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Tom Herbert  
Quantonium

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Updates to Requirements for IPv6 Options  
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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] specifies 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] states 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], a Destination Option is marked as changeable en route when 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 examined or processed by any intermediate nodes in the path. 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, even at 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 adding, removing, or changing 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 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 its final destination, so that requirements about changing Destination Options en route 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, that is the third-highest order bit of the Option Type is set, then the Option Data may be changed by any intermediate 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 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 of a changeable option 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. 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. The final destination of a packet, which is the last node listed in the Routing header, MUST process a Destination Options header that appears before the routing header. Any intermediate nodes that are not explicitly listed as intermediate destinations in the Routing header MUST NOT examine or process a Destination Options header preceding a 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 a Destination Options header precedes a Routing header.

An implementation MAY determine that Destination Options precede a Routing header by inspecting the Next Header field of the Destination Options header. 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 header 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 unable 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 option in a Destination Options header that precedes a Routing header.

## 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>>.

### Author's Address

Tom Herbert  
Quantonium  
Santa Clara, CA  
USA

Email: [tom@quantonium.net](mailto:tom@quantonium.net)