Stream: Internet Engineering Task Force (IETF)
RFC: 9740
Category: Standards Track
Published: March 2025
ISSN: 2070-1721
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RFC 9740
New IPFIX Information Elements for TCP Options and IPv6 Extension Headers

Abstract

This document specifies new IP Flow Information Export (IPFIX) Information Elements (IEs) to solve issues with existing ipv6ExtensionHeaders and tcpOptions IPFIX IEs, especially the ability to export any observed IPv6 extension headers or TCP options.

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 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at https://www.rfc-editor.org/info/rfc9740.

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1. Introduction

This document specifies new IP Flow Information Export (IPFIX) [RFC7011] Information Elements (IEs) to solve a set of issues encountered with the specifications of two IEs -- ipv6ExtensionHeaders (to export IPv6 extension headers) and tcpOptions (to export TCP options) [IANA-IPFIX]. More details about these issues are provided in the following subsections.

This document deprecates the ipv6ExtensionHeaders and tcpOptions IPFIX IEs that were initially defined in [RFC5102].

> Note that [RFC7012] obsoletes [RFC5102] and specifies that [IANA-IPFIX] is the normative reference for these IEs.

1.1. Issues with ipv6ExtensionHeaders Information Element

The specification of the ipv6ExtensionHeaders IPFIX IE (64) does not:

- Cover the full extension headers' range defined in the IPv6 specification (Section 4 of [RFC8200]).
- Specify the procedure to follow when all bits are exhausted.
- Specify a means to export the order and the number of occurrences of a given extension header.
- Specify how to automatically update the IANA IPFIX registry [IANA-IPFIX] when a new value is assigned in the IPv6 Extension Header Types registry [IANA-EH]. Only a frozen set of extension headers can be exported using the ipv6ExtensionHeaders IE. For example, the ipv6ExtensionHeaders IE can't report some IPv6 EHs, specifically EHs for the Host Identity Protocol (139), Shim6 Protocol (140), or extension headers for experimentation and testing.

- Specify whether the exported values match the full enclosed values or only up to a limit imposed by hardware or software (e.g., Section 1.1 of [RFC8883]). Note that some implementations may not be able to export all observed extension headers in a Flow because of a hardware or software limit (see, e.g., [EH-LIMITS]).
- Discuss whether it covers all enclosed extension headers or only up to a limit.
- Specify how to report the length of IPv6 extension headers.
- Optimize the encoding.
- Explain the reasoning for reporting values that do not correspond to extension headers (e.g., "Unknown Layer 4 header" or "Payload compression header").
- Specify how to report extension header chains or aggregate lengths of extension headers.

Section 3 addresses these issues.

This specification deprecates the ipv6ExtensionHeaders IPFIX IE in favor of the new IEs defined in this document.

1.2. Issues with tcpOptions Information Element

The specification of the tcpOptions IPFIX IE (209) does not:

- Describe how some observed TCP options in a Flow can be exported using IPFIX. Only TCP options having a Kind <= 63 can be exported in a tcpOptions IE.
- Allow reporting the observed Experiment Identifiers (ExIDs) that are carried in shared Experimental TCP options (Kind=253 or 254) [RFC6994].
- Optimize the encoding.

Section 4 addresses these issues.

This specification deprecates the tcpOptions IE in favor of the new IEs defined in this document.

2. Conventions and Definitions

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.

This document uses the IPFIX-specific terminology (Information Element, Template Record, Flow, etc.) defined in Section 2 of [RFC7011]. As in the base IPFIX specification [RFC7011], these IPFIX-specific terms have the first letter of a word capitalized.

Also, the document uses the terms defined in the IPv6 [RFC8200] and TCP [RFC9293] specifications.

In addition, the document makes use of the following terms:

Extension header chain: Refers to the chain of extension headers that are present in an IPv6 packet.

This term should not be confused with the IPv6 header chain, which includes the IPv6 header, zero or more IPv6 extension headers, and zero or a single Upper-Layer Header.

Flow with varying extension header chains: Refers to a Flow where distinct extension header chains are observed. Concretely, different packets in such a Flow will have a different sequence of extension header type codes.

3. Information Elements for IPv6 Extension Headers

3.1. ipv6ExtensionHeaderType Information Element

Name: ipv6ExtensionHeaderType

ElementID: 513

Description: Type of an IPv6 extension header observed in at least one packet of this Flow.

Abstract Data Type: unsigned8

Data Type Semantics: identifier

Additional Information: See the "IPv6 Extension Header Types" registry at [IANA-EH].

See Section 4 of [RFC8200] for the general definition of IPv6 extension headers.

Reference: RFC 9740

3.2. ipv6ExtensionHeaderCount Information Element

Name: ipv6ExtensionHeaderCount

ElementID: 514

Description: The number of consecutive occurrences of the same extension header type in a Flow.

This IE is reported, e.g., in the ipv6ExtensionHeaderTypeCountList IE.

The type of the extension header is provided in the ipv6ExtensionHeaderType IE.

Abstract Data Type: unsigned8

Data Type Semantics: totalCounter

Additional Information: See the "IPv6 Extension Header Types" registry at [IANA-EH].

See Section 4 of [RFC8200] for the general definition of IPv6 extension headers.

Reference: RFC 9740

3.3. ipv6ExtensionHeadersFull Information Element

Name: ipv6ExtensionHeadersFull

ElementID: 515

Description: IPv6 extension headers observed in packets of this Flow. The information is encoded in a set of bit fields. For each IPv6 extension header, there is a bit in this set. The bit is set to 1 if any observed packet of this Flow contains the corresponding IPv6 extension header. Otherwise, if no observed packet of this Flow contains the respective IPv6 extension header, the value of the corresponding bit is 0.

The IPv6 extension header associated with each bit is provided in [IANA-IPFIX-IPv6EH]. Bit 0 corresponds to the least significant bit (LSB) in the ipv6ExtensionHeadersFull IE, while bit 255 corresponds to the most significant bit (MSB) of the IE. In doing so, few octets will be needed to encode common IPv6 extension headers when observed in a Flow.

The "No Next Header" (bit 2) value (Section 4.7 of [RFC8200]) is used if there is no upper-layer header in an IPv6 packet. Even if the value is not considered as an extension header as such, the corresponding bit is set in the ipv6ExtensionHeadersFull IE whenever that value is encountered in the Flow.

Extension headers observed in a Flow with varying extension header chains **MUST NOT** be grouped in the ipv6ExtensionHeadersFull IE if the ipv6ExtensionHeaderChainLengthList IE is also present.

If the ipv6ExtensionHeaderChainLengthList IE is not present, then extension headers observed in a Flow with varying extension header chains **MAY** be grouped in one single ipv6ExtensionHeadersFull IE or be exported in separate ipv6ExtensionHeadersFull IEs, one for each extension header chain.

The ipv6ExtensionHeadersFull IE **MUST NOT** be exported if ipv6ExtensionHeaderTypeCountList IE is also present because of the overlapping scopes of these two IEs.

The value of ipv6ExtensionHeadersFull IE may be encoded in fewer octets per the guidelines in Section 6.2 of [RFC7011].

Abstract Data Type: unsigned256

Data Type Semantics: flags

Additional Information: See the "IPFIX ipv6ExtensionHeaders Bits" registry at [IANA-IPFIX-IPv6EH].

See the "IPv6 Extension Header Types" registry at [IANA-EH].

See Section 4 of [RFC8200] for the general definition of IPv6 extension headers.

The ipv6ExtensionHeadersFull IE deprecates the ipv6ExtensionHeaders IE (64) that was initially defined in [RFC5102].

[RFC7012] obsoletes [RFC5102] and specifies that [IANA-IPFIX] is the normative reference for the ipv6ExtensionHeaders IE (64).

Reference: RFC 9740

3.4. ipv6ExtensionHeaderTypeCountList Information Element

Name: ipv6ExtensionHeaderTypeCountList

ElementID: 516

Description: As per Section 4.1 of [RFC8200], IPv6 nodes must accept and attempt to process extension headers occurring any number of times in the same packet. This IE echoes the order of extension headers and number of consecutive occurrences of the same extension header type in a Flow.

This IE is a subTemplateList of ipv6ExtensionHeaderType and ipv6ExtensionHeaderCount IEs.

Each header chain in a Flow with varying extension header chains **MUST** be exported in a separate IE.

The same extension header type may appear several times in an ipv6ExtensionHeaderTypeCountList IE. For example, if an IPv6 packet of a Flow includes a Hop-by-Hop Options header, a Destination Options header, a Fragment header, and a Destination Options header, the ipv6ExtensionHeaderTypeCountList IE will report:

- the count of Hop-by-Hop Options headers,
- the occurrences of the Destination Options headers that are observed before a Fragment header,
- the occurrences of the Fragment headers, and
- the occurrences of the Destination Options headers that are observed right after a Fragment header.

If an implementation determines that an observed packet of a Flow includes an extension header (including an extension header that it does not support), then the exact observed code of that extension header **MUST** be echoed in the ipv6ExtensionHeaderTypeCountList IE. How an implementation disambiguates between unknown upper-layer protocols vs. extension headers is not IPFIX-specific. Refer, for example, to Section 2.2 of [RFC8883] for a behavior of an intermediate node that encounters an unknown Next Header type.

Abstract Data Type: subTemplateList

Data Type Semantics: list

Additional Information: See the "IPv6 Extension Header Types" registry at [IANA-EH].

See Section 4 of [RFC8200] for the general definition of IPv6 extension headers.

Reference: RFC 9740

3.5. ipv6ExtensionHeadersLimit Information Element

Name: ipv6ExtensionHeadersLimit

ElementID: 517

Description: When set to "false", this IE indicates that the exported extension header information (e.g., ipv6ExtensionHeadersFull or ipv6ExtensionHeaderTypeCountList) does not match the full enclosed extension headers, but only up to a limit that is typically set by hardware or software.

When set to "true", this IE indicates that the exported extension header information matches the full enclosed extension headers.

Abstract Data Type: boolean

Data Type Semantics: default

Additional Information: See Section 4 of [RFC8200] for the general definition of IPv6 extension headers.

See [RFC8883] for an example of IPv6 packet processing due to limits on extension headers.

Reference: RFC 9740

3.6. ipv6ExtensionHeadersChainLength Information Element

Name: ipv6ExtensionHeadersChainLength

ElementID: 518

Description: In theory, there are no limits on the number of IPv6 extension headers that may be present in a packet other than the path MTU. However, it was regularly reported that IPv6 packets with extension headers were often dropped in the Internet (e.g., [RFC7872]).

As discussed in Section 1.2 of [RFC8883], some hardware devices implement a parsing buffer of a fixed size to process packets, including all the headers. When the aggregate length of headers of an IPv6 packet exceeds that size, the packet will be discarded or deferred to a slow path.

The ipv6ExtensionHeadersChainLength IE is used to report, in octets, the length of an extension header chain observed in a Flow. The length is the sum of the lengths of all extension headers of the chain. Exporting such information might help identifying root causes of performance degradation, including packet drops.

Each header chain length of a Flow with varying extension header chains **MUST** be exported in a separate ipv6ExtensionHeadersChainLength IE.

Abstract Data Type: unsigned32

Data Type Semantics: identifier

Units: octets

Additional Information: See Section 4 of [RFC8200] for the general definition of IPv6 extension headers.

See [RFC9098] for an overview of operational implications of IPv6 packets with extension headers.

Reference: RFC 9740

3.7. ipv6ExtensionHeaderChainLengthList Information Element

Name: ipv6ExtensionHeaderChainLengthList

ElementID: 519

Description: This IE is used to report the chains and their lengths as observed in a Flow with varying extension header chains.

This IE is a subTemplateList of ipv6ExtensionHeadersFull and ipv6ExtensionHeadersChainLength IEs.

If several extension header chains are observed in a Flow, each header chain **MUST** be exported in a separate ipv6ExtensionHeaderChainLengthList IE.

Abstract Data Type: subTemplateList

Data Type Semantics: list

Additional Information: See the "IPv6 Extension Header Types" registry at [IANA-EH].

See Section 4 of [RFC8200] for the general definition of IPv6 extension headers.

Reference: RFC 9740

4. Information Elements for TCP Options

4.1. tcpOptionsFull Information Element

This section specifies a new IE to cover the full TCP options range.

Name: tcpOptionsFull

ElementID: 520

Description: TCP options in packets of this Flow. The information is encoded in a set of bit fields. For each TCP option, there is a bit in this set. The bit is set to 1 if any observed packet of this Flow contains the corresponding TCP option. Otherwise, if no observed packet of this Flow contains the respective TCP option, the value of the corresponding bit is 0.

Options are mapped to bits according to their option numbers. TCP option Kind 0 corresponds to the least significant bit in the tcpOptionsFull IE, while Kind 255 corresponds to the most significant bit of the IE. This approach allows an observer to export any observed TCP option even if it does not support that option and without requiring updating a mapping table.

The value of tcpOptionsFull IE may be encoded in fewer octets per the guidelines in Section 6.2 of [RFC7011].

The presence of tcpSharedOptionExID16List or tcpSharedOptionExID32List IEs is an indication that a shared TCP option (Kind=253 or 254) is observed in a Flow. The presence of tcpSharedOptionExID16List or tcpSharedOptionExID32List IEs takes precedence over setting the corresponding bits in the tcpOptionsFull IE for the same Flow. In order to optimize the use of the reduced-size encoding in the presence of tcpSharedOptionExID16List or tcpSharedOptionExID32List IEs, the Exporter **MUST NOT** set to 1 the shared TCP options (Kind=253 or 254) of the tcpOptionsFull IE that is reported for the same Flow.

Abstract Data Type: unsigned256

Data Type Semantics: flags

Additional Information: See the "TCP Option Kind Numbers" registry at [IANA-TCP].

See [RFC9293] for the general definition of TCP options.

The tcpOptionsFull IE deprecates the tcpOptions IE (209) that was initially defined in [RFC5102].

[RFC7012] obsoletes [RFC5102] and specifies that [IANA-IPFIX] is the normative reference for the tcpOptions IE (209).

Reference: RFC 9740

4.2. tcpSharedOptionExID16 Information Element

Name: tcpSharedOptionExID16

ElementID: 521

Description: Reports an observed 2-byte ExID in a shared TCP option (Kind=253 or 254) in a Flow.

A basicList of tcpSharedOptionExID16 is used to report tcpSharedOptionExID16List values.

Abstract Data Type: unsigned16

Data Type Semantics: identifier

Additional Information: See the "TCP Experimental Option Experiment Identifiers (TCP ExIDs)" registry at [IANA-TCP-ExIDs].

See [RFC9293] for the general definition of TCP options.

See [RFC6994] for the shared use of experimental TCP Options.

Reference: RFC 9740

4.3. tcpSharedOptionExID32 Information Element

Name: tcpSharedOptionExID32

ElementID: 522

Description: Reports an observed 4-byte ExID in a shared TCP option (Kind=253 or 254) in a Flow.

A basicList of tcpSharedOptionExID32 is used to report tcpSharedOptionExID32List values.

Abstract Data Type: unsigned32

Data Type Semantics: identifier

Additional Information: See the "TCP Experimental Option Experiment Identifiers (TCP ExIDs)" registry at [IANA-TCP-ExIDs].

See [RFC9293] for the general definition of TCP options.

See [RFC6994] for the shared use of experimental TCP Options.

Reference: RFC 9740

4.4. tcpSharedOptionExID16List Information Element

Name: tcpSharedOptionExID16List

ElementID: 523

Description: Reports observed 2-byte ExIDs in shared TCP options (Kind=253 or 254) in a Flow.

A basicList of tcpSharedOptionExID16 IEs in which each tcpSharedOptionExID16 IE carries an observed 2-byte ExID in a shared option.

Abstract Data Type: basicList

Data Type Semantics: list

Additional Information: See the "TCP Experimental Option Experiment Identifiers (TCP ExIDs)" registry at [IANA-TCP-ExIDs].

See [RFC9293] for the general definition of TCP options.

See [RFC6994] for the shared use of experimental TCP Options.

Reference: RFC 9740

4.5. tcpSharedOptionExID32List Information Element

Name: tcpSharedOptionExID32List

ElementID: 524

Description: Reports observed 4-byte ExIDs in shared TCP options (Kind=253 or 254) in a Flow.

A basicList of tcpSharedOptionExID32 IEs in which each tcpSharedOptionExID32 IE carries an observed 4-byte ExID in a shared option.

Abstract Data Type: basicList

Data Type Semantics: list

Additional Information: See the "TCP Experimental Option Experiment Identifiers (TCP ExIDs)" registry at [IANA-TCP-ExIDs].

See [RFC9293] for the general definition of TCP options.

See [RFC6994] for the shared use of experimental TCP Options.

Reference: RFC 9740

5. Implementation and Operational Considerations

Implementations of tcpSharedOptionExID16, tcpSharedOptionExID32, tcpSharedOptionExID16List, and tcpSharedOptionExID32List IEs are assumed to be provided with a list of valid ExIDs [IANA-TCP-ExIDs]. How that list is maintained is implementation-specific. Absent that list, an implementation can't autonomously determine whether an ExID is present and, if so, whether its length is 2 or 4 bytes.

If a TCP Flow contains packets with a mix of 2-byte and 4-byte ExIDs, the same Template Record is used with both tcpSharedOptionExID16 and tcpSharedOptionExID32 IEs.

6. Examples

This section provides a few examples to illustrate the use of some IEs defined in this document.

6.1. IPv6 Extension Headers

Figure 1 provides an example of EH/bit mappings in an ipv6ExtensionHeadersFull IE for an IPv6 Flow in which only the IPv6 Destination Options (0) header is observed. The bits are set following the table provided in Section 8.4.1.

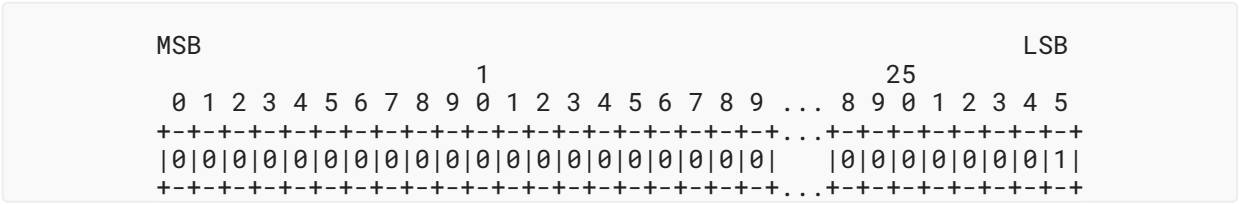

Figure 1: Example of EH/Bit Mappings in the ipv6ExtensionHeadersFull IE

The leading zeros are dropped per the reduced-size encoding guidance. One octet is thus sufficient to send these observed options on the wire. Concretely, the ipv6ExtensionHeadersFull IE will be set to 0x01 (Figure 2).

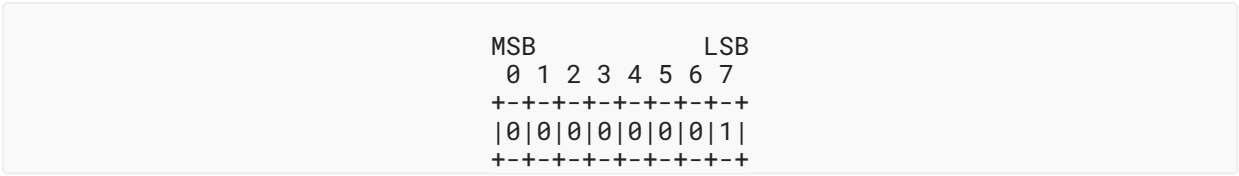

Figure 2: Example A of ipv6ExtensionHeadersFull IE with Reduced-Size Encoding

Figure 3 provides another example of reported values in an ipv6ExtensionHeadersFull IE for an IPv6 Flow in which the Destination Options (0), IPv6 Hop-by-Hop Options (1), and Routing (5) headers are observed. One octet is sufficient to report these observed options. Concretely, the ipv6ExtensionHeadersFull IE will be set to 0x23.

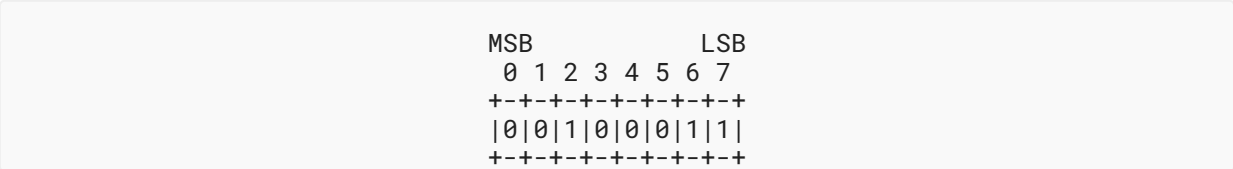

Figure 3: Example B of ipv6ExtensionHeadersFull IE with Reduced-Size Encoding

Let us now consider an IPv6 Flow in which the following EH chain is observed: Routing (5), Mobility (7), and Authentication (9) header. Figure 4 shows the ipv6ExtensionHeadersFull IE (0x02A0) to report this individual chain.

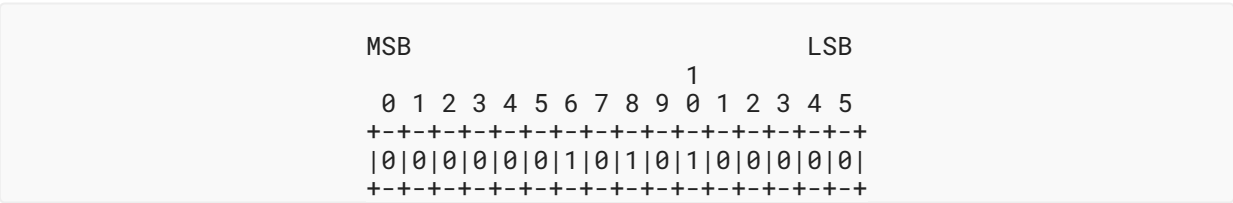

Figure 4: Example of ipv6ExtensionHeadersFull IE Reported for an Extension Header Chain

6.2. TCP Options

6.2.1. Reduced-Size Encoding

Given TCP Kind allocation practices and the option mapping defined in Section 4.1, fewer octets are likely to be used for Flows with common TCP options.

Figure 5 shows an example of Kind/bit mappings in a tcpOptionsFull IE for a TCP Flow in which End of Option List (0), Maximum Segment Size (2), and Window Scale (3) options are observed.

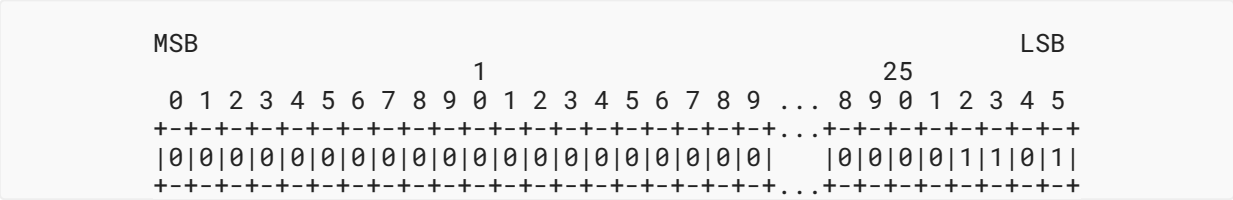

Figure 5: Example of TCP Options / Bit Mappings in a tcpOptionsFull IE

One octet is sufficient to report these observed options. Concretely, the tcpOptionsFull IE will be set to 0x0D (Figure 6).

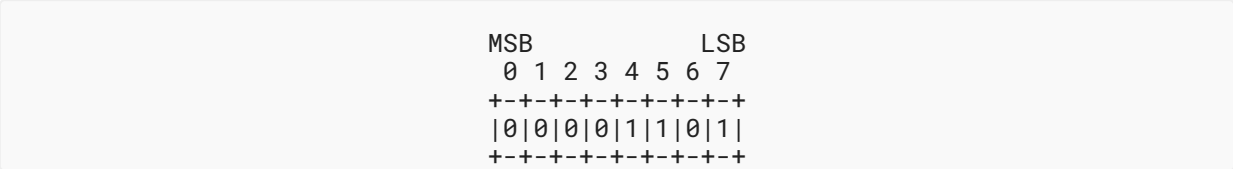

Figure 6: Example of tcpOptionsFull IE with Reduced-Size Encoding

6.2.2. Shared Options

Let us consider a TCP Flow in which shared options with ExIDs 0x0348 (HOST_ID) [RFC7974], 0x454E (TCP-ENO) [RFC8547], and 0xE2D4C3D9 (Shared Memory Communications over RDMA protocol) [RFC7609] are observed. Figure 7 shows an excerpt of the Data Set encoding with a focus on the tcpSharedOptionExID16 and tcpSharedOptionExID32 IEs. The meaning of the fields is defined in [RFC6313].

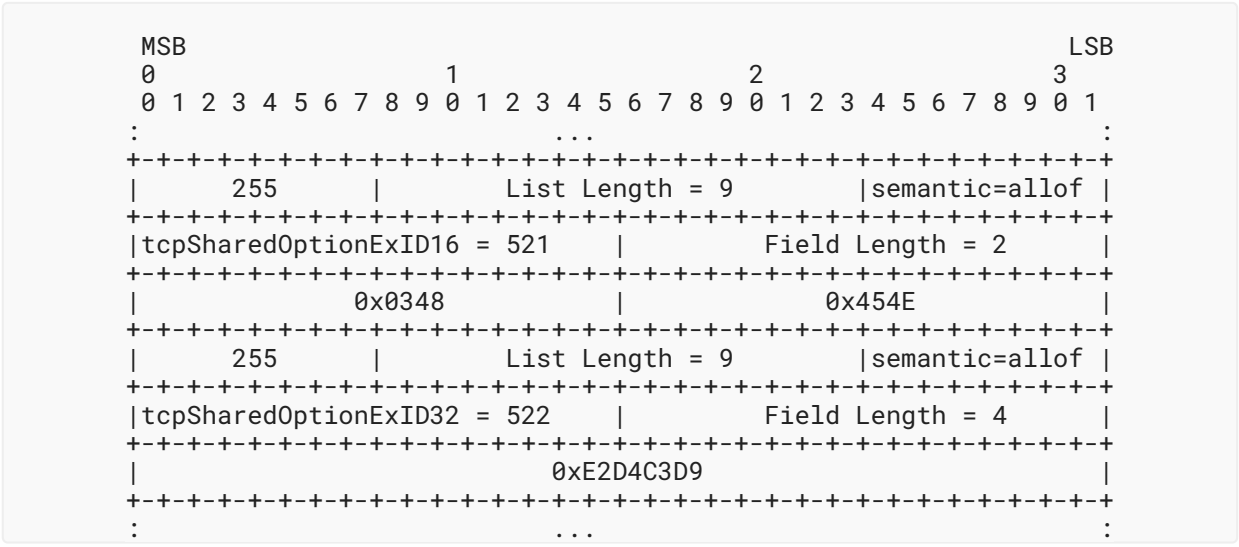

Figure 7: Example of TCP Shared IEs

7. Security Considerations

IPFIX security considerations are discussed in Section 11 of [RFC7011].

ipv6ExtensionHeadersChainLength and ipv6ExtensionHeadersLimit IEs can be exploited by an unauthorized observer as a means to deduce the processing capabilities of nodes. Section 8 of [RFC7012] discusses the required measures to guarantee the integrity and confidentiality of the exported information.

This document does not add new security considerations for exporting IEs other than those already discussed in Section 8 of [RFC7012].

8. IANA Considerations

8.1. Deprecate ipv6ExtensionHeaders and tcpOptions Information Elements

IANA has updated the "IPFIX Information Elements" registry under the "IP Flow Information Export (IPFIX) Entities" registry group [IANA-IPFIX] as follows:

- The ipv6ExtensionHeaders IE (64) entry has been marked as deprecated in favor of the ipv6ExtensionHeadersFull IE defined in this document. This note is echoed in the "Additional Information" of the ipv6ExtensionHeaders IE.
- The tcpOptions IE (209) entry has been marked as deprecated in favor of the tcpOptionsFull IE defined in this document. This note is echoed in the "Additional Information" of the tcpOptions IE.
- The following has been added to the "Additional Information" of both the ipv6ExtensionHeaders and tcpOptions IEs:
  - This Information Element was initially specified in [RFC5102].
  - [RFC7012] has obsoleted [RFC5102] and specifies that [IANA-IPFIX] is the normative reference for this Information Element.

Also, IANA has updated the reference of ipv6ExtensionHeaders IE (64) and tcpOptions IE (209) to point to this document.

8.2. IPFIX Information Elements

IANA has added the following new IPFIX IEs to the "IPFIX Information Elements" registry under the "IP Flow Information Export (IPFIX) Entities" registry group [IANA-IPFIX]:

ElementID	Name	Specification
513	ipv6ExtensionHeaderType	Section 3.1 of RFC 9740
514	ipv6ExtensionHeaderCount	Section 3.2 of RFC 9740
515	ipv6ExtensionHeadersFull	Section 3.3 of RFC 9740
516	ipv6ExtensionHeaderTypeCountList	Section 3.4 of RFC 9740
517	ipv6ExtensionHeadersLimit	Section 3.5 of RFC 9740
518	ipv6ExtensionHeadersChainLength	Section 3.6 of RFC 9740
519	ipv6ExtensionHeaderChainLengthList	Section 3.7 of RFC 9740
520	tcpOptionsFull	Section 4.1 of RFC 9740

ElementID	Name	Specification
521	tcpSharedOptionExID16	Section 4.2 of RFC 9740
522	tcpSharedOptionExID32	Section 4.3 of RFC 9740
523	tcpSharedOptionExID16List	Section 4.4 of RFC 9740
524	tcpSharedOptionExID32List	Section 4.5 of RFC 9740

Table 1: New IPFIX Information Elements

8.3. IPFIX Information Element Data Type

IANA has added the following new abstract data type to the "IPFIX Information Element Data Types" registry under the "IP Flow Information Export (IPFIX) Entities" registry group [IANA-IPFIX]:

Value	Description	Reference
23	unsigned256	RFC 9740

Table 2: New IPFIX Information Element Data Type

8.3.1. unsigned256

The type "unsigned256" represents a non-negative integer value in the range of '0' to '2^{256} - 1'. Similar to Section 6.1.1 of [RFC7011], this type **MUST** be encoded using the default canonical format in network byte order.

Reduced-size encoding (Section 6.2 of [RFC7011]) applies to this data type. The reduction in size can be to any number of octets smaller than the unsigned256 type if the data value still fits, i.e., so that only leading zeros are dropped.

8.4. IPFIX Registry for IPv6 Extension Headers

IANA has created a new registry entitled "IPFIX ipv6ExtensionHeaders Bits" in the IANA IPFIX registry group [IANA-IPFIX].

When a new code is assigned to an IPv6 EH in [IANA-EH], the next available free bit is selected by IANA for this EH from the "IPFIX ipv6ExtensionHeaders Bits" registry, and the registry is updated with the details that mirror the assigned EH. The "Label" mirrors the "keyword" of an EH as indicated in [IANA-Protocols], while the "Protocol Number" mirrors the "Protocol Number" in [IANA-EH]. IANA has added the following note to [IANA-EH]:

Note: When a new code is assigned to an IPv6 Extension Header, the next available free bit in [IANA-IPFIX-IPv6EH] is selected for this new Extension Header. [IANA-IPFIX-IPv6EH] is updated accordingly. Modifications to existing registrations must be mirrored in [IANA-IPFIX-IPv6EH].

Otherwise, the registration policy for the registry is Expert Review (Section 4.5 of [RFC8126]). See more details in Section 8.4.2.

8.4.1. Initial Values

The initial values of this registry are provided in Table 3.

Bit	Label	Protocol Number	Description	Reference
0	DST	60	Destination Options for IPv6	RFC 9740
1	HOP	0	IPv6 Hop-by-Hop Options	RFC 9740
2	NoNxt	59	No Next Header for IPv6	RFC 9740
3	UNK		Unknown extension or transport header	RFC 9740
4	FRA0	44	Fragment header - first fragment	RFC 9740
5	RH	43	Routing header	RFC 9740
6	FRA1	44	Fragmentation header - not first fragment	RFC 9740
7	MOB	135	Mobility Header	RFC 9740
8	ESP	50	Encapsulating Security Payload	RFC 9740
9	AH	51	Authentication Header	RFC 9740
10	HIP	139	Host Identity Protocol	RFC 9740
11	SHIM6	140	Shim6 Protocol	RFC 9740
12		253	Use for experimentation and testing	RFC 9740
13		254	Use for experimentation and testing	RFC 9740
14 to 255			Unassigned	

Table 3: Initial Values of the "IPFIX ipv6ExtensionHeaders Bits" Registry

8.4.2. Guidelines for the Designated Experts

It is suggested that multiple designated experts be appointed for registry change requests.

Designated experts are solicited only for changes that are not covered by the automatic mirroring described above. For example, a registration may request two bits for a new EH to cover specific behaviors or uses of that EH.

Criteria that should be applied by the designated experts include determining whether the proposed registration duplicates existing entries, whether the exception to the automatic mirroring procedure is justified, and whether the registration description is clear and fits the purpose of this registry.

Within the review period, the designated experts will either approve or deny the registration request, communicating this decision to the IANA. Denials should include an explanation and, if applicable, suggestions as to how to make the request successful.

9. References

9.1. Normative References

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Acknowledgments

Thanks to Paul Aitken, Éric Vyncke, and Joe Touch for the reviews and comments. Special thanks to Andrew Feren for sharing data about scans of IPFIX data he collected.

Thanks to Wesley Eddy for the tsvart review, Yingzhen Qu for the opsdir review, Dirk Von Hugo for intdir review, Joel Halpern for the genart review, and Tero Kivinen for the secdir review.

Thanks to Thomas Graf for the Shepherd review.

Thanks to Mahesh Jethanandani for the AD review.

Thanks to Éric Vyncke, Erik Kline, Roman Danyliw, and Zaheduzzaman Sarker for the IESG review.

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