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                   RObust Header Compression (ROHC):
              Profiles for User Datagram Protocol (UDP) Lite

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Abstract

   This document defines Robust Header Compression (ROHC) profiles for
   compression of Real-Time Transport Protocol, User Datagram Protocol-
   Lite, and Internet Protocol (RTP/UDP-Lite/IP) packets and UDP-
   Lite/IP. These profiles are defined based on their differences with
   the profiles for UDP as specified in RFC 3095.

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1. Introduction

   The ROHC WG has developed a header compression framework on top of
   which various profiles can be defined for different protocol sets or
   compression strategies. Due to the demands of the cellular industry
   for an efficient way to transport voice over IP over wireless, ROHC
   [2] has mainly focused on compression of IP/UDP/RTP headers, which
   are generous in size, especially compared to the payloads often
   carried by packets with these 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 high
   extent, even when residual bit errors are present in compressed
   headers delivered to the decompressor.

   UDP-Lite [4] is a transport protocol similar to the UDP protocol [7].
   UDP-Lite is useful for applications designed with the capability to
   tolerate errors in the payload, for which receiving damaged data is
   better than dealing with the loss of entire packets. This may be
   particularly suitable when packets are transported over link
   technologies in which data can be partially damaged, such as wireless
   links.

   Although these transport protocols are very similar, ROHC profiles
   must be defined separately for robust compression of UDP-Lite headers
   because UDP-Lite does not share the same protocol identifier with
   UDP. Also, the UDP-Lite Checksum Coverage field does not share the
   semantics of the corresponding UDP Length field, and as a consequence
   it cannot always be inferred anymore.

   This document defines two ROHC profiles for efficient compression of
   UDP-Lite headers. The objective of this document is to provide
   simple modifications to the corresponding ROHC profiles for UDP,
   specified in RFC 3095 [2]. In addition, the ROHC profiles for UDP-
   Lite support some of the mechanisms defined in the profile for
   compression of IP headers [3] (ROHC IP-Only). This specification
   includes support for compression of multiple IP headers and for
   compressing IP-ID fields with constant behavior, as well as improved
   mode transition logic and a feedback option for decompressors with
   limited memory resources.

2. Terminology

   In this document, the key words "MUST", "MUST NOT", "REQUIRED",
   "SHALL", "SHALL NOT", "SHOULD, "SHOULD NOT", "RECOMMENDED", "MAY",
   and "OPTIONAL" are to be interpreted as described in RFC 2119 [1].

   ROHC RTP   : RTP/UDP/IP profile 0x0001 defined in RFC 3095 [2].
   ROHC UDP   : UDP/IP profile 0x0002 defined in RFC 3095 [2].
   ROHC UDP-Lite   : UDP-Lite/IP profile defined in this document.
   ROHC RTP/UDP-Lite: RTP/UDP-Lite/IP profile defined in this document.

3. Background

3.1. Overview of the UDP-Lite Protocol

   UDP-Lite is a transport protocol defined as an independent variant of
   the UDP transport protocol. UDP-Lite is very similar to UDP, and it
   allows applications that can tolerate errors in the payload to use a
   checksum with an optional partial coverage. This is particularly
   useful with IPv6 [6], in which the use of the transport-layer
   checksum is mandatory.

   UDP-Lite replaces the Length field of the UDP header with a Checksum
   Coverage field. This field indicates the number of octets covered by
   the 16-bit checksum, which is applied on a per-packet basis. The
   coverage area always includes the UDP-Lite header and may cover the
   entire packet, in which case UDP-Lite becomes semantically identical
   to UDP. UDP-Lite and UDP do not share the same protocol identifier.

The UDP-Lite header format:

```
       0                15 16                31
       +--------+--------+--------+--------+
       |      Source      |    Destination   |
       |       Port       |       Port       |
       +--------+--------+--------+--------+
       |     Checksum     |                  |
       |     Coverage     |    Checksum      |
       +--------+--------+--------+--------+
       |                                    |
       :              Payload               :
       |                                    |
       +------------------------------------+
```
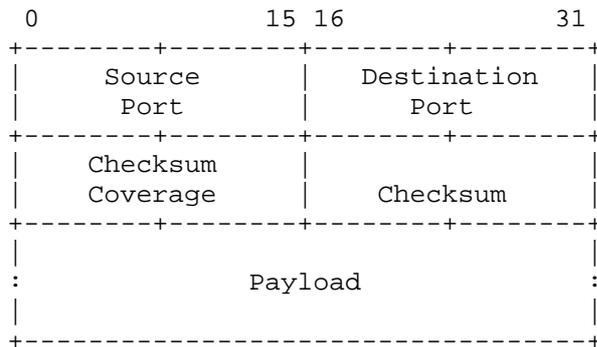
Like the UDP checksum, the UDP-Lite checksum is an end-to-end
mechanism against erroneous delivery of error sensitive data. This
checksum is mandatory with IPv6 [5] for both protocols. However,
unlike its UDP counterpart, the UDP-Lite checksum may not be
transmitted as all zeroes and cannot be disabled for IPv4 [5]. For
UDP, if the checksum is disabled (IPv4 only), the Checksum field
maintains a constant value and is normally not sent by the header
compression scheme. If the UDP checksum is enabled (mandatory for
IPv6), such an unpredictable field cannot be compressed and is sent
uncompressed. The UDP Length field, however, is always redundant and
can be provided by the IP module. Header compression schemes do not
normally transmit any bits of information for this field, as its
value can be inferred from the link layer.

For UDP-Lite, the checksum also has unpredictable values, and this
field must always be included as-is in the compressed header for both
IPv4 and IPv6. Furthermore, as the UDP Length field is redefined as
the Checksum Coverage field by UDP-Lite, this leads to different
properties for this field from a header-compression perspective.

The following summarizes the relationship between UDP and UDP-Lite:

- UDP-Lite and UDP have different protocol identifiers.
- The UDP-Lite checksum cannot be disabled for IPv4.
- UDP-Lite redefines the UDP Length field as the Checksum Coverage
  field, with different semantics.
- UDP-Lite is semantically equivalent to UDP when the Checksum
  Coverage field indicates the total length of the packet.

The next section provides a more detailed discussion of the behavior
of the Checksum Coverage field of UDP-Lite in relation to header
compression.

3.2. Expected Behaviours of UDP-Lite Flows

3.2.1. Per-Packet Behavior

   As mentioned in the previous section, the checksum coverage value is
   applied independently of other packets that may belong to the same
   flow. Specifically, the value of the checksum coverage may indicate
   that the UDP-Lite packet is either entirely covered by the checksum
   or covered up to some boundary less than the packet size but
   including the UDP-Lite header.

3.2.2. Inter-Packet Behavior

   In relation to each other, UDP-Lite packets may exhibit one of three
   possible change patterns, where within a sequence of packets the
   value of the Checksum Coverage field is

   1. changing, while covering the entire packet;
   2. unchanging, covering up to a fixed boundary within the packet; or
   3. changing, but it does not follow any specific pattern.

   The first pattern above corresponds to the semantics of UDP, when the
   UDP checksum is enabled. For this case, the checksum coverage field
   varies according to the packet length and may be inferred from the IP
   header, as is the UDP Length field value.

   The second pattern corresponds to the case where the coverage is the
   same from one packet to another within a particular sequence. For
   this case, the Checksum Coverage field may be a static value defined
   in the context, and it does not have to be sent in the compressed
   header. For the third case, no useful change pattern can be
   identified from packet to packet for the value of the checksum
   coverage field, and it must be included in the compressed header.

3.2.3. Per-Flow behavior

   It can be expected that any one of the above change patterns for
   sequences of packets may be predominant at any time during the
   lifetime of the UDP-Lite flow. A flow that predominantly follows the
   first two change patterns described above may provide opportunities
   for compressing the Checksum Coverage field for most of the packets.

3.3. Header Field Classification

   In relation to the header field classification of RFC 3095 [2], the
   first two patterns represent the case where the value of the Checksum
   Coverage field behavior is fixed and may be either INFERRED (pattern

1) or STATIC (pattern 2). Pattern 3 is for the case where the value
varies unpredictably, the field is CHANGING, and the value must be
sent along with every packet.

Additional information regarding the analysis of the behavior of the
UDP-Lite fields may be found in Appendix A.

4. Rationale behind the Design of ROHC Profiles for UDP-Lite

4.1. Design Motivations

Simplicity is a strong motivation for the design of the UDP-Lite
header compression profiles. The profiles defined for UDP-Lite
should entail only a few simple modifications to the corresponding
profiles defined for UDP in RFC 3095 [2]. In addition, it is
desirable to include some of the improvements found in the ROHC IP-
Only profile [3]. Finally, whenever UDP-Lite is used in a manner
that is semantically identical to UDP, the compression efficiency
should be similar.

4.2. ROHC Considerations

The simplest approach to the definition of ROHC profiles for UDP-Lite
is to treat the Checksum Coverage field as an irregular value, and to
send it uncompressed for every packet. This may be achieved simply
by adding the field to the definition of the general packet format
[2]. However, then the compression efficiency would always be less
than for UDP.

Some care should be given to achieve compression efficiency for UDP-
Lite similar to that for UDP when the Checksum Coverage field behaves
like the UDP Length field. This requires the possibility to infer
the Checksum Coverage field when it is equal to the length of the
packet. Otherwise, this would put the UDP-Lite protocol at a
disadvantage over links where header compression is used, when its
behavior is made similar to the semantics of UDP.

A mechanism to detect the presence of the Checksum Coverage field in
compressed headers is thus needed. This is achieved by defining a
new packet type with the identifiers left unused in RFC 3095 [2].

5. ROHC Profiles for UDP-Lite

This section defines two ROHC profiles:

   - RTP/UDP-Lite/IP compression (profile 0x0007)
   - UDP-Lite/IP compression   (profile 0x0008)

These profiles build on the specifications found in RFC 3095 [2],
with as little modification as possible. Unless it is explicitly
stated otherwise, the profiles defined herein follow the
specifications of ROHC UDP and ROHC RTP, respectively.

Note also that this document reuses the notation found in [2].

5.1. Context Parameters

As described in [2], information about previous packets is maintained
in a context. This includes information describing the packet stream
and compression parameters. Although the UDP and UDP-Lite protocols
share many commonalities, the differences in semantics as described
earlier render the following parameter inapplicable:

The parameter context(UDP Checksum)

   The UDP-Lite checksum cannot be disabled, as opposed to UDP. The
   parameter context(UDP Checksum) defined in [2] (section 5.7) is
   therefore not used for compression of UDP-Lite.

In addition, the UDP-Lite checksum is always sent as-is in every
compressed packet. However, the Checksum Coverage field may not
always be sent in each compressed packet, and the following context
parameter is used to indicate whether the field is sent:

The parameter context(UDP-Lite Coverage Field Present)

   Whether the UDP-Lite Checksum Coverage field is present or not in
   the general packet format (see section 5.3.1) is controlled by the
   value of the Coverage Field Present (CFP) flag in the context.

   If context(CFP) is nonzero, the Checksum Coverage field is not
   compressed, and it is present within compressed packets. If
   context(CFP) is zero, the Checksum Coverage field is compressed,
   and it is not sent. This is the case when the value of the
   Checksum Coverage field follows a stable inter-packet change
   pattern; the field has either a constant value or it has a value
   equal to the packet length for most packets in a sequence (see
   section 3.2).

Finally, the following context parameter is needed to indicate
whether the field should be inferred or taken from a value previously
saved in the context:

   The parameter context(UDP-Lite Coverage Field Inferred)

      When the UDP-Lite Checksum Coverage field is not present in the
      compressed header (CFP=0), whether it is inferred is controlled by
      the value of the Coverage Field Inferred (CFI) flag in the context.

      If context(CFI) is nonzero, the Checksum Coverage field is inferred
      from the packet length, similarly as for the UDP Length field in
      ROHC RTP. If context(CFI) is zero, the Checksum Coverage field is
      decompressed by using context(UDP-Lite Checksum Coverage).
      Therefore, when context(CFI) is updated to a nonzero value, the
      value of the Checksum Coverage field stored in the context must
      also be updated.

5.2. Initialization

   Unless it is stated otherwise, the mechanisms of ROHC RTP and ROHC
   UDP found in [2] are used also for the ROHC RTP/UDP-Lite and the ROHC
   UDP-Lite profiles, respectively.

   In particular, the considerations of ROHC UDP regarding the UDP SN
   taking the role of the RTP Sequence Number apply to ROHC UDP-Lite.
   Also, the static context for ROHC UDP-Lite may be initialized by
   reusing an existing context belonging to a stream compressed by using
   ROHC RTP/UDP-Lite (profile 0x0007), similarly as for ROHC UDP.

5.2.1. Initialization of the UDP-Lite Header [1]

   The structure of the IR and IR-DYN packets and the initialization
   procedures are the same as for the ROHC profiles for UDP [2], with
   the exception of the dynamic part as specified for UDP. A 2-octet
   field containing the checksum coverage is added before the Checksum
   field. This affects the format of dynamic chains in both IR and IR-
   DYN packets.

   Dynamic part:

```
      +---+---+---+---+---+---+---+---+
      /       Checksum Coverage       /   2 octets
      +---+---+---+---+---+---+---+---+
      /           Checksum            /   2 octets
      +---+---+---+---+---+---+---+---+
```

   CRC-DYNAMIC: Checksum Coverage field, Checksum field (octets 5 - 8).

   CRC-STATIC: All other fields (octets 1 - 4).

5.2.2. Compressor and Decompressor Logic

   The following logic must be used by both the compressor and the
   decompressor for assigning values to the parameters context(CFP) and
   context(CFI) during initialization:

   Context(CFP)

      During context initialization, the value of context(CFP) MUST be
      set to a nonzero value if the Checksum Coverage field differs from
      the length of the UDP-Lite packet, for any one IR or IR-DYN packet
      sent (compressor) or received (decompressor); otherwise, the value
      MUST be set to zero.

   Context(CFI)

      During context initialization, the value of context(CFI) MUST be
      set to a nonzero value if the Checksum Coverage field is equal to
      the length of the UDP-Lite packet within an IR or an IR-DYN packet
      sent (compressor) or received (decompressor); otherwise, the value
      MUST be set to zero.

5.3. Packet Formats

   The general packet format, as defined in RFC 3095 [2], is modified to
   include an additional field for the UDP-Lite checksum coverage. A
   packet type is also defined to handle the specific semantics and
   characteristics of this field.

5.3.1. General Packet Format

   The general packet format of a compressed ROHC UDP-Lite header is
   similar to the compressed ROHC RTP header ([2], section 5.7), with
   modifications to the Checksum field, as well as additional fields for
   handling multiple IP headers and for the UDP-Lite checksum coverage:

```
 --- --- --- --- --- --- --- ---
:              List of              :  variable, given by static chain
/          dynamic chains          /  (does not include SN)
:    for additional IP headers     :  see also [3], section 3.2.
 --- --- --- --- --- --- --- ---
:                                  :  2 octets,
+  UDP-Lite Checksum Coverage      +  if context(CFP) = 1 or
:                                  :  if packet type = CCE (see 5.3.2)
 --- --- --- --- --- --- --- ---
:                                  :
+        UDP-Lite Checksum         +  2 octets
:                                  :
 --- --- --- --- --- --- --- ---
```

The list of dynamic header chains carries the dynamic header part for
each IP header in excess of the initial two, if there is any (as
indicated by the presence of corresponding header parts in the static
chain). Note that there is no sequence number at the end of the
chain, as SN is present within compressed base headers.

The order of the fields following the optional extension of the
general ROHC packet format is the same as the order between the
fields in the uncompressed header.

When the CRC is calculated, the Checksum Coverage field is CRC-
DYNAMIC.

5.3.2. Packet Type CCE: CCE(), CCE(ON), and CCE(OFF)

The ROHC profiles for UDP-Lite define a packet type to handle the
various possible change patterns of the checksum coverage. This
packet type may be used to manipulate the context values that control
the presence of the Checksum Coverage field within the general packet
format (i.e., context(CFP)) and how the field is decompressed (i.e.,
context(CFI)). The 2-octet Checksum Coverage field is always present
within the format of this packet (see section 5.3.1).

This type of packet is named Checksum Coverage Extension, or CCE, and
its updating properties depend on the final two bits of the packet
type octet (see format below). A naming scheme of the form
CCE(<some_property>) is used to uniquely identify the properties of a
particular CCE packet.

Although this packet type defines its own format, it may be
considered as an extension mechanism for packets of type 2, 1, or 0
[2]. This is achieved by substitution of the packet type identifier
of the first octet of the base header (the "outer" identifier) with

one of the unused packet types from RFC 3095 [2]. The substituted
identifier is then moved to the first octet of the remainder of the
base header (the "inner" identifier).

The format of the ROHC UDP-Lite CCE packet type is as follows:

```
    0   1   2   3   4   5   6   7
  +---+---+---+---+---+---+---+---+
  | 1   1   1   1   1   0   F | K |  Outer packet type identifier
  +===+===+===+===+===+===+===+===+
  :                           :    (with inner type identifier)
  /        Inner Base header   /    variable number of bits, given by
  :                           :    the inner packet type identifier
  +---+---+---+---+---+---+---+---+
```

   F,K: F,K = 00 is reserved at framework level (IR-DYN);
         F,K = 01 indicates CCE();
         F,K = 10 indicates CCE(ON);
         F,K = 11 indicates CCE(OFF).

   Updating properties: The updating properties of the inner packet
         type carried within any of the CCE packets are always
         maintained. CCE(ON) and CCE(OFF) MUST NOT be used to extend
         R-0 and R-1* headers. In addition, CCE(ON) always updates
         context(CFP); CCE(OFF) always updates context(CFP),
         context(CFI), and context(UDP-Lite Checksum Coverage).

   Appendix B provides an expanded view of the resulting format of the
   CCE packet type.

5.3.2.1. Properties of CCE()

   Aside from the updating properties of the inner packet type carried
   within CCE(), this packet does not update any other context values.
   CCE() thus is mode-agnostic; e.g., it can extend any of packet types
   2, 1, and 0, regardless of the current mode of operation [2].

   CCE() may be used when the checksum coverage deviates from the change
   pattern assumed by the compressor, where the field could previously
   be compressed. This packet is useful if the occurrence of such
   deviations is rare.

5.3.2.2. Properties of CCE(ON)

   In addition to the updating properties of the inner packet type,
   CCE(ON) updates context(CFP) to a nonzero value; i.e., it effectively
   turns on the presence of the Checksum Coverage field within the

general packet format. This is useful when the predominant change
pattern of the checksum coverage precludes its compression.

CCE(ON) can extend any of the context-updating packets of type 2, 1,
and 0; that is, packets with a compressed header containing a CRC
[2]. Specifically, R-0 and R-1* headers MUST NOT be extended by
using CCE(ON).

5.3.2.3. Properties of CCE(OFF)

In addition to the updating properties of the inner packet type,
CCE(OFF) updates context(CFP) to a value of zero; i.e., it
effectively turns off the presence of the Checksum Coverage field
within the general packet format. This is useful when the change
pattern of the checksum coverage seldom deviates from the pattern
assumed by the compressor.

CCE(OFF) also updates context(CFI) to a nonzero value, if field(UDP-
Lite Checksum Coverage) is equal to the packet length; otherwise, it
must be set to zero. Note that when context(CFI) is updated by using
packet type CCE(OFF), a match of field(Checksum Coverage) with the
packet length always has precedence over a match with
context(Checksum Coverage). Finally, context(UDP-Lite Checksum
Coverage) is also updated by CCE(OFF).

Similarly to CCE(ON), CCE(OFF) can extend any of the context updating
packets of type 2, 1, and 0 [2].

5.4. Compressor Logic

If hdr(UDP-Lite Checksum Coverage) is different from context(UDP-Lite
Checksum Coverage) and different from the packet length when
context(CFP) is zero, the Checksum Coverage field cannot be
compressed. In addition, if hdr(UDP-Lite Checksum Coverage) is
different from the packet length when context(CFP) is zero and
context(CFI) is nonzero, the Checksum Coverage field cannot be
compressed by either. For both cases, the field must be sent
uncompressed using a CCE packet, or the context must be reinitialized
by using an IR packet.

5.5. Decompressor Logic

For packet types other than IR, IR-DYN, and CCE that are received
when the value of context(CFP) is zero, the Checksum Coverage field
must be decompressed by using the value stored in the context if the
value of context(CFI) is zero; otherwise, the field is inferred from
the length of the UDP-Lite packet derived from the IP module.

5.6. Additional Mode Transition Logic

   The profiles defined in this document allow the compressor to decline
   a mode transition requested by the decompressor. This is achieved by
   redefining the Mode parameter for the value mode = 0 (in packet types
   UOR-2, IR, and IR-DYN) as follows (see also [3], section 3.4):

           Mode: Compression mode. 0 = (C)ancel Mode Transition

   Upon receiving the Mode parameter set to 0, the decompressor MUST
   stay in its current mode of operation and SHOULD refrain from sending
   further mode transition requests for the declined mode.

5.7. The CONTEXT_MEMORY Feedback Option

   This feedback option informs the compressor that the decompressor
   does not have sufficient memory resources to handle the context of
   the packet stream required by the current compressed structure.

        0   1   2   3   4   5   6   7
      +---+---+---+---+---+---+---+---+
      | Opt Type = 9 | Opt Len = 0 |
      +---+---+---+---+---+---+---+---+

   When receiving a CONTEXT_MEMORY option, the compressor SHOULD take
   actions to compress the packet stream in a way that requiring less
   decompressor memory resources or stop compressing the packet stream.

5.8. Constant IP-ID

   The profiles for UDP-Lite support compression of the IP-ID field with
   constant behavior, with the addition of the Static IP Identifier
   (SID) flag within the dynamic part of the chain used to initialize
   the IPv4 header, as follows (see also [3], section 3.3):

   Dynamic part:

      +---+---+---+---+---+---+---+---+
      | Type of Service |
      +---+---+---+---+---+---+---+---+
      | Time to Live |
      +---+---+---+---+---+---+---+---+
      /   Identification   /   2 octets
      +---+---+---+---+---+---+---+---+
      | DF|RND|NBO|SID| 0 |
      +---+---+---+---+---+---+---+---+
      / Generic extension header list / variable length
      +---+---+---+---+---+---+---+---+

SID: Static IP Identifier.

   For IR and IR-DYN packets:

      The logic is the same as that for the respective ROHC
      profiles for UDP, with the addition that field (SID)
      must be kept in the context.

   For compressed headers other than IR and IR-DYN:

      If value(RND) = 0 and context(SID) = 0, hdr(IP-ID) is
      compressed by using Offset IP-ID encoding (see [2], section
      4.5.5) using p = 0 and default-slope(IP-ID offset) = 0.

      If value(RND) = 0 and context(SID) = 1, hdr(IP-ID) is constant
      and compressed away; hdr(IP-ID) is the value of context(IP-ID).

      If value(RND) = 1, IP-ID is the uncompressed hdr(IP-ID). IP-ID
      is then passed as additional octets at the end of the
      compressed header, after any extensions.

   Note: Only IR and IR-DYN packets can update context(SID).

   Note: All other fields are the same as for the respective ROHC
   profiles for UDP [2].

6. Security Considerations

   The security considerations of RFC 3095 [2] apply integrally to this
   document, without modification.

7. IANA Considerations

   ROHC profile identifiers 0x0007 (ROHC RTP/UDP-Lite) and 0x0008 (ROHC
   UDP-Lite) have been reserved by the IANA for the profiles defined in
   this document (RFC 4019).

   Two ROHC profile identifiers must be reserved by the IANA for the
   profiles defined in this document. Since profile number 0x0006 is
   being saved for the TCP/IP (ROHC-TCP) profile, profile numbers 0x0007
   and 0x0008 are the most suitable unused identifiers available, and
   should thus be used. As for previous ROHC profiles, profile numbers
   0xnn07 and 0xnn08 must also be reserved for future variants of these
   profiles. The registration suggested for the "RObust Header
   Compression (ROHC) Profile Identifiers" name space:

```
    OLD:    0x0006-0xnn7F      To be Assigned by IANA

    NEW:    0xnn06             To be Assigned by IANA
            0x0007             ROHC RTP/UDP-Lite          [RFC4019]
            0xnn07             Reserved
            0x0008             ROHC UDP-Lite              [RFC4019]
            0xnn08             Reserved
            0x0009-0xnn7F      To be Assigned by IANA
```

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   [7]   Postel, J., "User Datagram Protocol", STD 6, RFC 768, August
         1980.

   [8] Schulzrinne, H., Casner, S., Frederick, R., and V. Jacobson,
        "RTP: A Transport Protocol for Real-Time Applications", STD 64,
        RFC 3550, July 2003.

Appendix A. Detailed Classification of Header Fields

   This section summarizes the difference from the classification found
   in the corresponding appendix in RFC 3095 [2] and similarly provides
   conclusions about how the various header fields should be handled by
   the header compression scheme to optimize compression and
   functionality. These conclusions are separated based on the behavior
   of the UDP-Lite Checksum Coverage field and use the expected change
   patterns described in section 3.2 of this document.

A.1. UDP-Lite Header Fields

   The following table summarizes a possible classification for the UDP-
   Lite header fields in comparison with the classification for UDP,
   using the same classes as in RFC 3095 [2].

   Header fields of UDP-Lite and UDP:

		UDP-Lite	UDP
Header Field	Size (bits)	Class	Class
Source Port	16	STATIC-DEF	STATIC-DEF
Destination Port	16	STATIC-DEF	STATIC-DEF
Checksum Coverage	16	INFERRED STATIC CHANGING	
Length	16		INFERRED
Checksum	16	CHANGING	CHANGING

   Source and Destination Port

      Same as for UDP. Specifically, these fields are part of the
      definition of a stream and must thus be constant for all packets in
      the stream. The fields are therefore classified as STATIC-DEF.

   Checksum Coverage

      This field specifies which part of the UDP-Lite datagram is covered
      by the checksum. It may have a value of zero or be equal to the
      datagram length if the checksum covers the entire datagram, or it
      may have any value between eight octets and the length of the
      datagram to specify the number of octets protected by the checksum,

calculated from the first octet of the UDP-Lite header. The value
of this field may vary for each packet, and this makes the value
unpredictable from a header-compression perspective.

Checksum

   The information used for the calculation of the UDP-Lite checksum
   is governed by the value of the checksum coverage and minimally
   includes the UDP-Lite header. The checksum is a changing field
   that must always be sent as-is.

The total size of the fields in each class, for each expected change
pattern (see section 3.2), is summarized in the tables below:

Pattern 1:

Class	Size (octets)	
INFERRED	2	Checksum Coverage
STATIC-DEF	4	Source Port / Destination Port
CHANGING	2	Checksum

Pattern 2:

Class	Size (octets)	
STATIC-DEF	4	Source Port / Destination Port
STATIC	2	Checksum Coverage
CHANGING	2	Checksum

Pattern 3:

Class	Size (octets)	
STATIC-DEF	4	Source Port / Destination Port
CHANGING	4	Checksum Coverage / Checksum

A.2. Header Compression Strategies for UDP-Lite

   The following table revisits the corresponding table (table A.1) for
   UDP from [2] (section A.2) and classifies the changing fields based
   on the change patterns previously identified in section 3.2.

   Header compression strategies for UDP-Lite:

Field	Pattern	Value/Delta	Class	Knowledge
	#1	Value	CHANGING	INFERRED
Checksum	#2	Value	RC	UNKNOWN
Coverage	#3	Value	IRREGULAR	UNKNOWN
Checksum	All	Value	IRREGULAR	UNKNOWN

A.2.1. Transmit initially but be prepared to update

   UDP-Lite Checksum Coverage (Patterns #1 and #2)

A.2.2. Transmit as-is in all packets

   UDP-Lite Checksum
   UDP-Lite Checksum Coverage (Pattern #3)

Appendix B. Detailed Format of the CCE Packet Type

   This section provides an expanded view of the format of the CCE
   packet, based on the general ROHC RTP compressed header [2] and the
   general format of a compressed header of the ROHC IP-Only profile
   [3]. The modifications necessary to carry the base header of a
   packet of type 2, 1 or 0 [2] within the CCE packet format, along with
   the additional fields to properly handle compression of multiple IP
   headers, result in the following structure for the CCE packet type:

```
        0   1   2   3   4   5   6   7
       --- --- --- --- --- --- --- ---
      :           Add-CID octet       :  If for small CIDs and CID 1 - 15
      +---+---+---+---+---+---+---+---+
      | 1   1   1   1   1   0   F | K |  Outer packet type identifier
      +---+---+---+---+---+---+---+---+
      :                               :
      /   0, 1, or 2 octets of CID    /  1 - 2 octets if large CIDs
      :                               :
      +---+---+---+---+---+---+---+---+
      |   First octet of base header  |  (with "inner" type indication)
      +---+---+---+---+---+---+---+---+
      /    Remainder of base header    /  Variable number of bits
      +---+---+---+---+---+---+---+---+
```
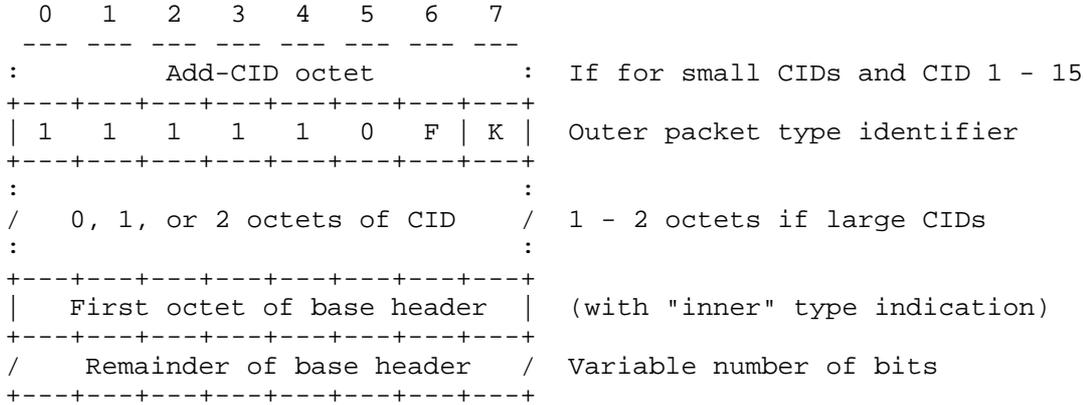
```
        0   1   2   3   4   5   6   7
      --- --- --- --- --- --- --- ---
     :                               :
     /           Extension           /  See RFC 3095 [2], section 5.7.
     :                               :
      --- --- --- --- --- --- --- ---
     :                               :
     +   IP-ID of outer IPv4 header  +  See RFC 3095 [2], section 5.7.
     :                               :
      --- --- --- --- --- --- --- ---
     /     AH data for outer list    /  See RFC 3095 [2], section 5.7.
      --- --- --- --- --- --- --- ---
     :                               :
     +          GRE checksum         +  See RFC 3095 [2], section 5.7.
     :                               :
      --- --- --- --- --- --- --- ---
     :                               :
     +   IP-ID of inner IPv4 header  +  See RFC 3095 [2], section 5.7.
     :                               :
      --- --- --- --- --- --- --- ---
     /     AH data for inner list    /  See RFC 3095 [2], section 5.7.
      --- --- --- --- --- --- --- ---
     :                               :
     +          GRE checksum         +  See RFC 3095 [2], section 5.7.
     :                               :
      --- --- --- --- --- --- --- ---
     :           List of             :  Variable, given by static chain
     /        dynamic chains         /  (includes no SN).
     :   for additional IP headers   :  See [3], section 3.2.
      --- --- --- --- --- --- --- ---
     :                               :
     +  UDP-Lite Checksum Coverage   +  2 octets
     :                               :
     +---+---+---+---+---+---+---+---+
     :                               :
     +       UDP-Lite Checksum       +  2 octets
     :                               :
     +---+---+---+---+---+---+---+---+

     F,K: F,K = 00 is reserved at framework level (IR-DYN);
          F,K = 01 indicates CCE();
          F,K = 10 indicates CCE(ON);
          F,K = 11 indicates CCE(OFF).
```

   Note that this document does not define (F,K) = 00, as this would
   collide with the IR-DYN packet type already reserved at the ROHC
   framework level.

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