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                 Updates to Requirements for IPv6 Options
                    draft-herbert-ipv6-update-opts-00

Abstract

   This document updates requirements for IPv6 Destination and Hop-by-
   Hop Options. The requirements that option type and option length
   cannot change en route, as well as the requirements that options
   cannot be added or removed, are made explicit. The meaning and
   requirements of a Destination Option marked as changeable are
   clarified. Finally, the requirement that all destinations listed in a
   Routing header must process options in a Destination Options header
   preceding the Routing header is relaxed.

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1 Introduction

    [RFC8200] defines Hop-by-Hop and Destination Options. This document
    clarifies requirements for changing, adding, or removing options in a
    packet en route to its final destination. It also relaxes the
    requirement that Destination Options preceding a Routing header must
    be processed by all destinations listed in the Routing header.

    [RFC8200] specifies that "The third-highest-order bit of the Option
    Type specifies whether or not the Option Data of that option can
    change en route to the packet's final destination." It is implicit in
    this requirement that neither the Option Type nor Option Data Length
    can change en route to the packet's destination. It also follows that
    options cannot be added or removed while a packet is en route. This
    document makes these requirements explicit.

    Per [RFC8200], Destination Options may be marked as changeable (the
    third-highest-order bit of the Option Type for the Destination Option
    is set). [RFC8200] also states that with the exception of Hop-by-Hop
    options, extension headers are not processed except by the
    destination node. It follows that the only possible case that a
    Destination Option may be modified en route is by a node that is one
    of destinations to be visited in a Routing header. This document
    clarifies this requirement.

    Per [RFC8200], if a Destination Options header precedes a Routing
    header, then all of the destinations listed in the Routing header
    must process the Destination Options. This document proposes to relax
    that requirement by allowing nodes listed in the Routing header to
    ignore Destination Options that precede the Routing header. The
    motivation for this is similar to that of relaxing the requirement
    that all intermediate nodes process Hop-by-Hop options in [RFC8200].
    Intermediate destination nodes may be closer in taxonomy to switches
    and routers than end hosts, so it follows that they may have similar
    processing constraints in efficiently processing extension headers
    and TLVs. Those constraints could lead to similar ad hoc behaviors
    for processing packets with options-- some implementations have
    dropped packets with options, others have relegated them to slow path
    processing. In any case, such behaviors at even a few nodes can
    essentially render options unusable. Allowing nodes to ignore options
    retains the primary value and usability of Destination Options
    preceding a Routing header. Nodes that are not interested in them can
    ignore them, nodes that fully support them can process them.

2 Requirements for adding, removing, or changing options

   This section clarifies requirements of [RFC8200] for changing,
   adding, or removing Destination Options or Hop-by-Hop Options.

   The Option Type of an option MUST NOT be changed en route to a
   packet's final destination. Note that this precludes changing the
   high order bits of an Option Type which indicate a changeable option
   or the action to take for an unknown option.

   The Option Data Length of an option MUST NOT be changed en route to a
   packet's final destination. If the third-highest-order bit of the
   Option Type is set indicating that the Option Data can change en
   route, then any changes MUST be to the existing Option Data and the
   Option Length MUST be preserved. Note, if the Option Data Length is
   zero then the option cannot be modified in any way.

   Options MUST NOT be added to or removed from a packet en route to its
   final destination. This requirement precludes adding or removing
   options within an existing extension header, as well as adding or
   removing a Destination or Hop-by-Hop extension headers in a packet.

   Note that in the case that a routing header is present, the "final
   destination" refers to the final destination listed to visit in the
   routing header. At intermediate destinations of a routing header, the
   packet is considered en route to the final destination, so that
   requirements about changing a packet en route to its final
   destination are applicable.

3 Requirements for changeable Destination Options

   If a Destination Option in a Destination Options header that precedes
   a Routing header is marked as changeable (the third-highest order bit
   of the option type is set), then the Option Data may be changed by
   any destination node en route to the final destination. Specifically,
   the node for the initial destination address as well as any nodes to
   visit as listed in the Routing header may change the Option Data.

   If a Destination Option is marked as changeable (the third-highest
   order bit of the option type is set) and is in a Destination Options
   header that follows a Routing header, or there is no Routing header
   present, then the Option Data cannot be changed en route. There are
   no nodes in the path that are permitted to change the Option Data.
   Note that the requirement when an Authentication header is present
   the entire Option Data field must be treated as zero-valued octets
   when computing or verifying the packet's authenticating value is
   still applicable.

4 Requirements for processing Destination Options

   This section clarifies requirements of processing Destination Options
   with respect to its relationship to a Routing header.

   Options in a Destination Options header that follow a Routing header,
   or are in a packet having no Routing header, MUST be processed by the
   destination node. In the case that a Routing header is present, the
   Destination Options that follow the Routing header MUST be processed
   by the final destination listed in the Routing header.

   Options in a Destination Options header that precede a Routing header
   MAY be examined or processed by the original destination node and
   nodes listed to visit in the Routing header (including the final
   destination of the Routing Header). If a node does not process the
   options in a Destination Option header, then it MUST skip over the
   Destination Options header and continue to process the next header
   which is likely the Routing header.

5 Detecting that Destination Options precede a Routing header

   As specified in requirements of this document, an implementation
   might process Destination Options differently depending on whether
   they precede a Routing header. Procedures are therefore needed to
   detect if Destination Options precede a Routing header.

   An implementation MAY determine that Destination Options precede a
   Routing Header by inspecting the Next Header field of the Destination
   Option. If the Next Header field indicates a Routing Header, then the
   implementation can conclude that Destination Options precede a
   Routing Header. Note that this employs a heuristic based on the
   recommended ordering of extension headers of [RFC8200] in which the
   Routing header should immediately follow Destination Options before a
   Routing header.

   An implementation MAY scan the packet to determine if a Routing
   header is present that follows a Destination Options header. If such
   a scan is performed, an implementation MUST NOT process any scanned
   extension headers beyond inspecting their Next Header and Header Ext
   Length fields. This requirement is necessary ensure that extension
   headers are strictly processed order as manadated by [RFC8200].

   If a node is not able to determine that Destination Options precede a
   Routing header, the Destinations Options MUST be processed as though
   they do not precede a Routing header. In this case, a destination
   node, regardless whether it is an intermediate or final destination,
   MUST process the Destination Options and MUST NOT change any
   Destination Options even if they are marked as changeable.

6 Security Considerations

   Relaxing the requirement that Destination Options preceding a Routing
   header can be ignored by intermediate destination nodes should not
   pose any new security risk. It should be noted that any security
   mechanism specified in a Destination Option should take into account
   that not all intermediate destinations would necessarily process the
   security option.

7 IANA Considerations

   There are no IANA considerations in this specification.

8 References

8.1 Normative References

   [RFC8200]   Deering, S. and R. Hinden, "Internet Protocol, Version 6
                (IPv6) Specification", STD 86, RFC 8200, DOI
                10.17487/RFC8200, July 2017, <https://www.rfc-
                editor.org/info/rfc8200>.

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