Datagram Congestion Control Protocol (DCCP)
Congestion Control ID 3 Dropped Packets Option

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Abstract

   This document describes the Dropped Packets option, a mechanism for
   reporting the number of lost and marked packets per loss interval in
   the Datagram Congestion Control Protocol (DCCP)'s Congestion Control
   ID 3, TCP-Friendly Rate Control. This option may be useful for
   applications that need to know precisely how many packets are being
   dropped.

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1. Introduction

   The Datagram Congestion Control Protocol (DCCP) [RFC4340] allows the
   use of several distinct congestion control mechanisms. One of these,
   Congestion Control Identifier 3 [RFC4342], specifies the use of TCP-
   Friendly Rate Control (TFRC) [RFC3448]. The core information
   reported by CCID 3 receivers is a list of recent loss intervals,
   where a loss interval begins with a lost or ECN-marked data packet;
   continues with at most one round-trip time's worth of packets that
   may or may not be lost or marked; and completes with an arbitrarily
   long series of non-dropped, non-marked data packets. Loss intervals
   model the congestion behavior of TCP NewReno senders, which reduce
   their sending rate at most once per window of data packets.
   Consequently, the number of packets lost in a loss interval is not
   important for either TCP's or TFRC's congestion response. CCID 3's
   Loss Intervals option reports the length of each loss interval's
   lossy part, not the number of packets that were actually lost or
   marked in that lossy part.

   Nevertheless, applications and experimental variants of TFRC, such as
   the Small Packet variant, may be interested in the number of packets
   lost or marked in a loss interval, over and above the length of the
   loss interval in packets. This document specifies the Dropped
   Packets option, a CCID 3-specific option that reports this
   information. Together with the existing Loss Intervals option, the
   Dropped Packets option allows CCID 3 senders to discover exactly how
   many packets were dropped from each loss interval.

   The mechanisms in this document do not change existing CCID 3
   congestion response behavior. CCID 3's congestion response still

depends entirely on loss interval lengths, not the number of packets
dropped per loss interval. Most CCID 3 senders will therefore ignore
the contents of any Dropped Packets options they receive. Sending
applications may, however, be interested in Dropped Packets
information.

2. Conventions

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 [RFC2119].

All multi-byte numerical quantities in CCID 3, such as arguments to
options, are transmitted in network byte order (most significant byte
first).

A DCCP half-connection consists of the application data sent by one
endpoint and the corresponding acknowledgements sent by the other
endpoint. The terms "HC-Sender" and "HC-Receiver" denote the
endpoints sending application data and acknowledgements,
respectively. Since CCIDs apply at the level of half-connections, we
abbreviate HC-Sender to "sender" and HC-Receiver to "receiver" in
this document. See [RFC4340] for more discussion.

For simplicity, we say that senders send DCCP-Data packets and
receivers send DCCP-Ack packets. Both of these categories are meant
to include DCCP-DataAck packets.

The phrases "ECN-marked" and "marked" refer to packets marked ECN
Congestion Experienced unless otherwise noted.

3. Options and Features

This document defines a single CCID 3-specific option, Dropped
Packets.

Type	Option Length	Meaning	DCCP-Data?	Section Reference
195	variable	Dropped Packets	N	3.1

Table 1: Additional DCCP CCID 3 Options

The "DCCP-Data?" column indicates that Dropped Packets MUST be
ignored when it occurs on a DCCP-Data packet.

A CCID 3-specific feature governing the use of the Dropped Packets
option is also defined.

```
                                    Rec'n Initial         Section
         Number   Meaning           Rule   Value  Req'd Reference
         ------   -------           -----  -----  ----- ---------
           195    Send Dropped Packets    SP      0      N      3.2
```

                Table 2: Additional DCCP CCID 3 Feature Numbers

   The column meanings are described in [RFC4340], Table 4. "Rec'n
   Rule" defines the feature's reconciliation rule, where "SP" means
   server-priority. "Req'd" specifies whether every CCID 3
   implementation MUST understand a feature; Send Dropped Packets is
   optional, in that it behaves like an extension ([RFC4340], Section
   15).

3.1. Dropped Packets Option

```
    +--------+--------+-------...-------+--------+-------
    |11000011| Length |   Drop Count    | More Drop Counts...
    +--------+--------+-------...-------+--------+-------
     Type=195            3 bytes
```

   The receiver reports the number of lost or marked packets in its
   recently observed loss intervals using a Dropped Packets option.

   The Dropped Packets option contains information about one to 84
   consecutive loss intervals, always including the most recent loss
   interval. As with CCID 3's Loss Intervals option, intervals are
   listed in reverse chronological order. Should more than 84 loss
   intervals need to be reported, multiple Dropped Packets options can
   be sent; the second option begins where the first left off, and so
   forth.

   One Drop Count is specified per loss interval. Drop Count is a
   24-bit number that equals the number of packets lost or received ECN-
   marked during the corresponding loss interval. By definition, this
   number MUST NOT exceed the corresponding loss interval's Loss Length.

   Dropped Packets options SHOULD be sent in tandem with corresponding
   Loss Intervals options. Consider a CCID 3 receiver that is reporting
   Dropped Packets information. When this receiver sends a feedback
   packet containing information about the N most recent loss intervals
   (packaged in one or more Loss Intervals options), it SHOULD include
   on the same feedback packet one or more Dropped Packets options
   covering exactly those N loss intervals. CCID 3 senders MUST ignore
   Drop Counts information for loss intervals not covered by a Loss
   Intervals option on the same feedback packet. Conversely, a CCID 3
   sender might want to interpolate Drop Counts information for a loss
   interval not covered by any Dropped Packets options; such a sender

SHOULD use the corresponding loss interval's Loss Length as its Drop
Count.

Each loss interval's Drop Count MUST by definition be less than or
equal to its Loss Length. A Drop Count that exceeds the
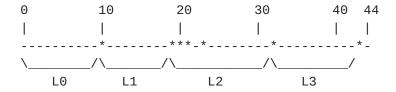corresponding Loss Length MUST be ignored.

3.1.1. Example

Consider the following sequence of packets, where "-" represents a
safely delivered packet and "*" represents a lost or marked packet.
This sequence is repeated from [RFC4342].

```
Sequence
 Numbers: 0           10          20          30          40  44
          |           |           |           |           |   |
          ----------*--------***-*--------*----------*-
```

Assuming that packet 43 was lost, not marked, this sequence might be
divided into loss intervals as follows:

```
          0           10          20          30          40  44
          |           |           |           |           |   |
          ----------*--------***-*--------*----------*-
          _____/_____/_____/_____/
              L0          L1          L2          L3
```

A Loss Intervals option sent on a packet with Acknowledgement Number
44 to acknowledge this set of loss intervals might contain the bytes
193,39,2, 0,0,10, 128,0,1, 0,0,10, 0,0,8, 0,0,5, 0,0,10, 0,0,8,
0,0,1, 0,0,8, 0,0,10, 128,0,0, 0,0,15; for interpretation of this
option, see [RFC4342]. A Dropped Packets option sent in tandem on
this packet would contain the bytes 195,14, 0,0,1, 0,0,4, 0,0,1,
0,0,0. This is interpreted as follows.

195 The Dropped Packets option number.

14 The length of the option, including option type and length bytes.
    This option contains information about (14 - 2)/3 = 4 loss
    intervals. Note that the two most recent sequence numbers are
    not yet part of any loss interval -- the Loss Intervals option
    includes them in its Skip Length -- and are thus not included in
    the Dropped Packets option.

0,0,1
    These bytes define the Drop Count for L3, which is 1. As
    required, the Drop Count is less than or equal to L3's Loss
    Length, which is also 1.

   0,0,4
      The Drop Count for L2 is 4.

   0,0,1
      The Drop Count for L1 is 1.

   0,0,0
      Finally, the Drop Count for L0 is 0.

3.2. Send Dropped Packets Feature

   The Send Dropped Packets feature lets CCID 3 endpoints negotiate
   whether the receiver MUST provide Dropped Packets options on its
   acknowledgements. DCCP A sends a "Change R(Send Dropped Packets, 1)"
   option to ask DCCP B to send Dropped Packets options as part of its
   acknowledgement traffic.

   Send Dropped Packets has feature number 195 and is server-priority.
   It takes one-byte Boolean values. DCCP B MUST send Dropped Packets
   options on its acknowledgements when Send Dropped Packets/B is one,
   although it MAY send Dropped Packets options even when Send Dropped
   Packets/B is zero. Values of two or more are reserved. A CCID 3
   half-connection starts with Send Dropped Packets equal to zero.

4. Security Considerations

   The Dropped Packets option does not affect the existing security
   considerations for DCCP CCID 3, which have been discussed in
   [RFC4340] and [RFC4342]. For instance, the Dropped Packets option
   neither helps nor hinders the existing CCID 3 mechanisms for ECN
   Nonce verification.

5. IANA Considerations

   This specification allocates two values in namespaces managed by
   IANA. Specifically, the value 195 is allocated from the DCCP CCID
   3-specific option type registry for the Dropped Packets option (Table
   1), and the value 195 is allocated from the DCCP CCID 3-specific
   feature number registry for the Send Dropped Packets feature (Table
   2).

6. Thanks

   Thanks to Sally Floyd for inspiring this document.

Normative References

    [RFC2119]   Bradner, S., "Key words for use in RFCs to Indicate
                    Requirement Levels", BCP 14, RFC 2119, March 1997.

    [RFC3448]   Handley, M., Floyd, S., Padhye, J., and J. Widmer,
                    "TCP Friendly Rate Control (TFRC): Protocol
                    Specification", RFC 3448, January 2003.

    [RFC4340]   Kohler, E., Handley, M., and S. Floyd, "Datagram
                    Congestion Control Protocol (DCCP)", RFC 4340, March
                    2006.

    [RFC4342]   Floyd, S., E. Kohler, and J. Padhye, "Profile for
                    Datagram Congestion Control Protocol (DCCP) Congestion
                    Control ID 3: TCP-Friendly Rate Control (TFRC)", RFC
                    4342, March 2006.

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