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A Uniform Format for IPv6 Extension Headers

Abstract

In IPv6, optional internet-layer information is encoded in separate headers that may be placed between the IPv6 header and the transport-layer header. There are a small number of such extension headers currently defined. This document describes the issues that can arise when defining new extension headers and discusses the alternate extension mechanisms in IPv6. It also provides a common format for defining any new IPv6 extension headers, if they are needed.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc6564.

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1. Introduction

The base IPv6 standard [RFC2460] defines extension headers as an expansion mechanism to carry optional internet-layer information. Extension headers, with the exception of the Hop-by-Hop Options header, are not usually processed on intermediate nodes. However, several existing deployed IPv6 routers and several existing deployed IPv6 firewalls, in contradiction to [RFC2460], are capable of parsing past or ignoring all currently defined IPv6 extension headers (e.g., to examine transport-layer header fields) at wire speed (e.g., by using custom Application-specific Integrated Circuits (ASICs) for packet processing). Hence, one must also consider that any new IPv6 extension header will break IPv6 deployments that use these existing capabilities.

Any IPv6 header or option that has hop-by-hop behavior, and is intended for general use in the public IPv6 Internet, could be subverted to create an attack on IPv6 routers that process packets containing such a header or option. Reports from the field indicate that some IP routers deployed within the global Internet are configured either to ignore the presence of headers with hop-by-hop

behavior or to drop packets containing headers with hop-by-hop behavior.

2. Conventions Used in This Document

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].

3. Applicability

The base IPv6 standard [RFC2460] allows the use of both extension headers and destination options in order to encode optional destination information in an IPv6 packet. The use of destination options to encode this information provides more flexible handling characteristics and better backward compatibility than using extension headers. Because of this, implementations SHOULD use destination options as the preferred mechanism for encoding optional destination information, and use a new extension header only if destination options do not satisfy their needs. The request for creation of a new IPv6 extension header MUST be accompanied by a specific explanation of why destination options could not be used to convey this information.

The base IPv6 standard [RFC2460] defines 3 extension headers (i.e., Routing header, Destination Options header, Hop-by-Hop Options header) to be used for any new IPv6 options. The same standard only allows the creation of new extension headers in limited circumstances ([RFC2460], Section 4.6).

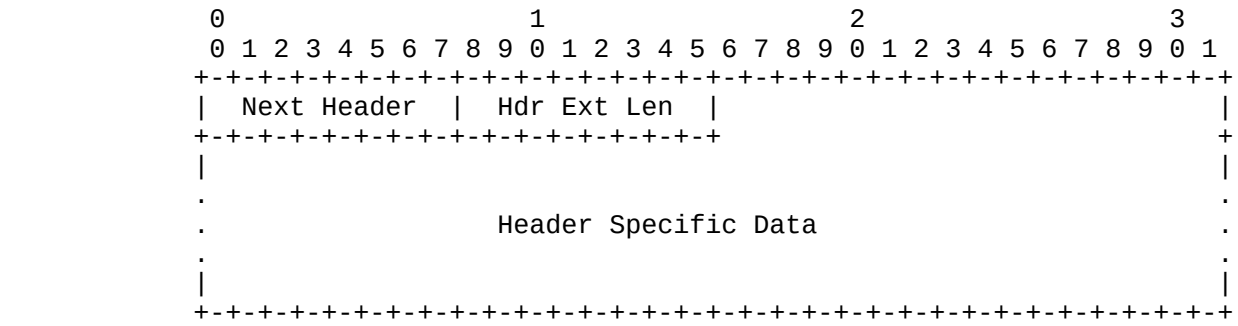
As noted above, the use of any option with hop-by-hop behavior can be problematic in the global public Internet. New IPv6 extension header(s) having hop-by-hop behavior MUST NOT be created or specified. New options for the existing Hop-by-Hop Header SHOULD NOT be created or specified unless no alternative solution is feasible. Any proposal to create a new option for the existing Hop-by-Hop Header MUST include a detailed explanation of why the hop-by-hop behavior is absolutely essential in the document proposing the new option with hop-by-hop behavior.

The use of IPv6 Destination Options to encode information provides more flexible handling characteristics and better backward compatibility than using a new extension header. Because of this, new optional information to be sent SHOULD be encoded in a new option for the existing IPv6 Destination Options header.

Mindful of the need for compatibility with existing IPv6 deployments, new IPv6 extension headers MUST NOT be created or specified, unless no existing IPv6 extension header can be used by specifying a new option for that existing IPv6 extension header. Any proposal to create or specify a new IPv6 extension header MUST include a detailed technical explanation of why no existing IPv6 extension header can be used in the document proposing the new IPv6 extension header.

4. Proposed IPv6 Extension Header Format

Any IPv6 extension headers defined in the future, keeping in mind the restrictions specified in Section 3 and also the restrictions specified in [RFC2460], MUST use the consistent format defined in Figure 1. This minimizes breakage in intermediate nodes that examine these extension headers.



Next Header	8-bit selector. Identifies the type of header immediately following the extension header. Uses the same values as the IPv4 Protocol field [IANA_IP_PARAM].
Hdr Ext Len	8-bit unsigned integer. Length of the extension header in 8-octet units, not including the first 8 octets.
Header Specific Data	Variable length. Fields specific to the extension header.

Figure 1: Extension Header Layout

5. Backward Compatibility

The scheme proposed in this document is not intended to be backward compatible with all the currently defined IPv6 extension headers. It applies only to newly defined extension headers. Specifically, the

fragment header predates this document and does not follow the format proposed in this document.

6. Future Work

This document proposes one step in easing the inspection of extension headers by middleboxes. There is further work required in this area. Some issues that are left unresolved beyond this document include:

- There can be an arbitrary number of extension headers.
- Extension headers must be processed in the order they appear.
- Extension headers may alter the processing of the payload itself, and hence the packet may not be processed properly without knowledge of said header.

7. Security Considerations

This document proposes a standard format for the IPv6 extension headers that minimizes breakage at intermediate nodes that inspect but do not understand the contents of these headers. Intermediate nodes, such as firewalls, that skip over unknown headers might end up allowing the setup of a covert channel from the outside of the firewall to the inside using the data field(s) of the unknown extension headers.

8. Acknowledgements

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9. Normative References

[IANA_IP_PARAM] IANA, "IP Parameters", <http://www.iana.org/assignments/ip-parameters>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC2460] Deering, S. and R. Hinden, "Internet Protocol, Version 6 (IPv6) Specification", RFC 2460, December 1998.

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