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L-E. Jonsson
Ericsson
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RObust Header Compression (ROHC):
Terminology and Channel Mapping Examples

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Abstract

This document aims to clarify terms and concepts presented in RFC 3095. RFC 3095 defines a Proposed Standard framework with profiles for RObust Header Compression (ROHC). The standard introduces various concepts which might be difficult to understand and especially to relate correctly to the surrounding environments where header compression may be used. This document aims at clarifying these aspects of ROHC, discussing terms such as ROHC instances, ROHC channels, ROHC feedback, and ROHC contexts, and how these terms relate to other terms, like network elements and IP interfaces, commonly used, for example, when addressing MIB issues.

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1. Introduction

In RFC 3095, the RObust Header Compression (ROHC) standard framework is defined, along with 4 compression profiles [RFC-3095]. Various concepts are introduced within the standard that are not all very extensively defined and described, which can easily be an obstacle when trying to understand the standard. This can especially be the case when one considers how the various parts of ROHC relate to the surrounding environments where header compression may be used.

The purpose of this document is to clarify these aspects of ROHC through examples and additional terminology, discussing terms such as ROHC instances, ROHC channels, ROHC feedback, and ROHC contexts. This especially means to clarify how these terms relate to other terms, such as network elements and IP interfaces, which are commonly used for example when addressing MIB issues. One explicit goal of this document is to support and simplify the ROHC MIB development work.

The main part of this document, sections 3 to 8, focuses on clarifying the conceptual aspects, entity relationships, and terminology of ROHC [RFC-3095]. Section 9 explains some implementation implications that arise from these conceptual aspects.

2. Terminology

ROHC instance

A logical entity that performs header compression or decompression according to one or several ROHC profiles can be referred to as a ROHC instance. A ROHC instance is either a ROHC compressor instance or a ROHC decompressor instance. See section 4.

ROHC compressor instance

A ROHC compressor instance is a logical entity that performs header compression according to one or several ROHC profiles. There is a one-to-one relation between a ROHC compressor instance and a ROHC channel, where the ROHC compressor is located at the input end of the ROHC channel. See section 4.1.

ROHC decompressor instance

A ROHC decompressor instance is a logical entity that performs header decompression according to one or several ROHC profiles. There is a one-to-one relation between a ROHC decompressor instance and a ROHC channel, where the ROHC decompressor is located at the output end of the ROHC channel. See section 4.2.

Corresponding decompressor

When talking about a compressor's corresponding decompressor, this refers to the peer decompressor located at the other end of the ROHC channel to which the compressor sends compressed header packets, i.e., the decompressor that decompresses the headers compressed by the compressor.

Corresponding compressor

When talking about a decompressor's corresponding compressor, this refers to the peer compressor located at the other end of the ROHC channel from which the decompressor receives compressed header packets, i.e., the compressor that compresses the headers the decompressor decompresses.

ROHC peers

A ROHC compressor and its corresponding ROHC decompressor are referred to as ROHC peers.

Link

A communication path between two network entities is, in this document, generally referred to as a link.

Bi-directional compression

If there are means to send feedback information from a decompressor to its corresponding compressor, the compression performance can be improved. This way of operating, utilizing the feedback possibility for improved compression performance, is referred to as bi-directional compression.

Unidirectional compression

If there are no means to send feedback information from a decompressor to its corresponding compressor, the compression performance might not be as good as if feedback could be utilized. This way of operating, without making use of feedback for improved compression performance, is referred to as unidirectional compression.

ROHC channel

When a ROHC compressor has transformed original packets into ROHC packets with compressed headers, these ROHC packets are sent to the corresponding decompressor through a logical point-to-point connection dedicated to that traffic. Such a logical channel, which only has to carry data in this single direction from compressor to decompressor, is referred to as a ROHC channel. See section 5.

ROHC feedback channel

To allow bi-directional compression operation, a logical point-to-point connection must be provided for feedback data from the decompressor to its corresponding compressor. Such a logical channel, which only has to carry data in the single direction from decompressor to compressor, is referred to as a ROHC feedback channel. See section 6.

Co-located compressor/decompressor

A minimal ROHC instance is only a compressor or a decompressor, communicating with a corresponding decompressor or compressor peer at the other end of a ROHC channel, thus handling packet streams sent in one direction over the link. However, in many cases, the link will carry packet streams in both directions, and it would then be desirable to also perform header compression in both directions. That would require both a ROHC compressor and a ROHC decompressor at each end of the link, each referred to as a co-located compressor/decompressor pair.

Associated compressor/decompressor

If there is a co-located ROHC compressor/decompressor pair at each end of a link, feedback messages can be transmitted from a ROHC decompressor to its corresponding compressor by creating a virtual ROHC feedback channel among the compressed header packets sent from the co-located ROHC compressor to the decompressor co-located with the compressor at the other end. When a co-located ROHC compressor/decompressor pair is connected for this purpose, they are said to be associated with each other.

Interspersed feedback

Feedback from a ROHC decompressor to a ROHC compressor can either be sent on a separate ROHC feedback channel dedicated to feedback packets, or sent among compressed header packets going in the opposite direction from a co-located (associated) compressor to a similarly co-located decompressor at the other end of the link. If feedback packets are transmitted in the latter way and sent as stand-alone packets, this is referred to as interspersed feedback. See section 6.2 for an example.

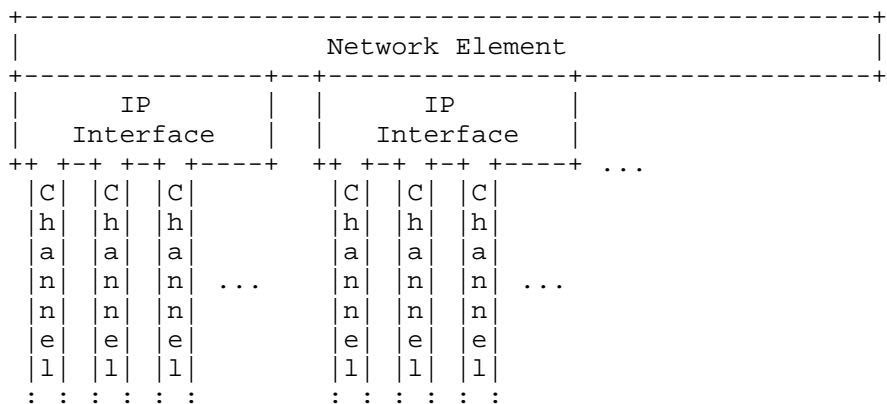
Piggybacked feedback

Feedback from a ROHC decompressor to a ROHC compressor can either be sent on a separate ROHC feedback channel dedicated to feedback packets, or sent among compressed header packets going in the opposite direction from a co-located (associated) compressor to a similarly co-located decompressor at the other end of the link. If feedback packets are transmitted in the latter way and sent encapsulated within compressed header packets going in the other direction, this is referred to as piggybacked feedback. See section 6.2 for an example.

3.2. Channels

As mentioned in the previous section, an IP interface can be implemented on top of almost any link technology, although different link technologies have different characteristics, and provide communication by different means. However, all link technologies provide the common capability to send and/or receive data to/from the IP interface. A generic way of visualizing the common ability to communicate is to envision it as one or several logical communication channels provided by the link, where each channel can be either bi-directional or unidirectional. Such logical point-to-point connections will, throughout the rest of this document, be referred to as "channels", either bi-directional or unidirectional. Note that this definition of "channels" is less restrictive than the definition of "ROHC channels", as given in section 5.

Extending the above network element hierarchy with the concept of channels would then lead to the following:



Whether there is more than one channel, and whether the channel(s) is/are bi-directional or unidirectional (or a mix of both) is link technology dependent, as is the way in which channels are logically created.

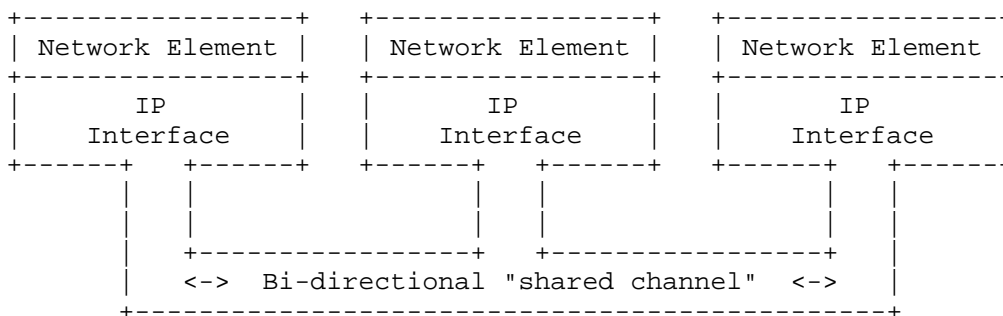
The following subsections, 3.3-3.6, give a number of different link examples, and relate these to the general descriptions above. Further, each section discusses how header compression might be applied in that particular case. The core questions for header compression are:

- Are channels bi- or unidirectional?
- Is the link point-to-point? If not, a lower layer addressing scheme is needed to create logical point-to-point channels.

A typical example of a point-to-point link with such a bi-directional channel is a PPP modem connection over a regular telephone line. Header compression can easily be applied here as well, as is usually done over e.g., PPP, and the compression scheme can make use of the return path to improve compression performance.

3.5. A Bi-directional Multipoint Link Example

Leaving the simple point-to-point link examples, this section addresses the case of a bi-directional link connecting more than two communicating network elements. To simplify the example, the case with three endpoints is considered.

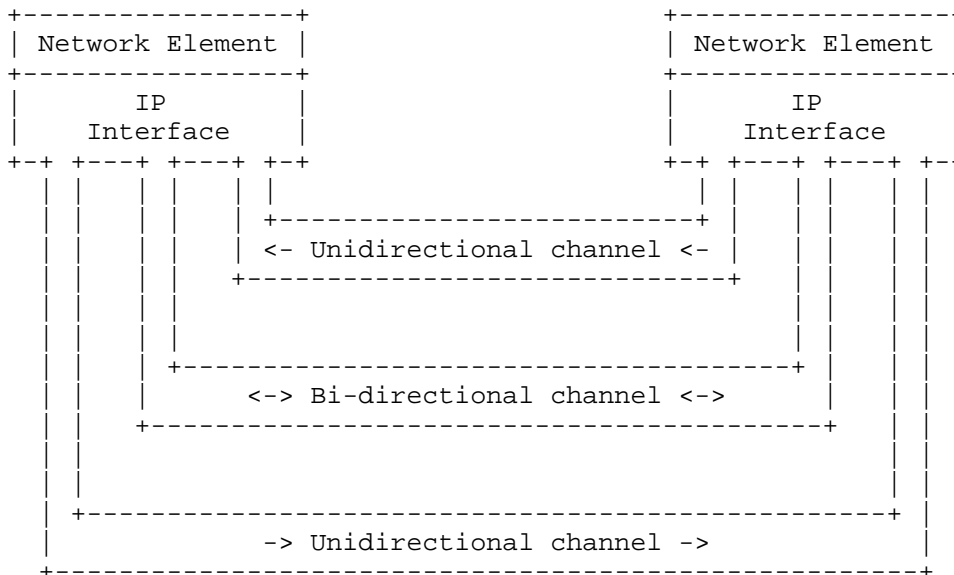


A typical example of a multipoint link with such a bi-directional "shared channel" is an Ethernet. Since the channel is shared, applying header compression would require a lower layer addressing scheme to provide logical point-to-point channels, according to the definition of "channels".

As an aside, it should be noted that a case of unidirectional multipoint links is basically the same as a number of unidirectional point-to-point links. In such a case, each receiver only sees one single sender, and the sender's behavior is independent of the number of receivers and is unaffected by their behavior.

3.6. A Multi-Channel Point-to-Point Link Example

This final example addresses a scenario which is expected to be typical in many environments where ROHC will be applied. The key point of the example is the multi-channel property, which is common in, for example, cellular environments. Data through the same IP interface might here be transmitted on different channels, depending on its characteristics. In the following example, there are three channels present, one bi-directional, and one unidirectional in each direction, but the channel configuration could of course be arbitrary.

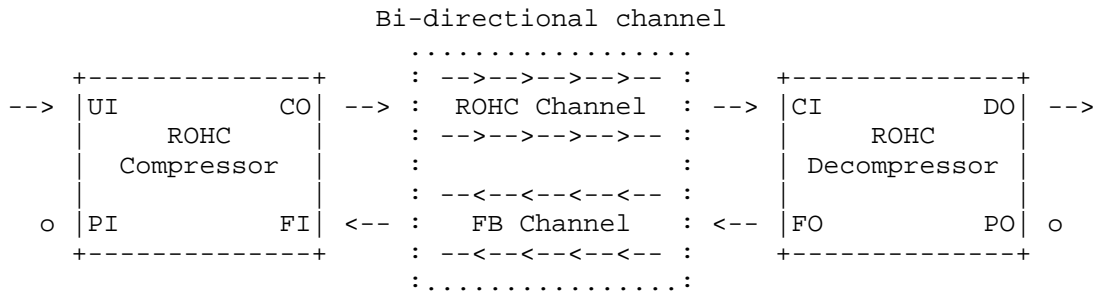


As mentioned above, a typical example of a multi-channel link is a cellular wireless link. In this example, header compression would be applicable on a per-channel basis, for each channel operating either in a bi-directional or unidirectional manner, depending on the channel properties.

4. ROHC Instances

For various purposes, such as network management on an IP interface implementing ROHC, it is necessary to identify the various ROHC entities that might be present on an interface. Such a minimal ROHC entity will, from now on, be referred to as a "ROHC instance". A ROHC instance can be one of two different types, either a "ROHC compressor" or a "ROHC decompressor" instance, and an IP interface can have N ROHC compressors and M ROHC decompressors, where N and M are arbitrary numbers. It should be noted that although a compressor is often co-located with a decompressor, a ROHC instance can never include both a compressor and a decompressor; where both are present, they will be referred to as two ROHC instances.

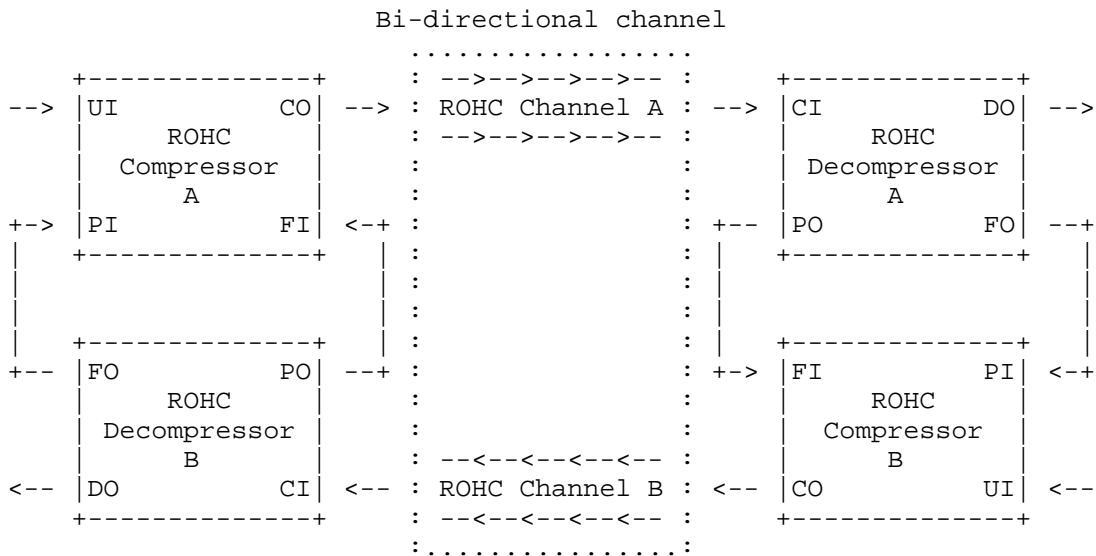
The following two subsections describe the two kinds of ROHC instances and their external interfaces, while sections 5 and 6 address how communication over these interfaces is realized through "ROHC channels" and "ROHC feedback channels". Section 7 builds on top of the instance, channel and feedback channel concepts, and clarifies how ROHC contexts map to this.



In this example, feedback is sent on its own dedicated channel, as discussed in e.g., feedback realization example 1-3 of ROHC [RFC-3095, page 44]. This means that the piggybacking/interspersion mechanism of ROHC is not used, and the PI/PO connections are thus left open (marked with a "o"). To facilitate communication with ROHC compression in a two-way manner using this approach, an identical configuration must be provided for the other direction, i.e., making use of four logical unidirectional channels.

6.2. Piggybacked/Interspersed ROHC Feedback Channel Example

This section illustrates how a bi-directional channel has been configured to represent one ROHC channel in each direction, while still allowing feedback to be transmitted through ROHC piggybacking and interspersing.

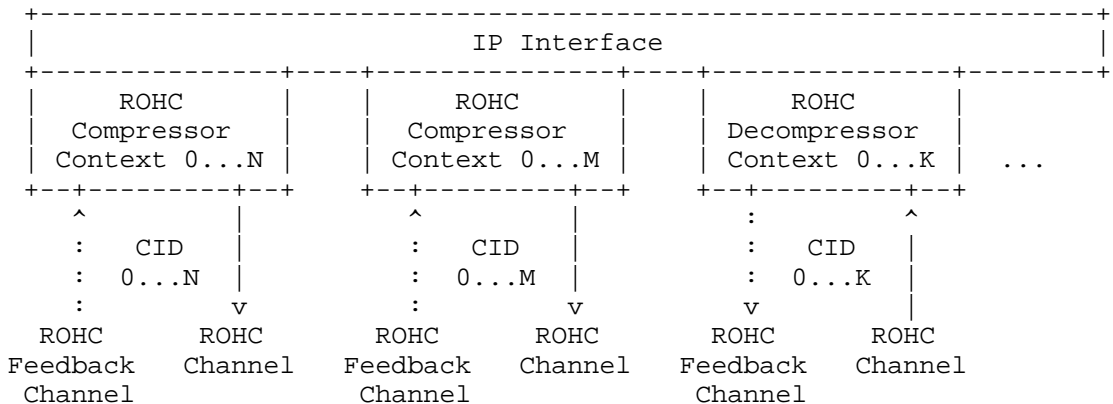


be noted that in this picture FI/PI and PO/FO at the A-instances have been swapped to simplify drawing, while the B-instances have been horizontally mirrored.

7. ROHC Contexts

In previous sections, it has been clarified that one network element may have multiple IP interfaces, one IP interface may have multiple ROHC instances running (not necessarily both compressors and decompressors), and for each ROHC instance, there is exactly one ROHC channel and optionally one ROHC feedback channel. How ROHC channels and ROHC feedback channels are realized will differ from case to case, depending on the actual layer two technology used.

Each compressor/decompressor can further compress/decompress an arbitrary (but limited) number of concurrent packet streams sent over the ROHC channel connected to that compressor/decompressor. Each packet stream relates to one particular context in the compressor/decompressor. When sent over the ROHC channel, compressed packets are labeled with a context identifier (CID), indicating to which context the compressed packet corresponds. There is thus a one-to-one mapping between the number of contexts that can be present in a compressor/decompressor and the context identifier (CID) space used in compressed packets over that ROHC channel. This is illustrated by the following figure:



It should be noted that each ROHC instance at an IP interface therefore has its own context and CID space, and it must be ensured that the CID size of the corresponding decompressor at the other end of the ROHC channel is not smaller than the CID space of the compressor.

8. Summary

This document has introduced and defined a number of concepts and terms for use in ROHC network integration, and explained how the various pieces relate to each other. In the following bullet list, the most important relationship conclusions are repeated:

- A network element may have one or several IP interfaces.
- Each IP interface is connected to one or several logical layer two channels.
- Each IP interface may have one or several ROHC instances, either compressors, decompressors, or an arbitrary mix of both.
- For each ROHC instance, there is exactly one ROHC channel, and optionally exactly one ROHC feedback channel.
- How ROHC channels and ROHC feedback channels are realized through the available logical layer two channels will vary, and there is therefore no general relation between ROHC instances and logical layer two channels. ROHC instances map only to ROHC channels and ROHC feedback channels.
- Each compressor owns its own context identifier (CID) space, which is the multiplexing mechanism it uses when sending compressed header packets to its corresponding decompressor. That CID space thus defines how many compressed packet streams can be concurrently sent over the ROHC channel allocated to the compressor/decompressor peers.

9. Implementation Implications

This section will address how the conceptual aspects discussed above affect implementations of ROHC.

ROHC is defined as a general header compression framework on top of which compression profiles can be defined for each specific set of headers to compress. Although the framework holds a number of important mechanisms, the separation between framework and profiles is mainly a separation from a standardization point of view, to indicate what must be common to all profiles, what must be defined by all profiles, and what are profile-specific details. To implement the framework as a separate module is thus not an obvious choice, especially if one wants to use profile implementations from different vendors. However, optimized implementations will probably separate the common parts and implement those in a ROHC framework module, and add profile modules to that.

A ROHC instance might thus consist of various pieces of implementation modules, profiles, and potentially also a common ROHC module, possibly from different vendors. If vendor and implementation version information is made available for network management purposes, this should thus be done on a per-profile basis, and potentially also for the instance as a whole.

10. Security Considerations

The clear understanding of ROHC channels and their relations to IP interfaces and the physical medium, plays a critical role in ensuring secure usage of ROHC. This document is therefore a valuable adjunct to the Security Considerations found in RFC 3095 and other ROHC specifications. However, as it just reviews information and definitions, it does not add new security issues to the ROHC protocol specifications.

11. Acknowledgements

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12. Informative References

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13. Author's Address

Lars-Erik Jonsson
Ericsson AB
Box 920
SE-971 28 Lulea
Sweden

Phone: +46 920 20 21 07
Fax: +46 920 20 20 99
EMail: lars-erik.jonsson@ericsson.com

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