

6lowpan
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ICMPv6/ND Compression for 6LoWPAN Networks
draft-oflynn-6lowpan-icmphc-00

Abstract

Compression for ICMPv6 Messages, specifically designed for 6lowpan-nd.

Status of this Memo

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Internet-Draft

[draft-oflynn-6lowpan-icmp-hc](#)

July 2010

Table of Contents

1.	Background	3
2.	ICMPv6 Compression Format	3
3.	LOWPAN_ICMPHC Encoding	3
3.1.	GENERIC LOWPAN_ICMPHC Encoding	4
3.2.	NON-GENERIC LOWPAN_ICMPHC Encoding	4
3.2.1.	A and B bit usage	5
4.	LOWPAN_ICMPOC Encoding	6
4.1.	HIJK Usage	7
5.	Examples of Compressed/Uncompressed ICMPv6 Messages	9
5.1.	RFC2463 Messages	10
5.1.1.	Destination Unreachable Message	10
5.1.2.	Time Exceeded Message	10
5.2.	RFC4861 Messages	11
5.2.1.	Router Solcitation Message	11
5.2.2.	Router Advertisement Message	12
5.2.3.	Neighbor Solicitation Message	12
5.2.4.	Neighbor Advertisement Message	14
5.3.	RFC4861 Options	15
5.3.1.	Source/Target Link-Layer Address	15
5.3.2.	Prefix Information	16
5.3.3.	MTU Header	17
5.3.4.	Redirect Header	18
5.4.	6lowpan-nd Options	19
5.4.1.	Address Registration Option	19
5.4.2.	6LoWPAN Context Prefix Option	20
5.4.3.	Authoritive Border Router	21
6.	Acknowledgements	22
7.	Security Considerations	22
8.	IANA Considerations	22
9.	Informative References	22
	Author's Address	23

Internet-Draft

[draft-oflynn-6lowpan-icmp-hc](#)

July 2010

1. Background

This document was written VERY quickly. It does not yet go over exhaustively how each option works, see the examples ([Section 5](#)) section for more details.

2. ICMPv6 Compression Format

The ICMPv6 compression has two parts. The first is the ICMPv6 header compression, the second is the ICMPv6 options compression. In 6lowpan-hc-07, the Next Header Compression (NHC) field is shown as fitting in as follows:

LOWPAN_IPHC	In-line	LOWPAN_NHC	In-line Next	Payload
Encoding	IP Fields	Encoding	Header Fields	

This is thus extended, where the LOWPAN_NHC is just the LOWPAN_ICMPHC field. However it may additionally have LOWPAN_ICMPOC (OC = Option Compression) fields after it. As an ICMPv6 message may have multiple options, each option that is compressed will have a LOWPAN_ICMPOC header. Thus a buffer with two ICMPv6 options would look like:

LOWPAN_IPHC	In-line	LOWPAN_ICMPHC	In-line ICMPv6	
Encoding	IP Fields	Encoding	Header Fields	

LOWPAN_ICMPOC	Inline Option	LOWPAN_ICMPOC	Inline Option	Payload
Encoding #1	Fields for #1	Encoding #2	Fields for #2	

The payload could be additional ICMP data, or could be uncompressed ICMP options.

3. LOWPAN_ICMPHC Encoding

The LOWPAN_ICMPHC header has two forms. The first is a 'generic' compression format, which is a single octet. The second is a specific form which compresses certain frequently occurring ICMPv6 messages better than the generic format.

The format is as follows:

O'Flynn

Expires January 27, 2011

[Page 3]

Internet-Draft

[draft-oflynn-6lowpan-icmp-hc](#)

July 2010

```

  0   1   2   3   4   5   6   7
+---+---+---+---+---+---+---+---+
| 1 | 1 | 1 | 1 | 1 | G | X | X |
+---+---+---+---+---+---+---+---
```

G: Generic Compress Format Flag:

1: LOWPAN_ICMPHC is a GENERIC format

0: LOWPAN_ICMPHC is a NON-GENERIC format

XX: Depends on the GENERIC flag. See two sections below.

3.1. GENERIC LOWPAN_ICMPHC Encoding

The format is as follows:

```

  0   1   2   3   4   5   6   7
+---+---+---+---+---+---+---+---+
| 1 | 1 | 1 | 1 | 1 | 1 | R | C |
+---+---+---+---+---+---+---+---
```

R: Reserved Octets Elided:

1: 4 Octets have been elided, at an offset of 4 octets from the start of the ICMPv6 Header.

0: No Change

C: Code Elided:

1: Code field in the ICMPv6 header has been elided, and is zero.

0: No Change

The GENERIC form takes advantage of two factors: many ICMPv6 messages have 4 reserved octets at a specific location, and many ICMPv6 messages do not use the CODE field. When using the GENERIC ICMPHC there is NO option compression used. Option compression is only possible when using the NON-GENERIC ICMP compression.

[3.2.](#) NON-GENERIC LOWPAN_ICMPHC Encoding

The format is as follows:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---																
1	1	1	1	1	0	RSV				TYPE		A		B	NUMOPTS	

O'Flynn

Expires January 27, 2011

[Page 4]

Internet-Draft

[draft-oflynn-6lowpan-icmp-hc](#)

July 2010

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---

RSV: Reserved Field, Do not use

TYPE: Type of ICMPv6 Message to Follow

000: RESERVED.

001: [RFC4861](#) Router Solicitation

010: [RFC4861](#) Router Advertisement

011: [RFC4861](#) Neighbor Solicitation

100: [RFC4861](#) Neighbor Advertisement

101: [RFC4861](#) Redirect

A: Usage depends on TYPE field

B: Usage depends on TYPE field

NUMOPTS: Number of ICMPv6 Compressed Options that will follow. Used so 6lowpan-icmphc knows when to stop processing!

3.2.1. A and B bit usage

TYPE = Router Solicitation

A: Not Used

B: Not Used

TYPE = Router Advertisement

A: Reachable Time Compression:

1: Reachable time field elided. Assume reachable time is zero.

0: Reachable time field inlined.

B: Retrans Time Compression:

1: Retrans time field elided. Assume retrans time is zero.

0: Retrans time field inlined.

TYPE = Neighbor Solicitation or Neighbor Advertisement. In this case

A and B are combined to form a 2-bit field AB:

00: No changes to TARGET ADDRESS field, included in-line.

01: TARGET ADDRESS field is elided. Target address is same as destination IPv6 address from IPv6 Header.

10: TARGET ADDRESS field is elided. Target address is same as source IPv6 address from IPv6 Header.

11: Reserved.

TYPE = Redirect

A: TARGET ADDRESS field compression:

1: Target address field elided, assume target address is same as destination address field.

0: Target address field inlined.

B: Not used

[4.](#) LOWPAN_ICMPOC Encoding

As mentioned option compression is only possible with NON-GENERIC ICMPHC format.

The option compression format is as follows:

0	1	2	3	4	5	6	7					
+---+---+---+---+---+---+---+---												
	OPTTYPE				H		I		J		K	
+---+---+---+---+---+---+---+---												

OPTTYPE is the OPTION TYPE. Defined values are:

0000: Reserved

0001: Source Link-layer Address ([RFC4861](#))

0010: Target Link-layer Address ([RFC4861](#))

0011: Prefix Information ([RFC4861](#))

0100: Redirected Header ([RFC4861](#))

0101: MTU ([RFC4861](#))

0110: Address Registration (6lowpan-nd)

0111: 6LoWPAN Context (6lowpan-nd)

1000: Authoritative Border Router (6lowpan-nd)

H: Depends on the OPTTYPE Field

I: Depends on the OPTTYPE Field

J: Depends on the OPTTYPE Field

K: Depends on the OPTTYPE Field

[4.1.](#) HIJK Usage

OPTTYPE = Source Link-Layer Address or Target Link-Layer Address.

HI: L2 Address Source:

00: L2 Address and Address Length Inline

01: L2 Address taken from L2 Source

10: L2 Address taken from L2 Dest

J: Length Compression:

0: Disabled

1: Enabled (only valid if HI = 00). Length compression removes any trailing zeros from the option, to a maximum of 15. It then splits the 'length' field up into two nibbles, and writes the number of trailing zeros removed in the upper nibble of the length field.

K: Not used

OPTTYPE = Prefix Information

H: On-Link/Autoconfiguration Flag Compression:

1: 'L', 'A', and 6 bits of reserved space elided. When reconstructing option set L=0, A=1

0: 'L', 'A', and 6 bits of reserved space inlined

I: Valid Lifetime Compression:

1: Valid lifetime elided, assumed to be infinite (0xFFFFFFFF)

0: Valid Lifetime inlined

J: Preferred Lifetime Compression:

1: Preferred lifetime elided, assumed to be same as valid.

0: Preferred Lifetime inlined

K: Prefix length compression

1: Prefix length is elided, assumed to be 64 bits

0: Prefix length inlined

OPTTYPE = Redirected Header

H: Not Used

I: Not Used

J: Not Used

K: Not Used

OPTTYPE = MTU

H: MTU Compression:

1: MTU is 1260

0: MTU is contained in next two bytes

I: Not Used

J: Not Used

K: Not Used

OPTTYPE = Address Registration

H: EUI64 Compression:

1: EUI64 Elided, copy from destination L2 Address

0: EUI64 Inlined

I: Registered Address Compression (Only valid if 'Registered Address Present Flag' is set):

1: Registered address elided, take from NA or NS TARGET address

0: Registered address inlined

J: Registered Address Present Flag:

1: Registered address present, so length field is 4

0: Registered address not present, so length field is 2

K: Not Used

OPTTYPE = 6LoWPAN Context

H: Context Length Compression:

1: Context length is elided, assumed to be 64

0: Context length is inlined

I: Not Used

J: Not Used

K: Not Used

OPTTYPE = Authorative Boarder Router

H: Not Used

I: Not Used

J: Not Used

K: Not Used

[5.](#) Examples of Compressed/Uncompressed ICMPv6 Messages

[illegible]


```

+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| 1 1 1 1 1 1 1 1 |      Type      |      Checksum      |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Options ...
+-----+-----+-----+-----+-----+-----+

```

Compressed with NON-GENERIC: 4 Octet Savings

```

0                               1                               2                               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-----+-----+-----+-----+-----+-----+-----+-----+
| 1 1 1 1 1 0 0 0 0 0 1 0 0 X X X |      Checksum      |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Options ...
+-----+-----+-----+-----+-----+-----+

```

O'Flynn

Expires January 27, 2011

[Page 11]

Internet-Draft

[draft-oflynn-6lowpan-icmp-hc](#)

July 2010

[5.2.2.](#) Router Advertisement Message

Maximum Saving: 8 Octets. Minimum Saving: 0 Octets.

Uncompressed

```

0                               1                               2                               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-----+-----+-----+-----+-----+-----+-----+-----+
|      Type      |      Code      |      Checksum      |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Cur Hop Limit |M|O|  Reserved |      Router Lifetime      |
+-----+-----+-----+-----+-----+-----+-----+-----+
|                                     Reachable Time                                     |
+-----+-----+-----+-----+-----+-----+-----+-----+
|                                     Retrans Timer                                     |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Options ...
+-----+-----+-----+-----+-----+-----+

```

Compressed: 8 Octet Savings

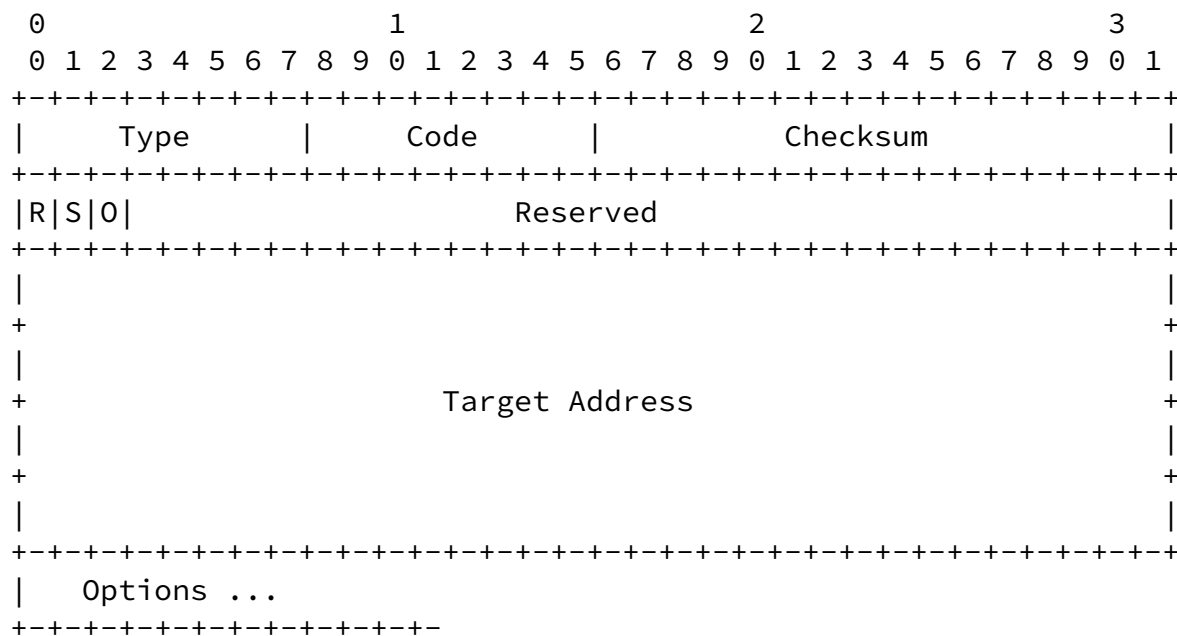
```

0                               1                               2                               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-----+-----+-----+-----+-----+-----+-----+-----+

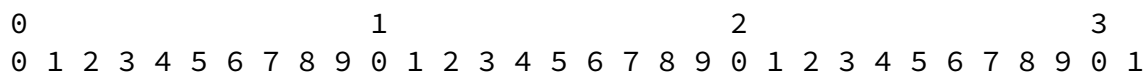
```


Uses NON-GENERIC header compression. Maximum Saving: 19 Octets.
Minimum Saving: 3 Octets

Uncompressed



Compressed: 3 Octet Saving




```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| 1 1 1 1 1 0 0 0 1 0 0 0 0 X X X|          Checksum          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|R|S|O| Reserved|
+---+---+---+---+---+---+
|
+
|          Target Address
+
|
+          +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|          | Options ...
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Compressed: 19 Octet Saving

```

      0              1              2              3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| 1 1 1 1 1 0 0 0 1 0 0 1 0 X X X|          Checksum          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|R|S|O| Reserved| Options ...
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

[5.3.](#) [RFC4861](#) Options

[5.3.1.](#) Source/Target Link-Layer Address

Uncompressed, 8-byte L2 Address

```

      0              1              2              3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      Type      |      Length = 2      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|          Link-Layer Address
+
|          +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|          Padding
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Compressed: 15 Octet Saving

```

      0                      1                      2                      3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|0 0 0 1 0 1 0 0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Compressed: 6 Octet Saving

```

      0                      1                      2                      3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|0 0 0 1 0 0 1 0| 6 | 2 |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|
|                               Link-Layer Address
+
+                               +---+---+---+---+---+---+---+---+---+
|
|                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

[5.3.2.](#) Prefix Information

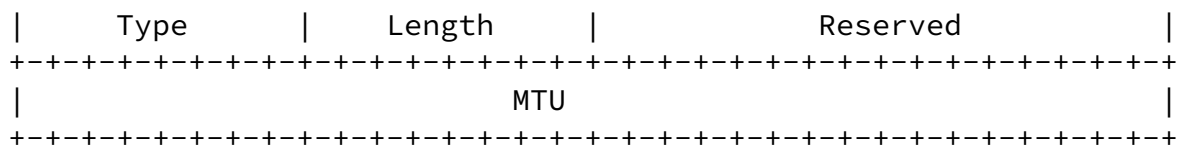
Uncompressed

```

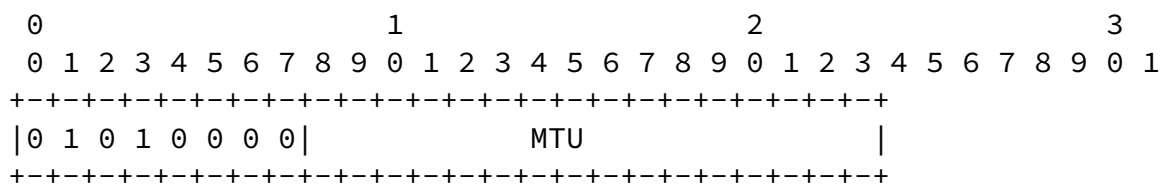
      0                      1                      2                      3
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      Type      |      Length      | Prefix Length |L|A| Reserved1 |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|
|                               Valid Lifetime
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|
|                               Preferred Lifetime
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|
|                               Reserved2
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|
+
|
+
|                               Prefix
+
|
+
|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

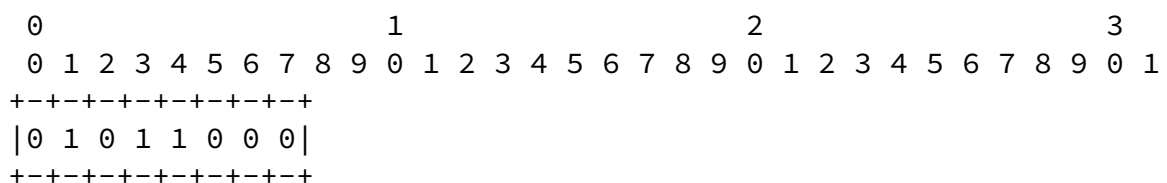
[illegible][illegible][illegible]



Compressed: 5 Octet Saving

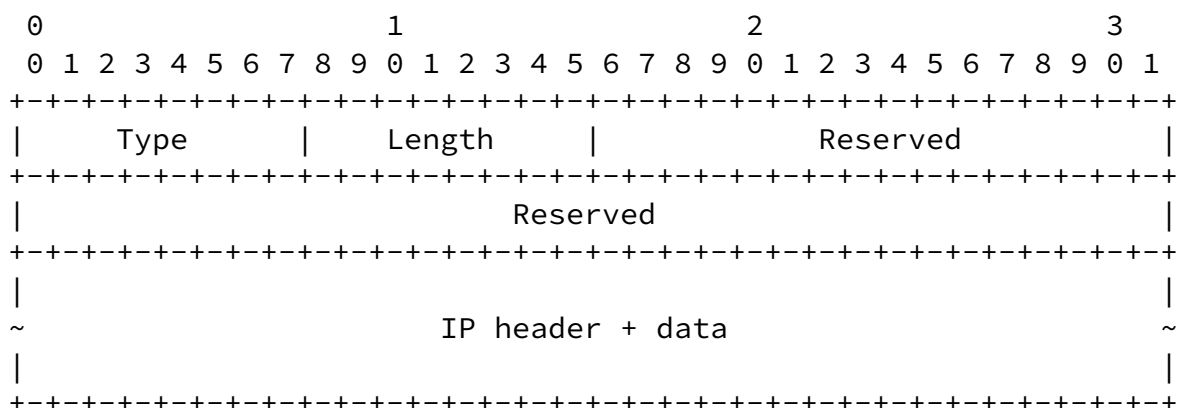


Compressed: 7 Octet Saving

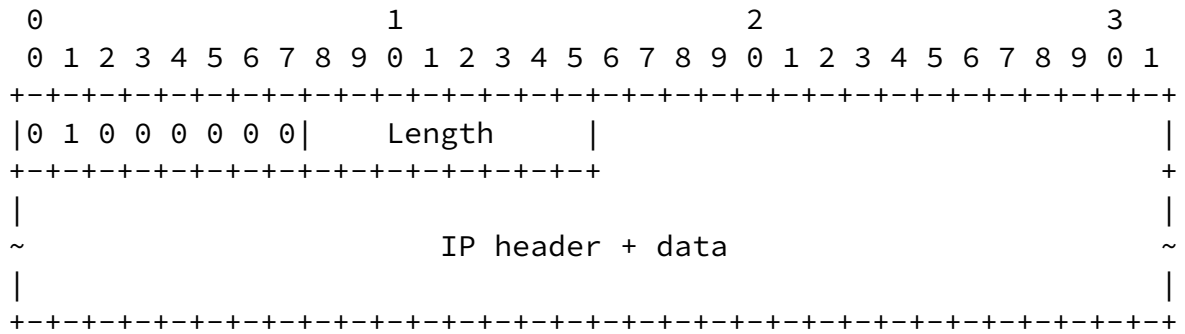


[5.3.4.](#) Redirect Header

Uncompressed



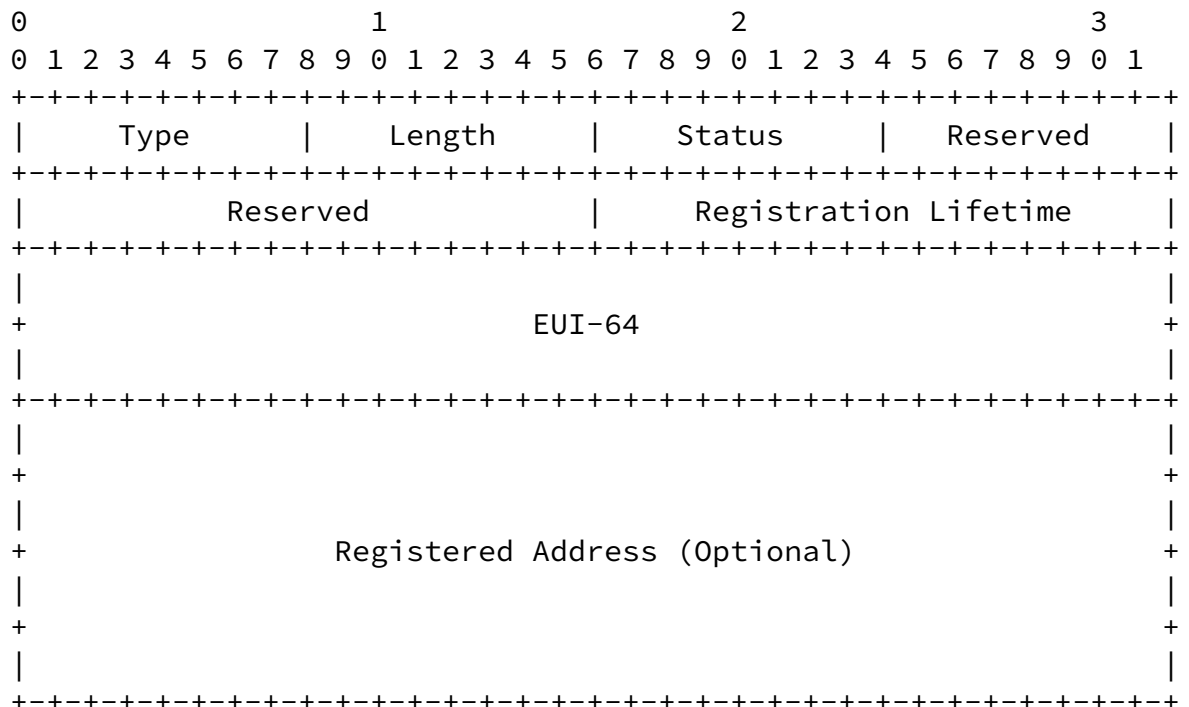
Compressed: 6 Octet Saving



5.4. 6lowpan-nd Options

5.4.1. Address Registration Option

Uncompressed



Compressed: 4 Octet Saving

```

0      1      2      3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+---+-----+-----+-----+-----+-----+-----+-----+
|0 1 1 0 0 0 X 0|   Status       |    Registration Lifetime     |
+-+-+---+-----+-----+-----+-----+-----+-----+-----+
|                                                         |
+                                     EUI-64                +
|                                                         |
+-+-+---+-----+-----+-----+-----+-----+-----+-----+
|                                                         |
+                                     Registered Address (Optional)  +
|                                                         |
+                                                     +
|                                                     +

```

O'Flynn

Expires January 27, 2011

[Page 19]

Internet-Draft

draft-oflynn-6lowpan-icmp-hc

July 2010

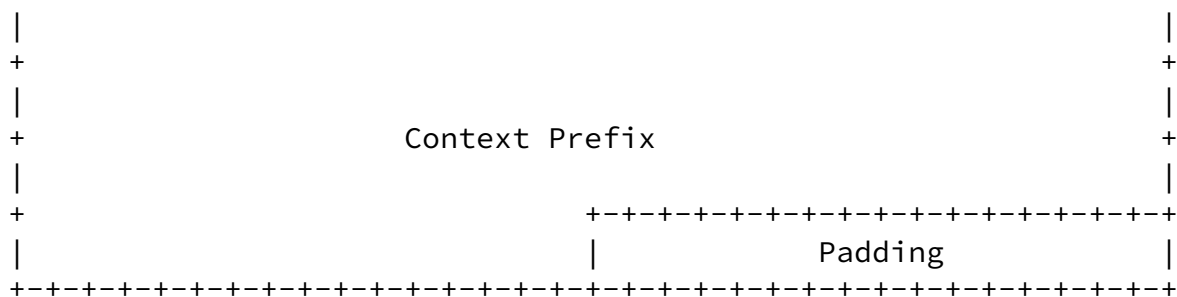
Compressed: 28 Octet Saving

[illegible]

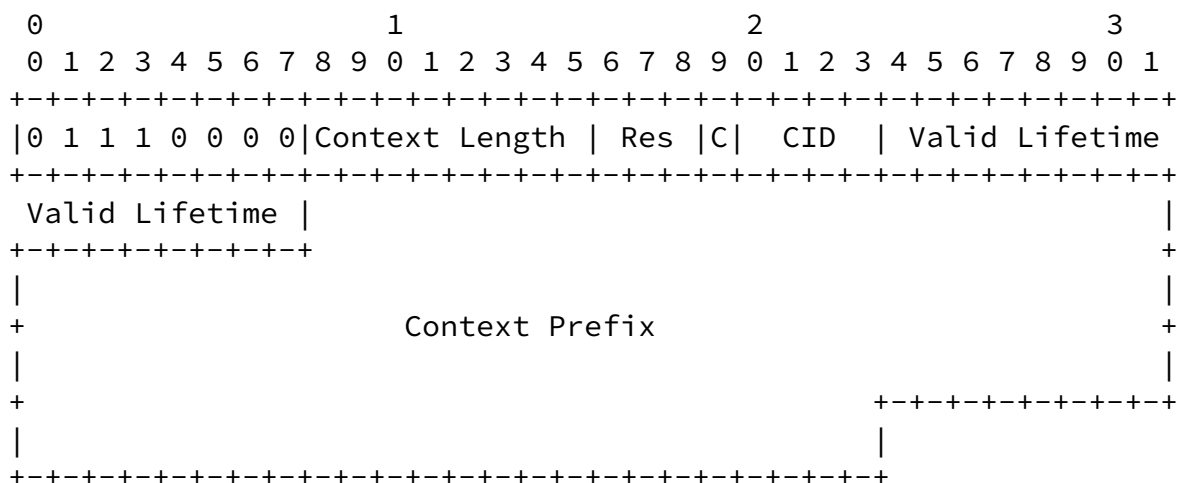
5.4.2. 6LoWPAN Context Prefix Option

Uncompressed 112-bit Context

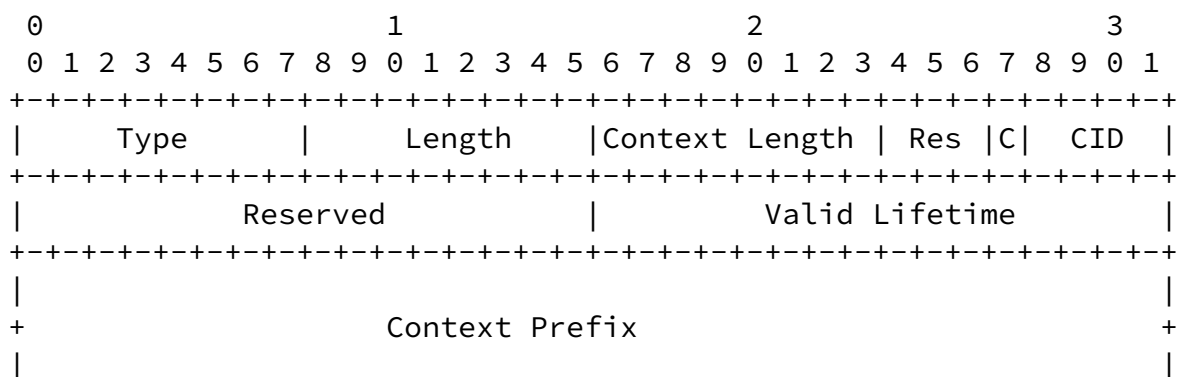
0										1										2										3									
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
Type										Length										Context Length										Res C CID									
Reserved										Valid Lifetime																													



Compressed 112-bit Context: 5 Octet Saving



Uncompressed 64-bit Context

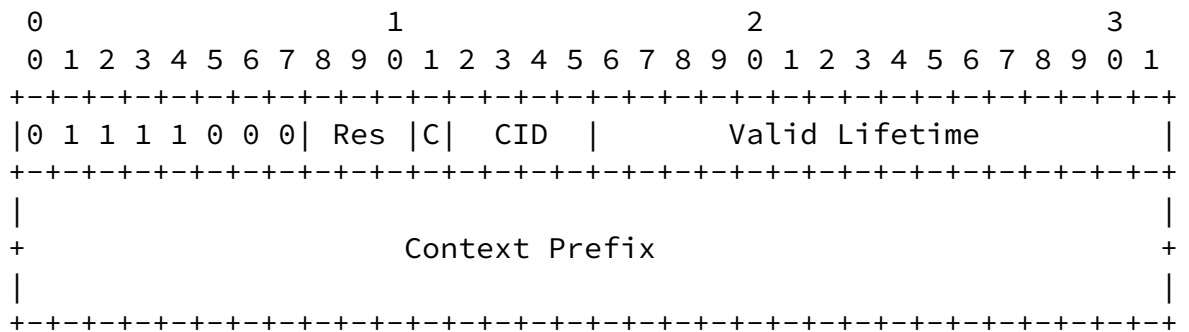


```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

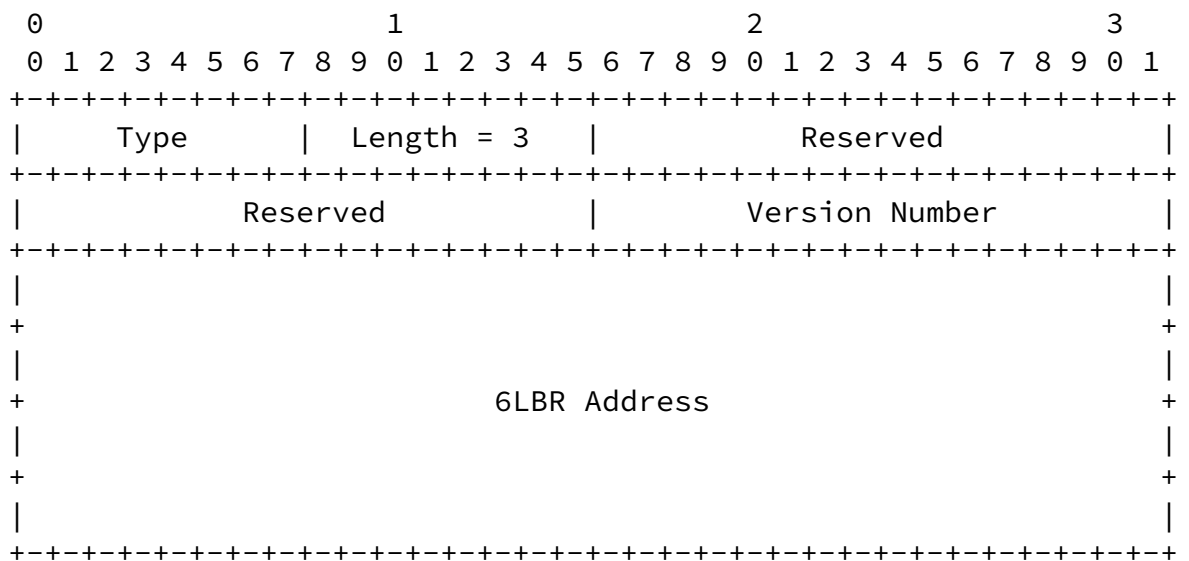
```

Compressed 64-bit Context: 4 Octet Saving

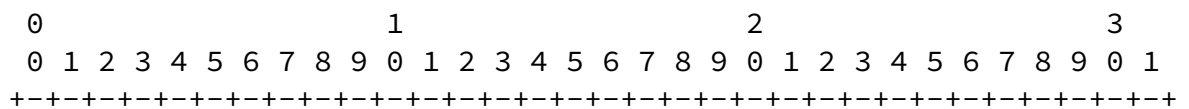


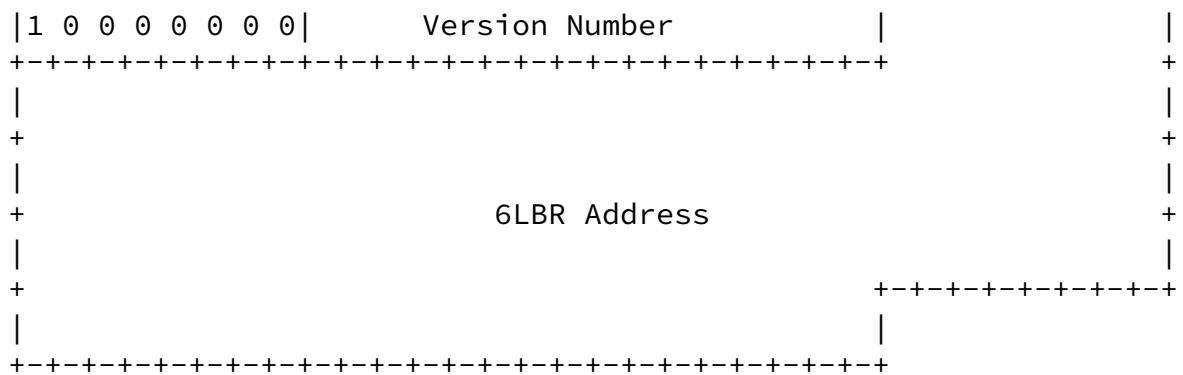
5.4.3. Authoritative Border Router

Uncompressed



Compressed: 5 Octet Saving





6. Acknowledgements

Thanks to Zach Shelby and Daniel Gavelle for various comments.

7. Security Considerations

None

8. IANA Considerations

This memo includes no request to IANA.

All drafts are required to have an IANA considerations section (see the update of [RFC 2434](#) [[I-D.narten-iana-considerations-rfc2434bis](#)] for a guide). If the draft does not require IANA to do anything, the section contains an explicit statement that this is the case (as above). If there are no requirements for IANA, the section will be removed during conversion into an RFC by the RFC Editor.

9. Informative References

[I-D.ietf-6lowpan-nd]

Shelby, Z., Chakrabarti, S., and E. Nordmark, "Neighbor Discovery Optimization for Low-power and Lossy Networks", [draft-ietf-6lowpan-nd-11](#) (work in progress), July 2010.

[I-D.narten-iana-considerations-rfc2434bis]

Narten, T. and H. Alvestrand, "Guidelines for Writing an

IANA Considerations Section in RFCs",
[draft-narten-iana-considerations-rfc2434bis-09](#) (work in progress), March 2008.

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