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IP Header Compression over PPP

Status of this Memo

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Abstract

This document describes an option for negotiating the use of header compression on IP datagrams transmitted over the Point-to-Point Protocol (RFC 1661). It defines extensions to the PPP Control Protocols for IPv4 and IPv6 (RFC 1332, RFC 2472). Header compression may be applied to IPv4 and IPv6 datagrams in combination with TCP, UDP and RTP transport protocols as specified in RFC 2507, RFC 2508 and RFC 3545.

1. Introduction

The IP Header Compression (IPHC) defined in [RFC2507] may be used for compression of both IPv4 and IPv6 datagrams or packets encapsulated with multiple IP headers. IPHC is also capable of compressing both TCP and UDP transport protocol headers. The IP/UDP/RTP header compression defined in [RFC2508] and [RFC3545] fits within the framework defined by IPHC so that it may also be applied to both IPv4 and IPv6 packets.

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.

This document obsoletes RFC 2509, adding two new suboptions to the IP header compression configuration option. One suboption negotiates usage of Enhanced RTP-Compression (specified in [RFC3545]), and the other suboption negotiates header compression for only TCP or only non-TCP packets.

IPHC relies on the link layer's ability to indicate the types of datagrams carried in the link layer frames. In this document nine new types for the PPP Data Link Layer Protocol Field are defined along with their meaning.

In general, header compression schemes that use delta encoding of compressed packets require that the lower layer does not reorder packets between compressor and decompressor. IPHC uses delta encoding of compressed packets for TCP and RTP. The IPHC specification [RFC2507] includes methods that allow link layers that may reorder packets to be used with IPHC. Since PPP does not reorder packets these mechanisms are disabled by default. 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.

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 IPHC scheme.

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. [RFC3241] 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.

NOTE: [RFC1332] is not explicit about whether the option negotiates the capabilities of the receiver or of the sender. In keeping with current practice, we assume that the option describes the capabilities of the decompressor (receiving side) of the peer that sends the Config-Req.

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 IP Header Compression. Successful negotiation of parameters enables the use of Protocol Identifiers FULL_HEADER, COMPRESSED_TCP, COMPRESSED_TCP_NODELTA, COMPRESSED_NON_TCP and CONTEXT_STATE as specified in [RFC2507]. The option format is summarized below. The fields are transmitted from left to right.

```
 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    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           TCP_SPACE           |         NON_TCP_SPACE         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         F_MAX_PERIOD          |          F_MAX_TIME           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           MAX_HEADER          |          suboptions...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type
   2

Length
   >= 14

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

IP-Compression-Protocol
   0061 (hex)

TCP_SPACE

The TCP_SPACE field is two octets and indicates the maximum value of a context identifier in the space of context identifiers allocated for TCP.

Suggested value: 15

TCP_SPACE must be at least 0 and at most 255 (the value 0 implies having one context).

NON_TCP_SPACE

The NON_TCP_SPACE field is two octets and indicates the maximum value of a context identifier in the space of context identifiers allocated for non-TCP. These context identifiers are carried in COMPRESSED_NON_TCP, COMPRESSED_UDP and COMPRESSED_RTP packet headers.

Suggested value: 15

NON_TCP_SPACE must be at least 0 and at most 65535 (the value 0 implies having one context).

F_MAX_PERIOD

Maximum interval between full headers. No more than F_MAX_PERIOD COMPRESSED_NON_TCP headers may be sent between FULL_HEADER headers.

Suggested value: 256

A value of zero implies infinity, i.e. there is no limit to the number of consecutive COMPRESSED_NON_TCP headers.

F_MAX_TIME

Maximum time interval between full headers. COMPRESSED_NON_TCP headers may not be sent more than F_MAX_TIME seconds after sending the last FULL_HEADER header.

Suggested value: 5 seconds

A value of zero implies infinity.

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.

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.

```
 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. RTP-Compression Suboption

The RTP-Compression suboption is included in the NCP IP-Compression-Protocol option for IPHC if IP/UDP/RTP compression is to be enabled.

Inclusion of the RTP-Compression suboption enables use of additional Protocol Identifiers COMPRESSED_RTP and COMPRESSED_UDP along with additional forms of CONTEXT_STATE as specified in [RFC2508].

Description

Enable use of Protocol Identifiers COMPRESSED_RTP, COMPRESSED_UDP and CONTEXT_STATE as specified in [RFC2508].

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

Type
   1

Length
   2

2.3. Enhanced RTP-Compression Suboption

To use the enhanced RTP header compression defined in [RFC3545], a new sub-option 2 is added. Sub-option 2 is negotiated instead of, not in addition to, sub-option 1.

Description

Enable use of Protocol Identifiers COMPRESSED_RTP and CONTEXT_STATE as specified in [RFC2508]. In addition, enable use of [RFC3545] compliant compression including the use of Protocol Identifier COMPRESSED_UDP with additional flags and use of the C flag with the FULL_HEADER Protocol Identifier to indicate use of HDRCKSUM with COMPRESSED_RTP and COMPRESSED_UDP packets.

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

Type
2

Length
2

2.4. Negotiating header compression for only TCP or only non-TCP packets

In RFC 2509 it was not possible to negotiate only TCP header compression or only non-TCP header compression because a value of 0 in the TCP_SPACE or the NON_TCP_SPACE fields actually means that 1 context is negotiated.

A new suboption 3 is added to allow specifying that the number of contexts for TCP_SPACE or NON_TCP_SPACE is zero, disabling use of the corresponding compression.

Description

Enable header compression for only TCP or only non-TCP packets.

```
 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     |   Parameter   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type
3

Length
3

Parameter

The parameter is 1 byte with one of the following values:

1 = the number of contexts for TCP_SPACE is 0
2 = the number of contexts for NON_TCP_SPACE is 0

This suboption overrides the values that were previously assigned to TCP_SPACE and NON_TCP_SPACE in the IP Header Compression option.

If suboption 3 is included multiple times with parameter 1 and 2, compression is disabled for all packets.

3. Multiple Network Control Protocols

The IPHC protocol is able to compress both IPv6 and IPv4 datagrams. Both IPCP and IPV6CP are able to negotiate option parameter values for IPHC. These values apply to the compression of packets where the outer header is an IPv4 header and an IPv6 header, respectively.

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.

Context identifier spaces are not shared between TCP and non-TCP/UDP/RTP. Doing so would require additional mechanisms to ensure that no error can occur when switching from using a context identifier for TCP to non-TCP.

4. Demultiplexing of Datagrams

The IPHC specification [RFC2507] defines four header formats for different types of compressed headers. They are compressed TCP, compressed TCP with no delta encoding, compressed non-TCP with 8 bit CID and compressed non-TCP with 16 bit CID. The two non-TCP formats may be distinguished by their contents so both may use the same link-level identifier. A fifth header format, the full header is distinct from a regular header in that it carries additional information to establish shared context between the compressor and decompressor.

The specification of IP/UDP/RTP Header Compression [RFC2508] defines four additional formats of compressed headers. They are for compressed UDP and compressed RTP (on top of UDP), both with either 8- or 16-bit CIDs. In addition, there is an explicit error message from the decompressor to the compressor.

The link layer must be able to indicate these header formats with distinct values. Nine PPP Data Link Layer Protocol Field values are specified below.

FULL_HEADER
    The frame contains a full header as specified in [RFC2508] Section 3.3.1. This is the same as the FULL_HEADER specified in [RFC2507] Section 5.3.
        Value: 0061 (hex)

COMPRESSED_TCP
    The frame contains a datagram with a compressed header with the format as specified in [RFC2507] Section 6a.
        Value: 0063 (hex)

COMPRESSED_TCP_NODELTA
    The frame contains a datagram with a compressed header with the format as specified in [RFC2507] Section 6b.
        Value: 2063 (hex)

COMPRESSED_NON_TCP
    The frame contains a datagram with a compressed header with the format as specified in either Section 6c or Section 6d of [RFC2507].
        Value: 0065 (hex)

COMPRESSED_RTP_8
The frame contains a datagram with a compressed header with the format as specified in [RFC2508] Section 3.3.2, using 8-bit CIDs.
Value: 0069 (hex)

COMPRESSED_RTP_16
The frame contains a datagram with a compressed header with the format as specified in [RFC2508] Section 3.3.2, using 16-bit CIDs.
Value: 2069 (hex)

COMPRESSED_UDP_8
The frame contains a datagram with a compressed header with the format as specified in [RFC2508] Section 3.3.3 or as specified in [RFC3545] Section 2.1, using 8-bit CIDs.
Value: 0067 (hex)

COMPRESSED_UDP_16
The frame contains a datagram with a compressed header with the format as specified in [RFC2508] Section 3.3.3 or as specified in [RFC3545] Section 2.1, using 16-bit CIDs.
Value: 2067 (hex)

CONTEXT_STATE
The frame is a link-level message sent from the decompressor to the compressor as specified in [RFC2508] Section 3.3.5.
Value: 2065 (hex)

5. Changes from RFC 2509

Two new suboptions are specified. See Sections 2.3 and 2.4.

6. References

6.1. Normative References

[RFC1144] Jacobson, V., "Compressing TCP/IP Headers for low-speed serial links", RFC 1144, February 1990.

[RFC1332] McGregor, G., "The PPP Internet Protocol Control Protocol (IPCP)", RFC 1332, May 1992.

[RFC2472] Haskin, D. and E. Allen, "IP Version 6 over PPP", RFC 2472, December 1998.

[RFC2507] Degermark, M., Nordgren, B. and S. Pink, "Header Compression for IP", RFC 2507, February 1999.

[RFC2508] Casner, S. and V. Jacobson, "Compressing IP/UDP/RTP Headers for Low-Speed Serial Links", RFC 2508, February 1999.

[RFC3241] Bormann, C., "Robust Header Compression (ROHC) over PPP", RFC 3241, April 2002.

[RFC3545] Koren, T., Casner, S., Geevarghese, J., Thompson, B. and P. Ruddy, "Enhanced Compressed RTP (CRTP) for Links with High Delay, Packet Loss and Reordering", RFC 3545, July 2003.

6.2. Informative References

[RFC1661] Simpson, W., Ed., "The Point-To-Point Protocol (PPP)", STD 51, RFC 1661, July 1994.

[RFC2434] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 2434, October 1998.

[RFC2686] Bormann, C., "The Multi-Class Extension to Multi-Link PPP", RFC 2686, September 1999.

[RFC3550] Schulzrinne, H., Casner, S., Frederick, R. and V. Jacobson, "RTP: A Transport Protocol for Real-Time Applications", RFC 3550, July 2003.

7. IANA Considerations

This document does not require any additional allocations from existing namespaces in the IANA Point-to-Point Protocol Field Assignments registry. However, there are three namespaces that were defined by RFC 1332, RFC 2472, and RFC 2509 but not created in the registry. Those three namespaces, described below, have been added to the PPP registry. This document specifies two additional allocations in the third one.

Section 3.2 of RFC 1332 specifies an IP-Compression-Protocol Configuration Option for the PPP IP Control Protocol and defines one value for the IP-Compression-Protocol type field in that option. An IANA registry has been created to allocate additional values for that type field. As stated in RFC 1332, the values for the IP-Compression-Protocol type field are always the same as the (primary) PPP DLL Protocol Number assigned to packets of the particular compression protocol. Assignment of additional IP-Compression-Protocol type values is through the IETF consensus procedure as specified in [RFC2434].

Section 4.2 of RFC 2472 specifies an IPv6-Compression-Protocol Configuration Option for the PPP IPv6 Control Protocol and defines one value for the IPv6-Compression-Protocol type field in that option. An IANA registry has been created to allocate additional values for that type field. The IPv6-Compression-Protocol Configuration Option has the same structure as the IP-Compression-Protocol Configuration Option defined in RFC 1332, but the set of values defined for the type field may be different. As stated in RFC 2472, the values for the IPv6-Compression-Protocol type field are always the same as the (primary) PPP DLL Protocol Number assigned to packets of the particular compression protocol. Assignment of additional IPv6-Compression-Protocol type values is through the IETF consensus procedure as specified in [RFC2434].

Section 2.1 of RFC 2509 specifies an additional type value to be registered for both the IP-Compression-Protocol Configuration Option and the IPv6-Compression-Protocol Configuration Option to indicate use of the "IP Header Compression" protocol. The specification of that type value is repeated in Section 2.1 of this document which obsoletes RFC 2509. In conjunction with the additional type value, the format for the variable-length option is specified. The format includes a suboption field that may contain one or more suboptions. Each suboption begins with a suboption type value. An IANA registry has been created for the suboption type values; and is titled, "IP Header Compression Configuration Option Suboption Types".

Section 2.2 of RFC 2509 (and this document) defines one suboption type. Sections 2.3 and 2.4 of this document define two additional suboption types. It is expected that the number of additional suboptions that will need to be defined is small. Therefore, anyone wishing to define new suboptions is required to produce a revision of this document to be vetted through the normal Internet Standards process, as specified in [RFC2434].

RFC 2509 also defines nine PPP Data Link Layer Protocol Field values which are already listed in the IANA registry of Point-to-Point Protocol Field Assignments. Section 4 of this document repeats the specification of those values without change.

8. Security Considerations

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

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 [RFC2507]. 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 [RFC3550]. This method is appropriate when the UDP and RTP header information need not be kept confidential.

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10. Acknowledgements

Mathias Engan was the primary author of RFC 2509, of which this document is a revision.

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