its CRH-FIB. If it cannot
   resolve the SID using CRH-FIB, it attempts to resolve the SID using
   information received in an applicable Helper. If no Helper applies
   to the current SID, the processing node discards the packet and sends
   an ICMPv6 Parameter Problem message to the source node.

   When the processing node uses a Helper to resolve a SID, it executes
   the following procedure:

   o Set the IPv6 Destination Address to 0::

   o Overwrite the low order bits of the IPv6 Destination Address with
      the current SID found in the CRH

o Overwrite the high order bits of the IPv6 Destination Address with
   the prefix found in the applicable Helper

If the prefix found in the applicable Helper is 16 bytes long, it
overwrites the entire IPv6 Destination Address.

The CRH Helper option MAY occur in a Destination Options header that
precedes a CRH. It SHOULD NOT occur in a Hop-by-hop options header
or in a Destination Options header that precedes an upper-layer
header.

When a segment ingress node resolves a SID using information obtained
from the CRH helper option, it forwards the packet through the least-
cost path to its new destination.

Information obtained from the CRH Helper option is transient. It is
discarded as soon as the packet that carried it has been processed.

5. Security Considerations

When a segment endpoint node processes a CRH, it attempts to resolve
the SID using information contained by its CRH-FIB. If it can
resolve the SID using CRH-FIB, it MUST ignore the CRH Helper option,
even if it contains an applicable Helper.

6. IANA Considerations

IANA is requested to allocate a code point from the Destination
Options and Hop-by-hop Options registry
(https://www.iana.org/assignments/ipv6-parameters/
ipv6-parameters.xhtml#ipv6-parameters-2). This option is called "CRH
Helper Option". The "act" bits are 00 and the "chg" bit is 0.
(Suggested value: 0x11).

7. Acknowledgements

Thanks to TBD for their careful review of this document.

8. Normative References

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