draft-ietf-lpwan-schc-over-sigfox-05 & PySCHC Implementation

Juan Carlos Zúñiga (Sigfox), Carles Gómez, Sergio Aguilar (UPC), Laurent Toutain (IMT-Atlantique), Sandra Céspedes, Diego Wistuba (U Chile)
Updates

- Hackathon: Off-line coding between UChile and UPC
  - ACK-on-Error and No-ACK SCHC/Sigfox parameter optimizations
  - Error conditions tested

- Last draft updates (rev 05)
  - Added message sequence examples to explain different ACK-on-Error and No-ACK SCHC/Sigfox scenarios
  - Update co-authors’ list

- Compound SCHC ACK message proposal (see next slides)
Compound SCHC ACK - Introduction

• ACK-on-Error over Sigfox:
  • Errors in intermediate windows “may” generate at least one ACK
  • Errors in the last window generate at least 2 ACKs
  • Sigfox DL payload is fixed to 64 bits

• When errors occur over multiple windows, the number of ACKs can be reduced by reporting losses from several windows with a single ACK
Compound SCHC ACK – Principles and Advantages

• The Compound ACK:
  • Only reports windows with fragment losses
  • Includes W field for each bitmap
  • May not fit all bitmaps of all windows for a SCHC packet
  • Has variable size
  • Compatible with SCHC Receiver Abort message format and ACK Failure message format (RFC8724)

• ACK Reduction when using Compound ACK:
  • Compound ACK messages = Regular SCHC ACKs - (# of windows – 1)
Compound SCHC ACK – Message Format

- Compound ACK message format (only for ACK Failure messages) with SCHC Fragment losses in all windows:
  - W = 1
  - SCHC Packet 14 tiles
  - Window size: 7 tiles
  - Fixed, same as RFC8724
  - W + bitmap groups as windows with losses (that can be fitted)
Compound ACK – Message Format

- W + Bitmap groups are ordered from the smallest window number to the largest.
- The window numbered 00 (if present) must always be between the Rule ID and C bit to avoid confusion with padding bits.

```
[ Rule ID | W | C-0 | Bitmap | W | Bitmap | (P-0) ]
000 00 0 111101 01 111011 42 padding bits
```

W = 0
W = 1
Thanks!

Questions? Comments?
Backup slides
### Example – SCHC Packet 28 tiles

<table>
<thead>
<tr>
<th>Window size: 7 tiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 SCHC ACK Messages</td>
</tr>
</tbody>
</table>

#### SCHC Packet 28 tiles

<table>
<thead>
<tr>
<th>Sender</th>
<th>Receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>-----W=0, FCN=6------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=0, FCN=5------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=0, FCN=4------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=0, FCN=3------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=0, FCN=2-X------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=0, FCN=1------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=0, FCN=0------&gt;</td>
<td></td>
</tr>
</tbody>
</table>

\[ W = 00 \]

- DL Enable
- \[ \text{<-- ACK, W=0, C=0 -- Bitmap: 1110111} \]
- \[ W = 10 \]
- \[ 1 \]
- (no ACK)

<table>
<thead>
<tr>
<th>Sender</th>
<th>Receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>-----W=1, FCN=6------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=1, FCN=5------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=1, FCN=4------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=1, FCN=3------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=1, FCN=2------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=1, FCN=1-X------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=1, FCN=0------&gt;</td>
<td></td>
</tr>
</tbody>
</table>

\[ W = 01 \]

- DL Enable
- \[ \text{<-- ACK, W=1, C=0 -- Bitmap: 111101} \]
- \[ 2 \]
- (no ACK)

<table>
<thead>
<tr>
<th>Sender</th>
<th>Receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>-----W=2, FCN=6------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=2, FCN=5------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=2, FCN=4-X------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=2, FCN=3------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=2, FCN=2------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=2, FCN=1------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=2, FCN=0------&gt;</td>
<td></td>
</tr>
</tbody>
</table>

\[ W = 10 \]

- DL Enable
- \[ \text{<-- ACK, W=2, C=0 -- Bitmap: 1101111} \]
- \[ 3 \]
- (no ACK)

<table>
<thead>
<tr>
<th>Sender</th>
<th>Receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>-----W=3, FCN=6------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=3, FCN=5------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=3, FCN=4------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=3, FCN=3------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=3, FCN=2-X------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=3, FCN=1------&gt;</td>
<td></td>
</tr>
<tr>
<td>-----W=3, FCN=0------&gt;</td>
<td></td>
</tr>
</tbody>
</table>

\[ W = 11 \]

- DL Enable
- \[ \text{<-- ACK, W=3, C=0 -- Bitmap: 1111011} \]
- \[ 4 \]

<table>
<thead>
<tr>
<th>Sender</th>
<th>Receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>-----W=3, FCN=7------&gt;</td>
<td></td>
</tr>
</tbody>
</table>

\[ W = 11 \]

- DL Enable
- \[ \text{<-- ACK, W=3, C=1} \]
- \[ 5 \]

\[ \text{End} \]

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Example – SCHC Packet 28 tiles

Sender | Receiver
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>W=0, FCN=6-----&gt;</td>
<td>W=10</td>
</tr>
<tr>
<td>W=0, FCN=5-----&gt;</td>
<td></td>
</tr>
<tr>
<td>W=0, FCN=4-----&gt;</td>
<td></td>
</tr>
<tr>
<td>W=0, FCN=3-----&gt;</td>
<td></td>
</tr>
<tr>
<td>W=0, FCN=2-X-----&gt;</td>
<td></td>
</tr>
<tr>
<td>W=0, FCN=1-----&gt;</td>
<td></td>
</tr>
<tr>
<td>W=0, FCN=0-----&gt;</td>
<td>Bitmap: 1111011</td>
</tr>
</tbody>
</table>

(no ACK - no DL Enable)

Sender | Receiver
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>W=1, FCN=6-----&gt;</td>
<td></td>
</tr>
<tr>
<td>W=1, FCN=5-----&gt;</td>
<td></td>
</tr>
<tr>
<td>W=1, FCN=4-----&gt;</td>
<td></td>
</tr>
<tr>
<td>W=1, FCN=3-----&gt;</td>
<td></td>
</tr>
<tr>
<td>W=1, FCN=2-----&gt;</td>
<td></td>
</tr>
<tr>
<td>W=1, FCN=1-X-----&gt;</td>
<td></td>
</tr>
<tr>
<td>W=1, FCN=0-----&gt;</td>
<td>Bitmap: 1111011</td>
</tr>
</tbody>
</table>

(no ACK - no DL Enable)

SCHC Packet 28 tiles
Window size: 7 tiles
2 SCHC ACK Messages

W = 00

W = 01

ACK Reduction:
- From 5 ACKs to 2 ACKs

Retransmission
Compound ACK – SCHC Packet 28 tiles

- W + Bitmap groups for all windows with losses
- ACK Reduction
  - Number of windows of the SCHC packet: 4
  - ACK reduction: 3 ACKs
Example – SCHC Packet: 14 tiles

Window size: 7 tiles
3 SCHC ACK Messages

Sender

--- 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 ---

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 ---

W = 00

--- W=0, FCN=2 ---

(no ACK)

W = 01

--- W=1, FCN=6 ---
--- W=1, FCN=5 ---
--- W=1, FCN=4 ---
--- W=1, FCN=3 ---
--- W=1, FCN=2-X ---
--- W=1, FCN=1 ---
--- W=1, FCN=0 ---

--- W=1, FCN=7 ---

--- W=1, FCN=1 ---

--- W=1, FCN=7 ---

All fragments received

(END)

Retransmission

Sender

--- 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 ---

Receiver

--- W=1, FCN=6 ---
--- W=1, FCN=5 ---
--- W=1, FCN=4 ---
--- W=1, FCN=3 ---
--- W=1, FCN=2-X ---
--- W=1, FCN=1 ---
--- W=1, FCN=0 ---

--- W=1, FCN=7 ---

--- W=1, FCN=1 ---

--- W=1, FCN=7 ---

All fragments received

(END)
Testing Network Architecture

- PySCHC SW
- Pycom (LoPy4)
- Sigfox Network
- Google Cloud *

* [https://cloud.google.com/community/tutorials/sigfox-gw](https://cloud.google.com/community/tutorials/sigfox-gw)