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SCHC over Sigfox LPWAN
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Abstract

The Static Context Header Compression (SCHC) specification describes a header compression scheme and a fragmentation functionality for Low Power Wide Area Network (LPWAN) technologies. SCHC offers a great level of flexibility that can be tailored for different LPWAN technologies.

The present document provides the optimal parameters and modes of operation when SCHC is implemented over a Sigfox LPWAN.

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[1.](#) Introduction

The Static Context Header Compression (SCHC) specification [[I-D.ietf-lpwan-ipv6-static-context-hc](#)] defines a header compression scheme and a fragmentation functionality. Both can be used on top of all the LPWAN systems defined in [[RFC8376](#)]. These LPWAN systems 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 systems. Even though there are a great number of similarities between LPWAN technologies, 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.

This document describes the optimal parameters and modes of operation when SCHC is implemented over a Sigfox LPWAN.

2. Terminology

The reader is assumed to be familiar with the terms and mechanisms defined in [\[RFC8376\]](#) and in [\[I-D.ietf-lpwan-ipv6-static-context-hc\]](#).

3. Static Context Header Compression

Static Context Header Compression (SCHC) avoids context synchronization because data flows are highly predictable in LPWAN networks. Contexts must be stored and configured on both ends. This can be done either by using a provisioning protocol, by out of band means, or by pre-provisioning them for instance at manufacturing time. The way the contexts are configured and stored on both ends is out of the scope of this document.

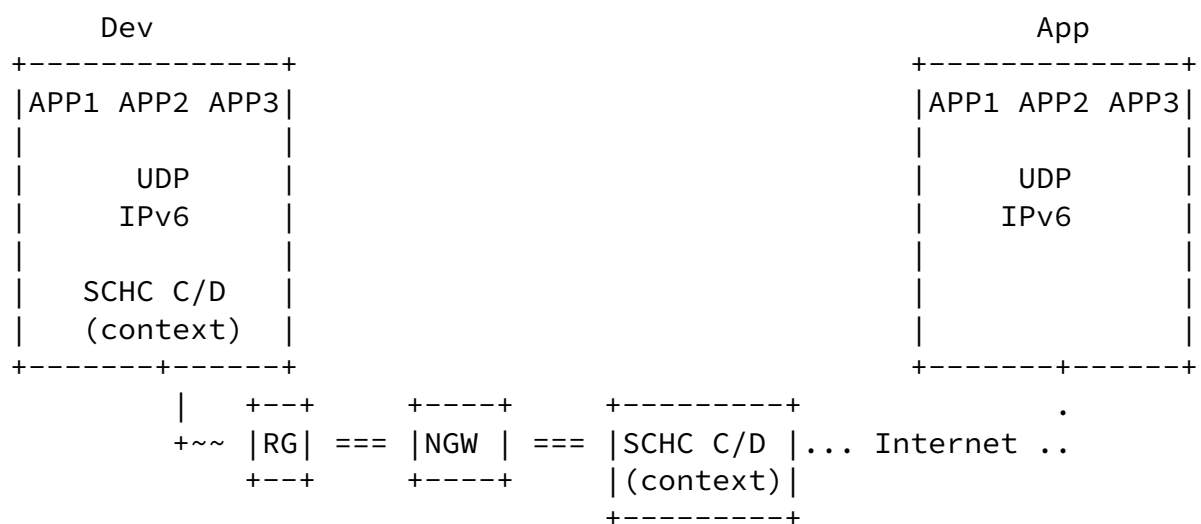


Figure 1: Architecture

Figure 1 represents the architecture for compression/decompression and fragmentation, which is based on [\[RFC8376\]](#) terminology.

The Device is sending applications flows that are compressed (and/or

fragmented) by a Static Context Header Compression Compressor/Decompressor (SCHC C/D) to reduce headers size and/or fragment the packet. The resulting information is sent over a layer two (L2) frame to a LPWAN Radio Gateway (RG) which forwards the frame to a Network Gateway (NGW).

[4.](#) SCHC over Sigfox

In the case of the global Sigfox network, RGs (or base stations) are distributed over the multiple countries where the Sigfox LPWAN service is provided. On the other hand, the NGW (or Cloud-based Core

network) is a single entity that connects to all Sigfox base stations in the world.

Uplink transmissions occur in repetitions over different times and frequencies. Besides these time and frequency diversities, the Sigfox network also provides space diversity, as potentially an uplink message will be received by several base stations. Since all messages are self-contained and base stations forward them all back to the same Core network (NGW), multiple input copies can be combined at the NGW and hence provide for extra reliability based on the triple diversity (i.e. time, space and frequency).

The NGW communicates with the Network SCHC C/D for compression/decompression and/or for fragmentation/reassembly. The Network SCHC C/D shares the same set of rules as the Dev SCHC C/D. The Network SCHC C/D can be collocated with the NGW or it could be in another place, as long as a tunnel is established between the NGW and the SCHC C/D. After decompression and/or reassembly, the packet can be forwarded over the Internet to one (or several) LPWAN Application Server(s) (App).

The SCHC C/D process is bidirectional, so the same principles can be applied on both uplink and downlink.

[4.1.](#) SCHC Rules

The RuleID MUST be sent at the beginning of the SCHC header. The total number of rules to be used affects directly the Rule ID field size, and therefore the total size of the fragmentation header. For

this reason, it is recommended to keep the number of rules that are defined for a specific device to the minimum possible.

[4.2.](#) Packet processing

TBD

[5.](#) Fragmentation

The SCHC specification [[I-D.ietf-lpwan-ipv6-static-context-hc](#)] defines a generic fragmentation functionality that allows sending data packets larger than the maximum size of a Sigfox data frame. The functionality also defines a mechanism to send reliably multiple frames, by allowing to resend selectively any lost frames.

The SCHC fragmentation supports several modes of operation. These modes have different advantages and disadvantages depending on the specifics of the underlying LPWAN technology and Use Case. This section describes how the SCHC fragmentation functionality should

optimally be implemented when used over a Sigfox LPWAN for the most typical use case applications.

[5.1.](#) Fragmentation headers

A list of fragmentation header fields, their sizes as well as recommended modes for SCHC fragmentation over Sigfox are provided in this section.

[5.2.](#) Uplink fragment transmissions

Uplink transmissions are completely asynchronous and can take place in any random frequency of the allowed uplink bandwidth allocation. Hence, devices can go to deep sleep mode, and then wake up and transmit whenever there is a need to send any information to the network. In that way, there is no need to perform any network attachment, synchronization, or other procedure before transmitting a data packet. All data packets are self contained with all the required information for the network to process them accordingly.

Since uplink transmissions occur asynchronously, an SCHC fragment can be transmitted at any given time by the Dev.

[5.2.1.](#) Uplink No-ACK mode

No-ACK is RECOMMENDED to be used for transmitting short, non-critical packets that require fragmentation.

The recommended Fragmentation Header size is 8 bits, and it is composed as follows:

The recommended Rule ID size is: 3 bits

The recommended DTag size (T) is: 0 bits, as the number of available Rule IDs are sufficient to interleave fragmented packets.

Fragment Compressed Number (FCN) size (N): 4 bits

As per [[I-D.ietf-lpwan-ipv6-static-context-hc](#)], in the No-ACK mode the W (window) 1-bit field is not present.

When fragmentation is used to transport IP frames, the Message Integrity Check (MIC) size, M: TBD bits

The algorithm for computing the MIC field MUST be TBD.

[5.2.2.](#) Uplink ACK-Always mode

TBD

[5.2.3.](#) Uplink ACK-on-Error mode

ACK-on-Error is RECOMMENDED for larger packets that need to be sent reliably, since it leads to a reduced number of ACKs in the lower capacity downlink channel.

In a generic case, the recommended Fragmentation Header size is 8 bits and it is composed as follows:

The recommended Rule ID size is: 2 bits.

The recommended DTag size (T) is: 1 bit.

The recommended Window (W) size is: 2 bits.

Fragment Compressed Number (FCN) size (N): 3 bits.

For the ACK-on-Error fragmentation mode(s), a single window size is RECOMMENDED.

The value of MAX_ACK_REQUESTS SHOULD be 2, and the value of MAX_WIND_FCN SHOULD be 6 (or 0b110, which allows a maximum window size of 7 fragments).

When fragmentation is used to transport IP frames, the Message Integrity Check (MIC) size, M: TBD bits

The algorithm for computing the MIC field MUST be TBD.

[5.3.](#) Downlink fragment transmissions

In some LPWAN technologies, as part of energy-saving techniques, downlink transmission is only possible immediately after an uplink transmission. This allows the device to go in a very deep sleep mode and preserve battery, without the need to listen to any information from the network. This is the case for Sigfox-enabled devices, which can only listen to downlink communications after performing an uplink transmission and requesting a downlink.

When there are fragments to be transmitted in the downlink, an uplink message is required to trigger the downlink communication. In order to avoid potentially high delay for fragmented datagram transmission in the downlink, the fragment receiver MAY perform an uplink transmission as soon as possible after reception of a downlink

fragment that is not the last one. Such uplink transmission MAY be triggered by sending a SCHC message, such as an ACK. In this sense, ACK-Always is the preferred fragmentation mode for downlink communications.

For downlink fragment transmission, the ACK-Always mode is RECOMMENDED.

The recommended Fragmentation Header size is: 8 bits

The recommended Rule ID size is: 3 bits.

The recommended DTag size (T) is: 0 bits, as the number of available Rule IDs are sufficient to interleave fragmented packets.

Fragment Compressed Number (FCN) size (N): 4 bits.

As per [[I-D.ietf-lpwan-ipv6-static-context-hc](#)], in the ACK-Always mode a Window (W) 1-bit field must be present.

For the ACK-Always fragmentation mode(s), a single window size is RECOMMENDED.

The value of MAX_ACK_REQUESTS SHOULD be 2, and the value of MAX_WIND_FCN SHOULD be 14 (which allows a maximum window size with 15 fragments).

When fragmentation is used to transport IP frames, the Message Integrity Check (MIC) size, M: TBD bits

The algorithm for computing the MIC field MUST be TBD.

Sigfox downlink frames have a fixed length of 8 bytes, which means that default SCHC algorithm for padding cannot be used. Therefore, the 3 last bits of the fragmentation header are used to indicate in bytes the size of the padding. A size of 000 means that the full remaining frame is used to carry payload, a value of 001 indicates that the last byte contains padding, and so on.

[6.](#) Padding

The Sigfox payload fields have different characteristics in uplink and downlink.

Uplink frames can contain a payload from 0 to 96 bits (i.e. 12 bytes). The radio protocol allows sending zero bits or one single bit of information for binary applications (e.g. status). However, for 2 or more bits of payload it is required to add padding to the

next integer number of bytes. The reason for this flexibility is to

optimize transmission time and hence save battery consumption at the device.

Downlink frames on the other hand have a fixed length. The payload length must be 64 bits (i.e. 8 bytes). Hence, if less information bits are to be transmitted padding would be necessary and it should be performed as described in the previous section.

7. Security considerations

The radio protocol authenticates and ensures the integrity of each message. This is achieved by using a unique device ID and an AES-128 based message authentication code, ensuring that the message has been generated and sent by the device with the ID claimed in the message.

Application data can be encrypted at the application level or not, depending on the criticality of the use case, to provide a balance between cost and effort vs. risk. AES-128 in counter mode is used for encryption. Cryptographic keys are independent for each device. These keys are associated with the device ID and separate integrity and confidentiality keys are pre-provisioned. A confidentiality key is only provisioned if confidentiality is to be used.

The radio protocol has protections against reply attacks, and the cloud-based core network provides firewalling protection against undesired incoming communications.

8. Acknowledgements

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9. Informative References

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