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JC. Zuniga
SIGFOX
C. Gomez
S. Aguilar
Universitat Politecnica de Catalunya
L. Toutain
IMT-Atlantique
S. Cespedes
D. Wistuba
NIC Labs, Universidad de Chile
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SCHC Compound ACK
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Abstract

The present document describes an extension to the SCHC (Static Header Compression and Fragmentation) protocol [[RFC8724](#)]. It defines a SCHC Compound ACK message format, which is intended to reduce the number of downlink transmissions (i.e., SCHC ACKs) by accumulating bitmaps of several windows in a single SCHC message (i.e., the SCHC Compound ACK).

The message format is generic, and can be used for instance by any the four LWPAN technologies defined in [[RFC8376](#)], being Sigfox, LoRaWAN, NB-IoT and IEEE 802.15.4w.

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[1.](#) Introduction

The Generic Framework for Static Context Header Compression and Fragmentation (SCHC) specification [[RFC8724](#)] describes two mechanisms: i) an application header compression scheme, and ii) a frame fragmentation and loss recovery functionality. Either can be used on top of radio technologies such as the four LPWAN defined in [[RFC8376](#)], being Sigfox, LoRaWAN, NB-IoT and IEEE 802.15.4w. These LPWANs have similar characteristics such as star-oriented topologies, network architecture, connected devices with built-in applications, etc.

SCHC offers a great level of flexibility to accommodate all these LPWAN technologies. Even though there are a great number of similarities between them, some differences exist with respect to the transmission characteristics, payload sizes, etc. Hence, there are optimal parameters and modes of operation that can be used when SCHC is used on top of a specific LPWAN technology.

The present document describes an extension to the SCHC protocol. It defines a SCHC Compound ACK format, which is intended to reduce the number of downlink transmissions (i.e., SCHC ACKs) in the ACK-on-Error mode of SCHC. The SCHC Compound ACK extends the SCHC ACK message format so that it can contain several bitmaps, each bitmap being identified by its corresponding window number.

The SCHC Compound ACK:

- o provides feedback only for windows with fragment losses,
- o has a variable size that depends on the number of windows with fragment losses being reported in the single Compound SCHC ACK,
- o includes the window number (i.e., W) of each bitmap,
- o has the same SCHC ACK format defined in [[RFC8724](#)] when only one window with losses is reported,
- o might not cover all windows with fragment losses of a SCHC Packet,
- o is distinguishable from the SCHC Receiver-Abort.

2. Terminology

It is assumed that the reader is familiar with the terms and mechanisms defined in [[RFC8376](#)] and in [[RFC8724](#)].

3. SCHC Compound ACK

The SCHC Compound ACK is a SCHC ACK message that can contain several bitmaps, each bitmap being identified by its corresponding window number.

When the ACK-on-Error mode is used for uplink fragmentation, SCHC Compound ACKs MAY be used in the downlink responses.

The SCHC Compound ACK groups the window number (W) with its corresponding bitmap. The included window numbers and corresponding bitmaps MUST be ordered from the lowest-numbered to the highest-numbered window.

3.1. SCHC Compound ACK Message Format

Figure 1 shows the regular SCHC ACK format when all fragments have been correctly received (C=1), as defined in [[RFC8724](#)].


```

|- SCHC ACK Header --|
+-----+---+-----+-----+
| RuleID | W | C=b'1 | b'0-pad(opt) |
+-----+---+-----+-----+

```

Figure 1: SCHC Success ACK message format, as defined in [RFC8724](#)

In case SCHC fragment losses are found in any of the windows of the SCHC Packet ($C=0$), the SCHC Compound ACK MAY be used. The SCHC Compound ACK message format is shown in Figure 2.

The window numbered 00, if present in the SCHC Compound ACK, MUST be placed between the Rule ID and the C bit to avoid confusion with padding bits. If padding is needed for the SCHC Compound ACK, padding bits MUST be 0 to make subsequent window numbers and bitmaps distinguishable.

```

|-SCHC ACK Header--| W = x |...| W = x + i |
+-----+-----+---+-----+-----+
|RuleID|W=b'x|C=b'0| Bitmap |...| W=b'x+i | Bitmap |b'0-pad(opt)|
+-----+-----+-----+-----+---+-----+-----+

```

Losses are found in windows $W = x, \dots, x+i$

Figure 2: SCHC Compound ACK message format

Each different SCHC LPWAN technology profile MUST specify how the SCHC Compound ACK is different from the Receiver-Abort message.

The SCHC Compound ACK MAY use a Compressed Bitmap, and bitmap fields MAY be of variable size.

3.2. SCHC Compound ACK Examples

Figure 3 shows an example transmission of a SCHC Packet in ACK-on-Error mode using the SCHC Compound ACK. In the example, the SCHC Packet is fragmented in 14 tiles, with $N=3$, $WINDOW_SIZE=7$, $M=2$ and two lost SCHC fragments. Only 1 compound SCHC ACK is generated.


```

Sender                                     Receiver
|-----W=0, FCN=6 ----->|
|-----W=0, FCN=5 ----->|
|-----W=0, FCN=4 ----->|
|-----W=0, FCN=3 ----->|
|-----W=0, FCN=2 --X-->|
|-----W=0, FCN=1 ----->|
|-----W=0, FCN=0 ----->| Bitmap: 1111011
(no ACK)
|-----W=1, FCN=6 ----->|
|-----W=1, FCN=5 ----->|
|-----W=1, FCN=4 ----->|
|-----W=1, FCN=3 ----->|
|-----W=1, FCN=2 ----->|
|-----W=1, FCN=1 --X-->|
|-- W=1, FCN=7 + RSC ->| Integrity check: failure
|<--- Compound ACK ----| C=0, W=0 - Bitmap:1111011, W=1 - Bitmap:
1111101
|-----W=0, FCN=2 ----->|
|-----W=1, FCN=1 ----->| Integrity check: success
|<--- ACK, W=1, C=1 ---| C=0
(End)

```

Figure 3: SCHC Compound ACK message sequence example

```

|-- SCHC ACK Header ---|- W=00 --|----- W=01 -----|
+-----+-----+-----+-----+-----+-----+
| RuleID | W=00 | C=0 | 1111011 | W=01 | 1111011 | b'0-pad (opt) |
+-----+-----+---+-----+-----+-----+-----+

```

On top are denoted the window numbers of the corresponding bitmap.
Losses are found in windows 00 and 01.

Figure 4: SCHC Compound ACK message format example

3.3. SCHC Compound ACK YANG Data Model

The present document also extends the YANG data model defined in [\[I-D.ietf-lpwan-schc-yang-data-model\]](#) by including a new leaf in the Ack-on-Error fragmentation mode to describe the option to use the SCHC Compound ACK, as well as its bitmap format. Figure 5 shows this definition:

```

// --- Bitmap format

identity bitmap-format-base-type {

```



```

        description "Define how the bitmap is defined in ACK messages.";
    }

    identity RFC8724-bitmap {
        base bitmap-format-base-type;
        description "Bitmap as defined in RFC8724.";
    }

    identity compound-ack-bitmap {
        base bitmap-format-base-type;
        description "Compound Ack.";
    }

    typedef bitmap-format-type {
        type identityref {
            base RCS-algorithm-base-type;
        }
        description "type used in rules";
    }

// -----

    choice mode {
        case no-ack;
        case ack-always;
        case ack-on-error {
            leaf tile-size {
                type uint8;
                description "size in bit of tiles, if not specified or set
to 0: tile fills the fragment.";
            }
            leaf tile-in-All1 {
                type schc:all1-data-type;
                description "When true, sender and receiver except a tile
in All-1 frag";
            }
            leaf ack-behavior {
                type schc:ack-behavior-type;
                description "Sender behavior to acknowledge, after All-0,
All-1 or when the
                LPWAN allows it (Always)";
            }
            leaf bitmap-format {
                type schc:bitmap-format-type,
                default schc:RFC8724-bitmap;
                description "how the bitmaps are included in the Ack
message.";
            }
        }
    }

```

```
}  
description "RFC 8724 defines 3 fragmentation modes";
```

Figure 5: SCHC Compound ACK YANG Data Model

4. Security considerations

The current document specifies a message format extension for SCHC. Hence, the same Security Considerations defined in [RFC8724] apply.

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Authors' Addresses

Juan Carlos Zuniga
SIGFOX
Montreal QC
Canada

Email: JuanCarlos.Zuniga@sigfox.com
URI: <http://www.sigfox.com/>

Carles Gomez
Universitat Politecnica de Catalunya
C/Esteve Terradas, 7
08860 Castelldefels
Spain

Email: carlesgo@entel.upc.edu

Sergio Aguilar
Universitat Politecnica de Catalunya
C/Esteve Terradas, 7
08860 Castelldefels
Spain

Email: sergio.aguilar.romero@upc.edu

Laurent Toutain
IMT-Atlantique
2 rue de la Chataigneraie
CS 17607
35576 Cesson-Sevigne Cedex
France

Email: Laurent.Toutain@imt-atlantique.fr

Sandra Cespedes
NIC Labs, Universidad de Chile
Av. Almte. Blanco Encalada 1975
Santiago
Chile

Email: scespedes@niclabs.cl

Diego Wistuba
NIC Labs, Universidad de Chile
Av. Almte. Blanco Encalada 1975
Santiago
Chile

Email: wistuba@niclabs.cl