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Robust Header Compression (ROHC) over PPP

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Abstract

This document describes an option for negotiating the use of robust header compression (ROHC) on IP datagrams transmitted over the Point-to-Point Protocol (PPP). It defines extensions to the PPP Control Protocols for IPv4 and IPv6.

1. Introduction

Robust Header Compression (ROHC) as defined in [RFC3095] may be used for compression of both IPv4 and IPv6 datagrams or packets encapsulated with multiple IP headers. The initial version of ROHC focuses on compression of the packet headers in RTP streams, while supporting compression of other UDP flows; however, it also defines a framework into which further header compression mechanisms can be plugged as new profiles. Planned additions to the set of profiles supported by ROHC will be capable of compressing TCP transport protocol headers as well.

In order to establish compression of IP datagrams sent over a PPP link each end of the link must agree on a set of configuration parameters for the compression. The process of negotiating link parameters for network layer protocols is handled in PPP by a family of network control protocols (NCPs). Since there are separate NCPs for IPv4 and IPv6, this document defines configuration options to be used in both NCPs to negotiate parameters for the compression scheme.

ROHC does not require that the link layer be able to indicate the types of datagrams carried in the link layer frames. However, there are two basic types of ROHC headers defined in the ROHC framework: small-CID headers (zero or one bytes are used to identify the compression context) and large-CID headers (one or two bytes are used for this purpose). To keep the PPP packets self-describing, in this document two new types for the PPP Data Link Layer Protocol Field are defined, one for small-CID ROHC packets and one for large-CID ROHC packets. (This also avoids a problem that would occur if PPP were to negotiate which of the formats to use in each of IPCP and IPV6CP and the two negotiation processes were to arrive at different results.) A PPP ROHC sender may send packets in either small-CID or large-CID format at any time, i.e., the LARGE_CIDS parameter from [RFC3095] is not used. Any PPP ROHC receiver MUST be able to process both small-CID and large-CID ROHC packets, therefore no negotiation of this function is required.

ROHC assumes that the link layer delivers packets in sequence. PPP normally does not reorder packets. When using reordering mechanisms such as multiclass multilink PPP [RFC2686], care must be taken so that packets that share the same compression context are not reordered. (Note that in certain cases, reordering may be acceptable to ROHC, such as within a sequence of packets that all do not change the decompression context.)

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119.

2. Configuration Option

This document specifies a new compression protocol value for the IPCP IP-Compression-Protocol option as specified in [RFC1332]. The new value and the associated option format are described in section 2.1.

The option format is structured to allow future extensions to the ROHC scheme.

It may be worth repeating [RFC1332], section 4: "The IP-Compression-Protocol Configuration Option is used to indicate the ability to receive compressed packets. Each end of the link must separately request this option if bi-directional compression is desired." I.e., the option describes the capabilities of the decompressor (receiving side) of the peer that sends the Configure-Request.

NOTE: The specification of link and network layer parameter negotiation for PPP [RFC1661], [RFC1331], [RFC1332] does not prohibit multiple instances of one configuration option but states that the specification of a configuration option must explicitly allow multiple instances. From the current specification of the IPCP IP-Compression-Protocol configuration option [RFC1332] one can infer that it can only be used to select a single compression protocol at any time.

This was appropriate at a time when only one header compression scheme existed. With the advent of IP header compression [RFC2507, RFC2509], this did not really change, as RFC 2507 essentially superseded RFC 1144. However, with ROHC, it may now very well be desirable to use RFC 2507 TCP compression in conjunction with RFC 3095 RTP/UDP compression.

The present document now updates RFC 1332 by explicitly allowing the sending of multiple instances of the IP-Compression-Protocol configuration option, each with a different value for IP-Compression-Protocol. Each type of compression protocol may independently establish its own parameters.

This change is believed to not cause significant harm in existing PPP implementations, as they would most likely Configure-Nak or Configure-Reject the duplicate option, or simply happen to accept the one option they understand. To aid interoperability, the peer implementing the present specification SHOULD react to a Configure-Nak or Configure-Reject by reducing the number of options offered to one.

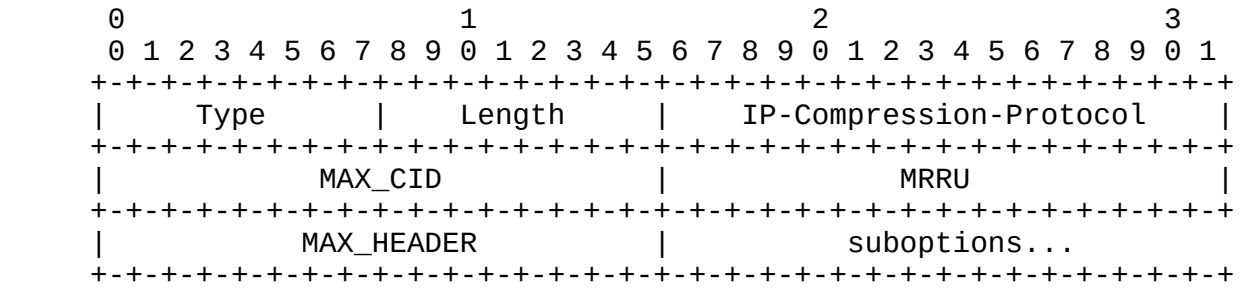
2.1. Configuration Option Format

Both the network control protocol for IPv4, IPCP [RFC1332] and the IPv6 NCP, IPV6CP [RFC2472] may be used to negotiate IP Header Compression parameters for their respective protocols. The format of the configuration option is the same for both IPCP and IPV6CP.

Description

This NCP configuration option is used to negotiate parameters for Robust Header Compression. The option format is summarized below. The fields are transmitted from left to right.

Figure 1: Robust Header Compression (ROHC) Option



Type
2

Length
>= 10

The length may be increased if the presence of additional parameters is indicated by additional suboptions.

IP-Compression-Protocol
0003 (hex)

MAX_CID
The MAX_CID field is two octets and indicates the maximum value of a context identifier.

Suggested value: 15

MAX_CID must be at least 0 and at most 16383 (The value 0 implies having one context).

MRRU
The MRRU field is two octets and indicates the maximum reconstructed reception unit (see [RFC3095], section 5.1.1).

Suggested value: 0

MAX_HEADER
The largest header size in octets that may be compressed.

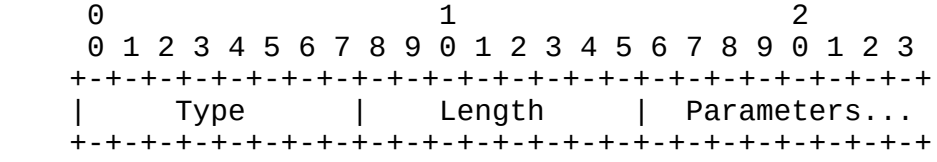
Suggested value: 168 octets

The value of MAX_HEADER should be large enough so that at least the outer network layer header can be compressed. To increase compression efficiency MAX_HEADER should be set to a value large enough to cover common combinations of network and transport layer headers.

NOTE: The four ROHC profiles defined in RFC 3095 do not provide for a MAX_HEADER parameter. The parameter MAX_HEADER defined by this document is therefore without consequence in these profiles. Other profiles (e.g., ones based on RFC 2507) can make use of the parameter by explicitly referencing it.

suboptions
The suboptions field consists of zero or more suboptions. Each suboption consists of a type field, a length field and zero or more parameter octets, as defined by the suboption type. The value of the length field indicates the length of the suboption in its entirety, including the lengths of the type and length fields.

Figure 2: Suboption



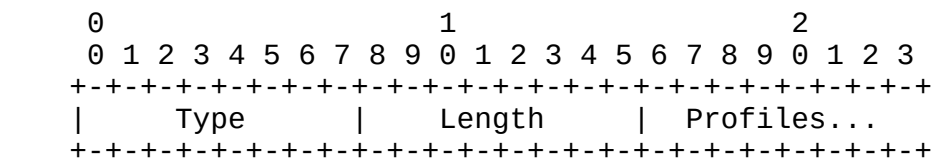
2.2. PROFILES Suboption

The set of profiles to be enabled is subject to negotiation. Most initial implementations of ROHC implement profiles 0x0000 to 0x0003. This option MUST be supplied.

Description

Define the set of profiles supported by the decompressor.

Figure 3: PROFILES suboption



Type
1

Length
2n+2

Value
n octet-pairs in ascending order, each octet-pair specifying a ROHC profile supported.

3. Multiple Network Control Protocols

The ROHC protocol is able to compress both IPv6 and IPv4 datagrams. Both IPCP and IPV6CP are able to negotiate option parameter values for ROHC. The ROHC capability negotiated as a whole applies to the compression of packets where the outer header is an IPv4 header and an IPv6 header, respectively; e.g., an outer IPv6 header MUST NOT be sent if the ROHC IP-Compression-Protocol option was not negotiated for IPV6CP.

Offering a specific ROHC capability in a Configure-Request in either IPCP or IPV6CP indicates that the capability is provided for the entire ROHC channel formed by the PPP link. When the option has been negotiated with different values in IPCP and IPV6CP, the result is that the set of parameter values for the entire ROHC channel is the logical union of the two values, i.e., the maximum for MAX_CID, MRRU or MAX_HEADER, and the logical union of the suboptions. For the PROFILES suboption, the logical union is the union of the two sets of profiles. The unified values are kept as valid parameter values for the ROHC channel even when either of the NCPs is taken down.

Note that each new suboption for this option must define the meaning of "logical union", if the concept applies.

3.1. Sharing Context Identifier Space

For the compression and decompression of IPv4 and IPv6 datagram headers, the context identifier space is shared. While the parameter values are independently negotiated, sharing the context identifier spaces becomes more complex when the parameter values differ. Since the compressed packets share context identifier space, the compression engine must allocate context identifiers out of a common pool; for compressed packets, the decompressor has to examine the context state to determine what parameters to use for decompression.

In particular, the context identifier space is shared between ROHC small-CID packets and ROHC large-CID packets. From the point of view of the ROHC framework, the PPP NCP instances for IPCP and IPV6CP together constitute exactly one ROHC channel; its feedback is destined for the ROHC channel defined by the NCP instances for IPCP and IPV6CP in the reverse direction on the same PPP link.

In particular, this means that taking down either of the NCPs while the other is still open means that the contexts of the channel stay active. To avoid race conditions, the same is true if both NCPs are taken down and then one or more is reopened. Taking down LCP destroys the channel, however; reopening LCP and then one or more of IPCP and IPV6CP restarts ROHC with all contexts in no-context state.

4. Demultiplexing of Datagrams

The ROHC specification [RFC3095] defines a single header format for all different types of compressed headers, with a variant for small CIDs and a variant for large CIDs. Two PPP Data Link Layer Protocol Field values are specified below.

ROHC small-CIDs

The frame contains a ROHC packet with small CIDs as defined in [RFC3095].

Value: 0003 (hex)

ROHC large-CIDs

The frame contains a ROHC packet with large CIDs as defined in [RFC3095].

Value: 0005 (hex)

Note that this implies that all CIDs within one ROHC packet MUST be of the same size as indicated by the Data Link Layer Protocol field, either small or large. In particular, embedded feedback MUST have a CID of the same size as indicated by the Protocol field value. For piggybacking feedback, a compressor must be able to control the feedback CID size used by the associated decompressor, ensure that all CIDs are of the same size, and indicate this size with the appropriate Protocol Field value.

To make CID interpretation unambiguous when ROHC segmentation is used, all packets that contribute to a segment MUST be sent with the same Data Link Layer Protocol Field value, either 0003 or 0005, which then also applies to the CID size in the reconstructed unit. A unit reconstructed out of packets with Protocol field values that differ MUST be discarded.

5. ROHC Usage Considerations

Certain considerations are required for any ROHC-over-X protocol. This section describes how some of these are handled for ROHC over PPP.

5.1. Uncompressed profile

There is no need for the ROHC uncompressed profile in ROHC over PPP, as uncompressed packets can always be sent using the PPP protocol demultiplexing method. Therefore, no consideration was given to locking down one of the context numbers for the uncompressed profile (see [RFC3095] section 5.1.2). Note, however, that according to the ROHC specification, profile 0x0000 must not be rejected [RFC3095], so it MUST be implemented by all receivers.

5.2. Parameter selection

For each of the ROHC channel parameters MAX_CID and MRRU, the value is the maximum of the respective values negotiated for the IPCP and IPv6CP instances, if any. The ROHC channel parameter FEEDBACK_FOR is set implicitly to the reverse direction on the same PPP link (see "Sharing Context Identifier Space" above). The ROHC channel parameter LARGE_CIDS is not used, instead the PPP protocol ID on the packet is used (see "Demultiplexing of Datagrams" above).

A number of parameters for ROHC must be set correctly for good compression on a specific link. E.g., the parameters k_1, n_1, k_2, n_2 in section 5.3.2.2.3 of [RFC3095] need to be set based on the error characteristics of the underlying links. As PPP links are usually run with a strong error detection scheme [RFC1662], k_1 = n_1 = k_2 = n_2 = 1 is usually a good set of values. (Note that in any case k values need to be set low enough relative to n values to allow for the limited ability of the CRC to detect errors, i.e., the CRC will succeed for about 1/8 of the packets even in case of context damage, so k/n should be significantly less than 7/8.)

6. Security Considerations

Negotiation of the option defined here imposes no additional security considerations beyond those that otherwise apply to PPP [RFC1661].

The security considerations of ROHC [RFC3095] apply.

The use of header compression can, in rare cases, cause the misdelivery of packets. If necessary, confidentiality of packet contents should be assured by encryption.

Encryption applied at the IP layer (e.g., using IPSEC mechanisms) precludes header compression of the encrypted headers, though compression of the outer IP header and authentication/security headers is still possible as described in [RFC3095]. For RTP packets, full header compression is possible if the RTP payload is encrypted by itself without encrypting the UDP or RTP headers, as described in [RFC1889]. This method is appropriate when the UDP and RTP header information need not be kept confidential.

7. IANA considerations

The ROHC suboption identifier is a non-negative integer. Following the policies outlined in [RFC2434], the IANA policy for assigning new values for the suboption identifier shall be Specification Required: values and their meanings must be documented in an RFC or in some other permanent and readily available reference, in sufficient detail that interoperability between independent implementations is possible. The range 0 to 127 is reserved for IETF standard-track specifications; the range 128 to 254 is available for other specifications that meet this requirement (such as Informational RFCs). The value 255 is reserved for future extensibility of the present specification.

The following suboption identifiers are already allocated:

Suboption identifier	Document	Usage
1	RFC3241	Profiles

The RFC 3006 compressibility hint [RFC3006] for ROHC is 0x0003pppp, where 0xpppp is the profile assumed.

(Note that the PPP protocol identifier values 0003 and 0005 were taken from a previously reserved space that exhibits inefficient transparency in the presence of asynchronous control character escaping, as it is considered rather unlikely that ROHC will be used over links with highly populated ACCMs.)

8. Acknowledgments

The present document borrows heavily from [RFC2509].

The author would like to thank Pete McCann and James Carlson for clarifying the multiple option instance issue, Craig Fox for helping with some PPP arcana, and Lars-Erik Jonsson for supplying some final clarifications.

9. References

9.1. Normative References

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9.2. Informative References

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