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IPv6 Universal Extension Header
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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 specifies a new IPv6 Extension Header - the Universal Extension Header - that overcomes the aforementioned problem, while enabling the extensibility of IPv6. Finally, this document formally obsoletes RFC 6564.

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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1. Introduction

There has recently been a lot of work in the area of IPv6 Extension Headers. Firstly, there has been research about the extent to which IPv6 packets employing Extension Headers are dropped in the public Internet [GONT-IEPG-Nov13] [GONT-IEPG-Mar14], and debate about the motivation behind such policy [I-D.gont-v6ops-ipv6-ehs-packet-drops]. Secondly, there has been a fair share of work to improve some technicalities of IPv6 Extension Headers (see e.g. [RFC7112] [RFC7045]) in the hopes that they can be reliably used in the public Internet.

A key challenge for IPv6 Extension Headers to be "deployable" in the public Internet is that they should not impair any nodes's ability to process the entire IPv6 header chain. One of the steps meant in that direction has been the specification of a Uniform Format for IPv6 Extension Headers [RFC6564], which was meant to be employed by any IPv6 Extension Headers that might be defined in the future, such that middle-boxes can still process the entire IPv6 header chain if new new extension headers were specified. However, a problem in the

aforementioned specification prevents such uniform format from being of use.

Section 3 discusses the aforementioned flaw in the Uniform Format for Extension Headers specified in [RFC6564]. Section 4 explicitly describes the implications of the aforementioned flaw. Section 5 specifies the new Universal Extension Header (UEH). Section 7 explains how new IPv6 extensions would be specified with the UEH. Section 6 formally forbids the specification of new IPv6 Extension Headers (with new Next Header values), and mandates that any new IPv6 extensions be conveyed/encoded in the UEH specified in this document.

2. Terminology

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 RFC 2119 [RFC2119].

3. A Problem with RFC 6564

A key problem with the Uniform Format for IPv6 Extension Headers [RFC6564] lies in that both IPv6 Extension Headers and Transport Protocols share the same "Next Header" registry/namespace. Thus, given an "unknown Next Header value", it is impossible to tell whether the aforementioned value refers to an IPv6 Extension Header that employs the aforementioned uniform format, or an "unknown" upper-layer protocol (e.g. an "unknown" transport protocol). That is, while [RFC6564] specifies the syntax for a Uniform Format for IPv6 Extension Headers, it does not provide a mechanism for a node to identify whether the aforementioned format is being employed in the first place.

4. Implications

The current impossibility to parse an IPv6 header chain that includes unknown Next Header values results in concrete implications for the extensibility of the IPv6 protocol, and the deployability of new transport protocols. Namely,

- New IPv6 extension headers cannot be incrementally deployed.

- New transport protocols cannot be incrementally deployed.

Since there is no way for a node to process IPv6 extension headers that employ unknown next header values, an IPv6 host that receives a packet that employs a new IPv6 extension header will not be able to parse the IPv6 header chain past that unknown extension header, and hence it will drop the aforementioned packet

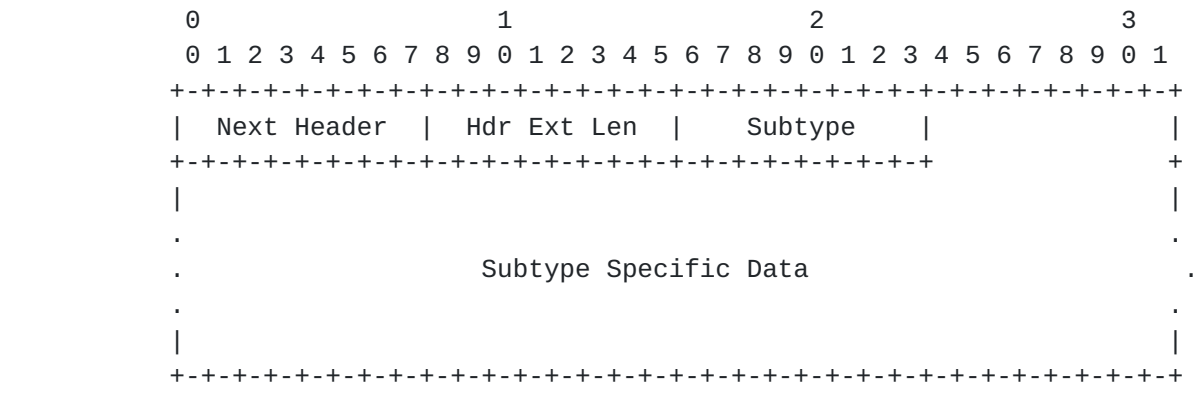
[I-D.gont-v6ops-ipv6-ehs-packet-drops]. In a similar way, a middlebox that needs to process the transport-protocol header will be faced with the dilemma of what to do with packets that employ unknown Next Header values. Since they will not be able to parse the IPv6 header chain past the unknown Next Header, it is very likely that they will drop such packets.

Unfortunately, since transport protocols share the same namespace as IPv6 Extension Headers, new transport protocols will pose the same challenge to middle-boxes, and hence they will be likely dropped in the network.

We believe that the current situation has implications that are generally overlooked, and that, whatever the outcome, it should be the result of an explicit decision by our community, rather than simply "omission".

5. UEH Specification

This document specifies a new IPv6 Extension Header: Universal Extension Header. This Extension Header is identified by the value [TBD] of [IANA-IP-PROTO]. The syntax of the Universal Extension Header is:



where:

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-PROTO].

Hdr Ext Len
: 8-bit unsigned integer. Length of the extension header in 8-octet units, not including the first 8 octets.

Subtype
8-bit unsigned integer. Specifies the subtype for this extension header. It uses a new namespace managed by IANA [IANA-UEH].

Subtype Specific Data
Variable length. Fields specific to this extension header/ Subtype.

The Universal Extension Header specified in this document MAY appear multiple times in the same IPv6 packet.

6. Forbidding New IPv6 Extension Headers

Since the specification of any new IPv6 Extension Headers (i.e., with new Next Header values) would hamper (among other things) the incremental deployment of extensions and new transport protocols, and basic operational practices such as the enforcement of simple ACLs, new IPv6 Extension Headers MUST NOT be specified in any future specifications. Any IPv6 extensions that would require a new IPv6 Extension Header MUST be implemented with the Universal Extension Header specified in this document. This minimizes breakage in intermediate nodes that need to parse the entire IPv6 header chain.

7. Operation of the UEH

This section describes the operation of the Universal Extension Header.

The goal of the UEH is to provide a common syntax for all future IPv6 extensions. Any future extension headers will be encoded in a UEH, and will be identified by a specific UEH Subtype assigned by IANA at the time the corresponding specification is published. The UEH thus provides the "common syntax" required to process "unrecognized extensions", and the Subtype field identifies the specific extension being encoded in the UEH. Any "future extension headers" would actually be new Subtypes (assigned by IANA) of the UEH.

As a result, unrecognized Next Header values should be interpreted to identify an upper-layer protocol, rather than an IPv6 extension header.

8. IANA Considerations

IANA is requested to create a new registry to maintain the Universal Extension Header Subtypes [IANA-UEH].

9. Security Considerations

Enabling nodes to parse an entire IPv6 header chain even in the presence of unrecognized extensions allows for security mechanisms to be implemented and deployed.

10. Acknowledgements

The authors would like to thank [TBD] for providing valuable input on earlier versions of this document.

11. Contributors

C.M. Heard identified the problems related with the Uniform Format for IPv6 Extension Headers specified in [RFC6564], and participated in the brainstorming that led to this document.

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