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Robust Header Compression (ROHC) over PPP

Status of this Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvements. Please refer to the current edition of the "Internet
   Official Protocol Standards" (STD 1) for the standardization state
   and status of this protocol. Distribution of this memo is unlimited.

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
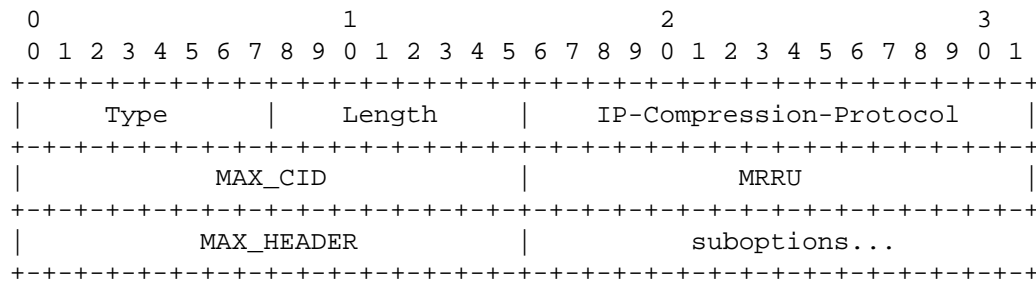one.

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

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |    Length     |    IP-Compression-Protocol    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            MAX_CID            |             MRRU              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           MAX_HEADER         |          suboptions...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

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.
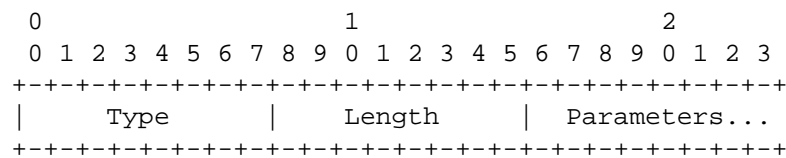
      Suggested value: 168 octets

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

```
      0                   1                   2
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |     Type      |    Length     |  Parameters...
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
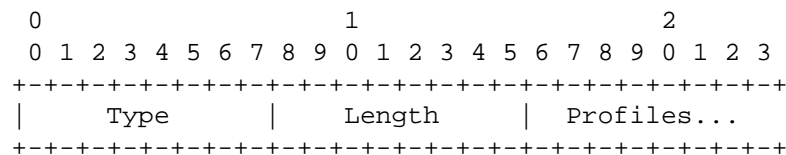
2.2. PROFILES Suboption

   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

```
      0                   1                   2
      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |     Type      |    Length     |  Profiles...
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   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   Document   Usage
identifier

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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