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RObust Header Compression (ROHC): A Link-Layer Assisted Profile for IP/UDP/RTP

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.

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Abstract

This document defines a ROHC (Robust Header Compression) profile for compression of IP/UDP/RTP (Internet Protocol/User Datagram Protocol/Real-Time Transport Protocol) packets, utilizing functionality provided by the lower layers to increase compression efficiency by completely eliminating the header for most packets during optimal operation. The profile is built as an extension to the ROHC RTP profile. It defines additional mechanisms needed in ROHC, states requirements on the assisting layer to guarantee transparency, and specifies general logic for compression and decompression related to the usage of the header-free packet format. This document is a replacement for RFC 3242, which it obsoletes.

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1. Introduction

Header compression is a technique used to compress and transparently decompress the header information of a packet on a per-hop basis, utilizing redundancy within individual packets and between consecutive packets within a packet stream. Over the years, several protocols [VJHC, IPHC] have been developed to compress the network and transport protocol headers [IPv4, IPv6, UDP, TCP], and these schemes have been successful in improving efficiency over many wired bottleneck links, such as modem connections over telephone networks. In addition to IP, UDP, and TCP compression, an additional compression scheme called Compressed RTP [CRTP] has been developed to improve compression efficiency further for real-time traffic using the Real-Time Transport Protocol [RTP].

The schemes mentioned above have all been designed by taking into account normal assumptions about link characteristics, which traditionally have been based on wired links only. However, with an increasing number of wireless links in the Internet paths, these assumptions are no longer generally valid. In wireless environments, especially wide-coverage cellular environments, relatively high error rates are tolerated in order to allow efficient usage of the radio resources. For real-time traffic, which is more sensitive to delays than to errors, such operating conditions will be norm over, for example, 3rd generation cellular links, and header compression must therefore tolerate packet loss. However, with the previously mentioned schemes, especially for real-time traffic compressed by CRTP, high error rates have been shown to significantly degrade header compression performance [CRTPC]. This problem was the driving force behind the creation of the RObust Header Compression (ROHC) WG in the IETF.

The ROHC WG has developed a header compression framework on top of which profiles can be defined for different protocol sets, or for different compression strategies. Due to the limited packet-loss robustness of CRTP and the demands of the cellular industry for an efficient way of transporting voice over IP over wireless, the main focus of ROHC has so far been on compression of IP/UDP/RTP headers, which are generous in size, especially when compared to the payloads often carried by packets with such headers.

ROHC RTP has become a very efficient, robust, and capable compression scheme, able to compress the headers down to a total size of one octet only. Also, transparency is guaranteed to an extremely great extent, even when residual bit errors are present in compressed headers delivered to the decompressor. The requirements for RTP compression [RTP-REQ], defined by the WG before and during the development process, have thus been fulfilled.

As mentioned above, the 3rd generation cellular systems, where IP will be used end-to-end, have been one of the driving forces behind ROHC RTP, and the scheme has also been designed to suit new cellular air interfaces, such as WCDMA, making it possible to run even speech services with spectrum efficiency insignificantly lower than for existing one-service circuit switched solutions [VTC2000]. However, other air interfaces (such as those based on GSM and IS-95) will also be used in all-IP networks, with further implications for the header compression issue. These older air interfaces are less flexible, with radio bearers optimized for specific payload sizes. This means that not even a single octet of header can be added without using the next higher fixed packet size supported by the link, something that is obviously very costly. For the already deployed speech vocoders, the spectrum efficiency over these links will thus be low compared to existing circuit-switched solutions. To achieve high spectrum efficiency overall with any application, more flexible air interfaces must be deployed, and then the ROHC RTP scheme will perform excellently, as shown for WCDMA [MOMUC01]. However, for deployment reasons, it is important to also provide a suitable header compression strategy for already existing vocoders and air interfaces, such as for GERAN and for CDMA2000, with minimal effects on spectral efficiency.

This document describes a link-layer-assisted ROHC RTP profile, originally defined by [LLA], extending ROHC RTP (profile 0x0001) [ROHC], and compliant with the ROHC 0-byte requirements [0B-REQ]. The purpose of this profile is to provide a header-free packet format that, for a certain application behavior, can replace a majority of the 1-octet header ROHC RTP packets during normal U/O-mode operation, while still being fully transparent and complying with all the requirements of ROHC RTP [RTP-REQ]. For other applications, compression will be carried out as with normal ROHC RTP.

To completely eliminate the compressed header, all functionality normally provided by the 1-octet header has to be provided by other means, typically by utilizing functionality provided by the lower layers and sacrificing efficiency for less-frequently occurring larger compressed headers. The latter is not a contradiction, since the argument for eliminating the last octet for most packets is not overall efficiency in general. It is important to remember that the purpose of this profile is to provide efficient matching of existing applications to existing link technologies, not efficiency in general. The additional complexity introduced by this profile, although minimized by a tight integration with already-existing ROHC functionality, implies that it should therefore only be used to optimize performance of specific applications over specific links.

When implementing this profile over various link technologies, care must be taken to guarantee that all the functionality needed is provided by ROHC and the lower layers together. Therefore, additional documents should specify how to incorporate this profile on top of various link technologies.

The profile defined by this document was originally specified by RFC 3242 [LLA], but to address one technical flaw and clarify one implementation issue, this document has been issued to replace RFC 3242, which becomes obsolete.

1.1. Differences from RFC 3242

This section briefly summarizes the differences of this document from RFC 3242. Acronyms and terminology can be found in Section 2.

The format of the CSP packet, as defined in [LLA], was identified as non-interoperable when carrying a RHP header with a 3-bit or 7-bit CRC. This problem occurs because the payload has been dropped by the compressor, and the decompressor is supposed to use the payload length to infer certain fields in the uncompressed header. These fields are the IPv4 total length, the IPv6 payload length, the UDP length, and the IPv4 header checksum field (all INFERRED fields in [ROHC]). To correct this flaw, the CSP packet must carry information about the payload length of the RHP packet. Therefore, the length of the RTP payload has been included in the CSP packet.

This document also clarifies an unclear referencing in RFC 3242, where Section 4.1.3 of [LLA] states that upon CRC failure, the actions of [ROHC], Section 5.3.2.2.3 MUST be taken. That section specifies that detection of SN wraparound and local repair must be performed, but neither of these steps apply when the failing packet is a CCP. Therefore, upon CRC failure, actions to be taken are the ones specified in Section 5.3.2.2.3, but steps a-d only.

2. Terminology

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 [RFC2119].

CCP	Context Check Packet
CRC	Cyclic Redundancy Check
CSP	Context Synchronization Packet
LLA	Link Layer Assisted ROHC RTP profile
NHP	No Header Packet
ROHC	RObust Header Compression
RHP	ROHC Header Packet (a non-NHP packet; i.e., RRP, CSP, or CCP)
RRP	ROHC RTP Packet as defined in [ROHC, profile 0x0001]

Assisting layer

"Assisting layer" refers to any entity implementing the interface to ROHC (Section 4.2). It may, for example, refer to a sub-layer used to adapt the ROHC implementation and the physical link layer. This layer is assumed to have knowledge of the physical layer synchronization.

Compressing side

"Compressing side" refers to the combination of the header compressor, operating with the LLA profile, and its associated assisting layer.

Lower layers

"Lower layers", in this document, refers to entities located below ROHC in the protocol stack, including the assisting layer.

ROHC RTP

"ROHC RTP" refers to the IP/UDP/RTP profile as defined in [ROHC].

3. Overview of the Link-Layer Assisted Profile

The ROHC IP/UDP/RTP profile defined in [LLA] and updated by this document, profile 0x0005 (hex), is designed to be used over channels that have been optimized for specific payload sizes and that therefore cannot efficiently accommodate header information when transmitted together with payloads corresponding to these optimal sizes.

The LLA profile extends, and thus also inherits all functionality from, the ROCH RTP profile by defining some additional functionality and an interface from the ROHC component towards an assisting lower layer.

```
                +----------------------------------------+
                |                                        |
   The LLA      |    ROHC RTP,                           |
   profile      |    Profile #1      +-----------------+
                |                    |  LLA Additions  |
                +----------------------+-----------------+
```

By imposing additional requirements on the lower layers compared to [ROHC], it is possible to infer the information needed to maintain robust and transparent header compression, even though the headers are completely eliminated during most of the operation time.

Basically, this profile replaces the smallest and most frequent ROHC U/O-mode headers with a no-header format, for which the header functionality must be provided by other means.

```
     Smallest header in                  Smallest header in
     ROHC RTP (profile #1)               LLA (profile #5)
   +--+--+--+--+--+--+--+--+               ++
   |        1 octet        |  ----->       ||  No Header
   +--+--+--+--+--+--+--+--+               ++
               |
               |                         Header field functionality
               +------------------->     provided by other means
```

The fields present in the ROHC RTP headers for U/O-mode PT0 are the packet type identifier, the sequence number, and the CRC. The subsequent sections elaborate more on how the functionality of these fields is replaced for NHP.

3.1. Providing Packet Type Identification

All ROHC headers carry a packet type identifier, indicating to the decompressor how the header should be interpreted. This is a function that must be provided by some means in 0-byte header compression. It will be possible to distinguish ROHC RTP packets with compressed headers thanks to the packet type identifier, but a mechanism is needed to separate packets with a header from packets without a header. This function MUST therefore be provided by the assisting layer in one way or another.

3.2. Replacing the Sequence Number

From the sending application, the RTP sequence number is increased by one for each packet sent. The purpose of the sequence number is to cope with packet reordering and packet loss. If reordering or loss has occurred before the transmission point, the compressing side, if needed, can easily avoid problems by not allowing the use of a header-free packet.

However, at the transmission point, loss or reordering that may occur over the link can not be anticipated and covered for. Therefore, for NHP, the assisting layer MUST guarantee in-order delivery over the link (already assumed by [ROHC]), and at the receiving side, it MUST provide an indication for each packet loss over the link. This is basically the same principle as that which the VJ header compression [VJHC] relies on.

Note that guaranteeing in-order delivery and packet loss indication over the link not only makes it possible to infer the sequence number information, but also supersedes the main function of the CRC, which normally takes care of errors due to link losses and bit errors in the compressed sequence number.

3.3. CRC Replacement

All context-updating RRP packets carry a CRC calculated over the uncompressed header. The CRC is used by the decompressor to verify that the updated context is correct. This verification serves three purposes in U/O-mode:

1) Detection of longer losses than can be covered by the sequence number LSBs.

2) Protection against failures caused by residual bit errors in compressed headers.

3) Protection against faulty implementations and other causes of error.

Since this profile defines an NHP packet without this CRC, care must be taken to fulfill these purposes by other means when an NHP is used as a replacement for a context-updating packet. Detection of long losses (1) is already covered, since the assisting layer MUST provide an indication of all packet losses. Furthermore, the NHP packet has one important advantage over RHP packets in that residual bit errors (2) cannot damage a header that is not even sent.

It is thus reasonable to assume that compression and decompression transparency can be assured with high confidence, even without a CRC in header-free packets. However, to provide additional protection against damage propagation due to undetected residual bit errors in context-updating packets (2) or other unexpected errors (3), periodic context verifications SHOULD be performed (see Section 4.6).

3.4. Applicability of This Profile

The LLA profile can be used with any link technology capable of providing the required functionality described in previous sections. Thus, whether LLA or ROHC RTP should be implemented depends on the characteristics of the link itself. For most RTP packet streams, LLA will work exactly as ROHC RTP, and it will have a higher compression efficiency for packet streams with certain characteristics. LLA will never have a lower compression efficiency than ROHC RTP.

Note as well that LLA, like all other ROHC profiles, is fully transparent to any packet stream reaching the compressor. LLA does not make any assumptions about the packet stream but will perform optimally for packet streams with certain characteristics, e.g., synchronized streams exactly timed with the assisting link over which the LLA profile is implemented.

The LLA profile is obviously not applicable if the UDP checksum (2 bytes) is enabled, which is always the case for IPv6/UDP. For IPv4/UDP, the sender may choose to disable the UDP checksum.

4. Additions and Exceptions Compared to ROHC RTP

4.1. Additional Packet Types

The LLA profile defines three new packet types to be used in addition to the RRP packet types defined by [ROHC]. The following sections describe these packet types and their purpose in detail.

4.1.1. No-Header Packet (NHP)

A No-Header Packet (NHP) is a packet that consists only of the payload of the original packet. The NHP MAY be used when only the sequence information needs to be conveyed to the decompressor. In other words, the NHP can be used when all header fields are either unchanged or follow the currently established change pattern. In addition, there are some considerations for the use of the NHP (see sections 4.3, 4.5, and 4.6). An LLA compressor is not allowed to deliver NHP packets when operating in R-mode.

The assisting layer MAY send the NHP for RTP SN = X only if an NHP was delivered by the LLA compressor AND the assisting layer can guarantee that the decompressor will infer the proper sequencing for this NHP. This guarantee is based on the confidence that the decompressor

a) has the means to infer proper sequencing for the packet corresponding to SN = X-1, AND

b) has either received a loss indication or the packet itself for the packet corresponding to SN = X-1.

Updating properties: NHP packets update context (RTP Sequence Number).

4.1.2. Context Synchronization Packet (CSP)

The case where the packet stream overruns the channel bandwidth may lead to discarded data, which may result in decompressor context invalidation. It might therefore be beneficial to send a packet with only the header information and to discard the payload. This would be helpful to maintain synchronization of the decompressor context while efficiently using the available bandwidth.

This case can be handled with the Context Synchronization Packet (CSP), which has the following format:

```
  0   1   2   3   4   5   6   7
+---+---+---+---+---+---+---+---+
| 1   1   1   1   1   0   1   0 | Packet type identifier
+===+===+===+===+===+===+===+===+
/       RTP Payload Length      / 2 octets
+---+---+---+---+---+---+---+---+
:  ROHC header without padding  :
:    see [ROHC, Section 5.7]    :
+---+---+---+---+---+---+---+---+
```

RTP Payload Length: This field is the length of the payload carried inside the RTP header, stored in network byte order. That is, this field will be set by the compressor to (UDP length - size of the UDP header - size of the RTP header including CSRC identifiers).

Updating properties: CSP maintains the updating properties of the ROHC header it carries.

The CSP is defined by one of the unused packet type identifiers from ROHC RTP, carried in the one-octet base header. As for any ROHC packet, except the NHP, the packet may begin with ROHC padding and/or feedback. It may also carry context identification after the packet type identifier. It is possible to have two CID fields present, one after the packet type ID and one within the encapsulated ROHC header. If a decompressor receives a CSP with two non-equal CID values included, the packet MUST be discarded. ROHC segmentation may also be applied to the CSP.

In the CSP packet, the payload has been dropped by the compressor. However, the decompressor is supposed to use the payload length to infer certain fields in the uncompressed header (the IPv4 total length, the IPv6 payload length, the UDP length, and the IPv4 header checksum field). When dropping the payload, the CSP packet needs to contain information about the payload length carried in the RHP packet. Therefore, the length of the RTP payload is carried in the CSP packet. When the decompressor receives a CSP packet, it can use the RTP payload length field to calculate the value of fields classified as INFERRED in [ROHC] when attempting to verify a 3- or 7-bit CRC carried in the RHP header enclosed in the CSP.

Note that when the decompressor has received and processed a CSP, the packet (including any possible data following the CSP encapsulated compressed header) MUST be discarded.

4.1.3. Context Check Packet (CCP)

A Context Check Packet (CCP), which does not carry any payload but only an optional CRC value in addition to the packet type identifier, is defined.

The purpose of the CCP is to provide a useful packet that MAY be sent by a synchronized physical link layer in the case where data must be sent at fixed intervals, even if no compressed packet is available. Whether the CCP is sent over the link and delivered to the decompressor is decided by the assisting layer. The CCP has the following format:

```
  0   1   2   3   4   5   6   7
+---+---+---+---+---+---+---+---+
| 1   1   1   1   1   0   1   1 | Packet type identifier
+===+===+===+===+===+===+===+===+
| C |          CRC              |
+---+---+---+---+---+---+---+---+
```

```
  C: C = 0 indicates that the CRC field is not used.
     C = 1 indicates that a valid CRC is present.
```

Updating properties: CCP packets do not update context.

The CCP is defined by one of the unused packet type identifiers from ROHC RTP, carried in the first octet of the base header. The first bit of the second octet, the C bit, indicates whether the CRC field is used. If C=1, the CRC field MUST be set to the 7-bit CRC calculated over the original uncompressed header defined in [ROHC, Section 5.9.2]. As for any ROHC packet, except NHP, the packet MAY begin with ROHC padding and/or carry context identification.

The use of the CRC field to perform decompressor context verification is optional and is therefore a compressor implementation issue. However, a CCP MUST always be made available to the assisting layer.

If the assisting layer receives CCPs with the C bit set (C=1) from the compressor, it MUST use the last CCP received if a CCP is to be sent, i.e., the CCP corresponding to the last non-CCP packet sent (NHP, RRP or CSP). An assisting layer MAY use the CCP for other purposes, such as signaling a packet loss before the link.

The decompressor is REQUIRED to handle a CCP received with the C bit set (C=1), indicating a valid CRC field, and to perform context verification. The received CRC MUST then be applied to the last decompressed packet, unless a packet loss indication was previously received. Upon CRC failure, actions MUST be taken as specified in

[ROHC, Section 5.3.2.2.3, steps a-d only]. A CCP received with C=0 MUST be ignored by the decompressor. The decompressor is not allowed to make any further interpretation of the CCP.

When using the 7-bit CRC in the CCP packet to verify the context, the decompressor needs to have access to the entire uncompressed header of the latest packet decompressed. Some implementations of [ROHC] might not save the values of INFERRED fields. An implementation of ROHC LLA MUST save these fields in the decompressor context to be able to successfully verify CCP packets.

The use of CCP by an assisting layer is optional and depends on the characteristics of the actual link. Whether it is used MUST therefore be specified in link-layer implementation specifications for this profile.

4.2. Interfaces Towards the Assisting Layer

This profile relies on the lower layers to provide the necessary functionality to allow NHP packets to be sent. This interaction between LLA and the assisting layer is defined as interfaces between the LLA compressor/decompressor and the LLA applicable link technology.

```
             |                              |
             +                              +
+-------------------------+    +-------------------------+
|       ROHC RTP HC       |    |       ROHC RTP HD       |
+-------------------------+    +-------------------------+
|       LLA profile       |    |       LLA profile       |
+=========================+    +=========================+
|        Interface        |    |        Interface        |
| ROHC to assisting layer |    | Assisting layer to ROHC |
+=========================+    +=========================+
|        Applicable       |    |        Applicable       |
|     link technology     |    |     link technology     |
+=========================+    +=========================+
             |                              |
             +------>---- CHANNEL ---->-----+
```

The figure above shows the various levels, as defined in [ROHC] and this document, constituting a complete implementation of the LLA profile. The figure also underlines the need for additional documents to specify how to implement these interfaces for a link technology for which this profile is relevant.

This section defines the information to be exchanged between the LLA compressor and the assisting layer for this profile to operate properly. While it does define semantics, it does not specify how these interfaces are to be implemented.

4.2.1. Interface, Compressor to Assisting Layer

This section defines the interface semantics between the compressor and the assisting layer, providing rules for packet delivery from the compressor.

The interface defines the following parameters: RRP, RRP segmentation flag, CSP, CSP segmentation flag, NHP, and RTP Sequence Number. All parameters, except the NHP, MUST always be delivered to the assisting layer. This leads to two possible delivery scenarios:

a. RRP, CSP, CCP, NHP, and RTP Sequence Number are delivered, along with the corresponding segmentation flags, set accordingly.

   This corresponds to the case when the compressor allows sending of an NHP packet, with or without segmentation applied to the corresponding RRP/CSP packets.

   Recall that delivery of an NHP packet occurs when the ROHC RTP compressor would have used a ROHC UO-0.

b. RRP, CSP, CCP, and RTP Sequence Number are delivered, along with the corresponding segmentation flags, set accordingly.

   This corresponds to the case when the compressor does not allow sending of an NHP packet. Segmentation might be applied to the corresponding RRP and CSP packets.

Segmentation may be applied independently to an RRP or a CSP packet if its size exceeds the largest value provided in the PREFERRED PACKET_SIZES list and if the LARGE_PACKET_ALLOWED parameter is set to false. The segmentation flags are explicitly stated in the interface definition to emphasize that the RRP and the CSP may be delivered by the compressor as segmented packets.

The RTP SN MUST be delivered for each packet by the compressor to allow the assisting layer to maintain the necessary sequencing information.

4.2.2. Interface, Assisting Layer to Decompressor

Here the interface semantics between the assisting layer and the decompressor are defined, providing simple rules for the delivery of received packets to the decompressor. The decompressor needs a way to distinguish NHP packets from RHP packets. Also, when receiving packets without a header, the decompressor needs a way to infer the sequencing information to keep synchronization between the received payload and the sequence information of the decompressed headers. To achieve this, the decompressor MUST receive the following from the assisting layer:

- an indication for each packet loss over the link between the compressing and decompressing sides for CID=0.

- the received packet together with an indication of whether the packet received is an NHP.

Note that the context is updated from a packet loss indication.

4.3. Optimistic Approach Agreement

ROHC defines an optimistic approach for updates to reduce the header overhead. This approach is fully exploited in the Optimistic and Unidirectional modes of operation. Due to the presence of a CRC in all compressed headers, the optimistic approach is defined as a compressor issue only because the decompressor will always be able to detect an invalid context through the CRC verification.

However, no CRC is present in the NHP packet defined by the LLA profile. Therefore, the loss of an RHP packet updating the context may not always be detected. To avoid this problem, the compressing and decompressing sides must agree on the principles for the optimistic approach, and the agreed principles MUST be enforced not only by the compressor but also by the transmitting assisting layer. If, for example, three consecutive updates are sent to convey a header field change, the decompressor must know this and invalidate the context if three or more consecutive physical packets are lost. Note that the mechanism used to enforce the optimistic approach must be reinitialized if a new field change needs to be conveyed while the compressing side is already sending packets to convey non-linear context updates.

An LLA decompressor MUST use the optimistic approach knowledge to detect possible context loss events. If context loss is suspected, it MUST invalidate the context and not forward any packets before the context has been synchronized.

It is REQUIRED that all documents describing how the LLA profile is implemented over a certain link technology define how the optimistic approach is agreed to between the compressing side and the decompressing side. It could be handled with a fixed principle, with negotiation at startup, or by other means, but the method must be unambiguously defined.

4.4. Fast Context Initialization, IR Redefinition

As initial IR packets might overrun the channel bandwidth and significantly delay decompressor context establishment, it might be beneficial to initially discard the payload. This allows state transitions and higher compression efficiency to be achieved with minimal delay.

To serve this purpose, the D-bit from the basic structure of the ROHC RTP IR packet [ROHC, Section 5.7.7.1] is redefined for the LLA profile. For D=0 (no dynamic chain), the meaning of the D-bit is extended to indicate that the payload has been discarded when assembling the IR packet. All other fields keep their meanings as defined for ROHC RTP.

The resulting structure, using small CIDs and CID=0, becomes:

```
  0   1   2   3   4   5   6   7
+---+---+---+---+---+---+---+---+
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | D |
+---+---+---+---+---+---+---+---+
|            Profile            | 1 octet
+---+---+---+---+---+---+---+---+
|              CRC              | 1 octet
+---+---+---+---+---+---+---+---+
|            Static             | variable length
|             chain             |
 - - - - - - - - - - - - - - - -
|            Dynamic            | not present if D = 0
|             chain             | present if D = 1, variable length
 - - - - - - - - - - - - - - - -
|            Payload            | not present if D = 0
|                               | present if D = 1, variable length
 - - - - - - - - - - - - - - - -
```

D: D = 0 indicates that the dynamic chain is not present and that the payload has been discarded.

After an IR packet with D=0 has been processed by the decompressor, the packet MUST be discarded.

4.5. Feedback Option, CV-REQUEST

The CV-REQUEST option MAY be used by the decompressor to request an RRP or CSP for context verification. This option should be used if only NHPs have been received for a long time and the context therefore has not been verified recently.

```
+---+---+---+---+---+---+---+---+
|  Opt Type = 8 |  Opt Len = 0  |
+---+---+---+---+---+---+---+---+
```

If the compressor receives a feedback packet with this option, the next packet compressed SHOULD NOT be delivered to the assisting layer as an NHP.

4.6. Periodic Context Verification

As described in Section 3.3, transparency is expected to be guaranteed by the functionality provided by the lower layers. This ROHC profile would therefore be at least as reliable as the older header compression schemes [VJHC, IPHC, CRTP], which do not make use of a header compression CRC. However, since ROHC RTP normally is extremely safe to use from a transparency point of view, it would be desirable to be able to achieve this with LLA also.

To provide an additional guarantee for transparency and also catch unexpected errors, such as errors due to faulty implementations, it is RECOMMENDED that context updating packets be sent periodically, even when the compressor logic allows NHP packets to be used.

4.7. Use of Context Identifier

Since an NHP cannot carry a context identifier (CID), there is a restriction on how this profile may be used, related to context identification. Independent of which CID size has been negotiated, NHP packets can only be used for CID=0. If the decompressor receives an NHP packet, it can only belong to CID=0.

Note that if multiple packet streams are handled by a compressor operating using LLA, the assisting layer must, in case of physical packet loss, be able to tell for which CID the loss occurred, or at least it MUST be able to tell if packets with CID=0 (packet stream with NHPs) have been lost.

5. Implementation Issues

This document specifies mechanisms for the protocol and leaves details on the use of these mechanisms to the implementers. The present section aims to provide guidelines, ideas, and suggestions for implementation of LLA.

5.1. Implementation Parameters and Signals

As described in [ROHC, Section 6.3], implementations use parameters to set up configuration information and to stipulate how a ROHC implementation is to operate. The following parameters are additions, useful to LLA, to the parameter set defined for ROHC RTP implementations. Note that if the PREFERRED_PACKET_SIZES parameters defined here are used, they obsolete all PACKET_SIZE and PAYLOAD_SIZE parameters of ROHC RTP.

5.1.1. Implementation Parameters at the Compressor

ALWAYS_PAD -- value: boolean

This parameter may be set by an external entity to specify to the compressor that every RHP packet MUST be padded with ROHC padding of one octet, minimum.

The assisting layer MUST provide a packet type identification. If no field is available for this purpose from the protocol at the link layer, then a leading sequence may be used to distinguish RHP packets from NHP packets. Although the use of a leading sequence is obviously not efficient, since it sacrifices efficiency for RHP packets, the efficiency loss should be insignificant because the leading sequence applies only to packets with headers in order to favor the use of packets without headers. If a leading sequence is desired for RHP identification, the lower layer MAY use ROHC padding for the leading sequence by setting the ALWAYS_PAD parameter. Note that in such cases, possible collisions of the padding with the NHP payload must be avoided.

By default, this parameter is set to FALSE.

PREFERRED_PACKET_SIZES -- list of:
  SIZE -- value: integer (octets)
  RESTRICTED_TYPE -- values: [NHP_ONLY, RHP_ONLY, NO_RESTRICTION]

This parameter set governs which packet sizes are preferred by the assisting layer. If this parameter set is used, all RHP packets MUST be padded to fit the smallest possible preferred size. If the size of the unpadded packet (or, in the case of ALWAYS_PAD being set, the packet with minimal one-octet padding) is larger than the maximal preferred packet size, the compressor has two options. Either it may deliver this larger packet with an arbitrary size, or it may split the packet into several segments using ROHC segmentation and pad each segment to one of the preferred sizes. Which method to use depends on the value of the LARGE_PACKETS_ALLOWED parameter below.

NHP packets can be delivered to the lower layer only if the payload size is part of the preferred packet size set. Furthermore, if RESTRICTED_TYPE is set to one of NHP_ONLY or RHP_ONLY for any of the preferred packet sizes, that size is allowed only for packets of the specified type.

By default, no preferred packet sizes are specified. When sizes are specified, the default value for RESTRICTED_TYPE is NO_RESTRICTION.

LARGE_PACKETS_ALLOWED -- value: boolean

This parameter may be set by an external entity to specify how to handle packets that do not fit any of the preferred packet sizes specified. If it is set to TRUE, the compressor MUST deliver the larger packet as-is and MUST NOT use segmentation. If it is set to FALSE, the ROHC segmentation scheme MUST be used to split the packet into two or more segments, and each segment MUST further be padded to fit one of the preferred packet sizes.

By default, this parameter is set to TRUE, which means that segmentation is disabled.

VERIFICATION_PERIOD -- value: integer

This parameter may be set by an external entity to specify to the compressor the minimum frequency with which a packet validating the context must be sent. This tells the compressor that a packet containing a CRC field MUST be sent at least once every N packets, where N=VERIFICATION_PERIOD (see Section 4.6).

By default, this parameter is set to 0, which indicates that periodical verifications are disabled.

5.1.2. Implementation Parameters at the Decompressor

NHP_PACKET -- value: boolean

This parameter informs the decompressor that the packet being delivered is an NHP packet. The decompressor MUST accept this packet type indicator from the lower layer. An assisting layer MUST set this indicator to true for every NHP packet delivered, and to false for any other packet.

PHYSICAL_PACKET_LOSS -- signal

This signal indicates to the decompressor that a packet has been lost on the link between the compressing and the decompressing sides, due to a physical link error. The signal is given once for each packet that was lost, and a decompressor must increase the sequence number accordingly when this signal is received.

PRE_LINK_PACKET_LOSS -- signal

This signal tells the decompressor to increase the sequence number due to a gap in the sequencing not related to a physical link error. A receiving assisting layer may, for example, use this signal to indicate to the decompressor that a packet was lost before the compressor, or that a packet was discarded by the transmitting assisting layer.

5.2. Implementation over Various Link Technologies

This document provides the semantics and requirements of the interface needed from the ROHC compressor and decompressor towards the assisting layer to perform link-layer-assisted header compression.

However, this document does not provide any link-layer-specific operational information, except for some implementation suggestions. Further details about how this profile is to be implemented over various link technologies must be described in other documents, where specific characteristics of each link layer can be taken into account to provide optimal usage of this profile.

These specifications MAY use a packet-type bit pattern unused by this profile to implement signaling on the lower layer. The pattern available to lower layer implementations is [11111001].

6. IANA Considerations

ROHC profile identifier 0x0005 has been reserved by the IANA for the IP/UDP/RTP profile defined in this document.

7. Security Considerations

The security considerations of ROHC RTP [ROHC, Section 7] apply also to this document, with one addition: in the case of a denial-of-service attack scenario where an intruder injects bogus CCP packets using random CRC values onto the link, the CRC check will fail for incorrect reasons at the decompressor side. This would obviously greatly reduce the advantages of ROHC and any extra efficiency provided by this profile due to unnecessary context invalidation, feedback messages, and refresh packets. However, the same remarks related to the presence of such an intruder apply.

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