PPP Over Ethernet (PPPoE) Extensions
for Credit Flow and Link Metrics

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Status of this Memo

Abstract

   The Point-to-Point Over Ethernet (PPPoE) Protocol [3] provides a
   standard method for encapsulating Point-to-Point Protocols (PPP) [1]
   over Ethernet.

   This document extends the PPPoE protocol with a credit based flow
   control mechanism and Link Quality Metric report. The PPPoE
   specification is also extended to allow TLV Tags in the PPP Session
   Stage. These extensions are optional to retain backwards
   compatibility and at the same time provide for future extendibility.

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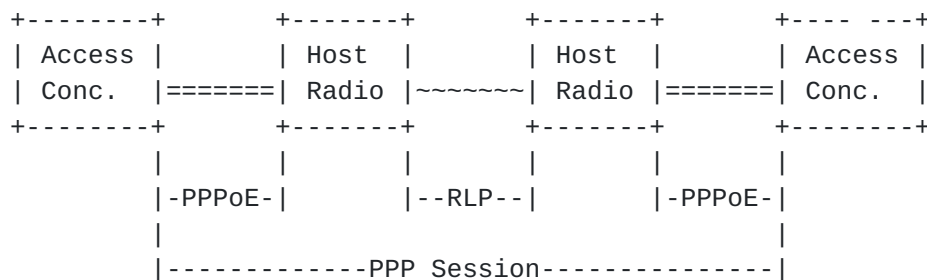
1. Introduction

   PPP over Ethernet (PPPoE) [3] is a method of establishing and
   encapsulating sessions between hosts and traffic aggregators (Access
   Concentrators) for PPP transport. This method of transporting PPP
   traffic works well when both session endpoints have similar
   bandwidth, forwarding, and buffering capabilities that do not vary
   over time. It is insufficient for applications with variable
   bandwidth and limited buffering. This document describes a method
   for extending PPPoE to support credit based session flow control and
   session based metrics exchanges for mobile radio network
   applications.

   In the diagram below PPPoE sessions between and access concentrator
   (IP routers) and a radio transmission system are used to represent
   individual radio neighbors. The radio transmission system
   establishes point to point Radio Link Protocol (RLP) sessions with
   its neighbors and establishes a corresponding PPPoE session for each
   neighbor with the transmission system's associated access
   concentrator (router).

```
   +--------+        +-------+        +-------+        +---- ---+
   | Access |        | Host  |        | Host  |        | Access |
   | Conc.  |=======| Radio |~~~~~~~| Radio |=======| Conc.  |
   +--------+        +-------+        +-------+        +--------+
        |        |        |        |        |        |
        |-PPPoE-|        |--RLP--|        |-PPPoE-|
        |                                          |
        |-------------PPP Session---------------|
```

   The capabilities of the RF links between RLP neighbors may vary over
   time due to mobility and environmental conditions. In many
   instances, the radio transmission system has limited buffering
   capability to handle capacity changes in the RLP sessions. To limit
   buffering in the radio transmission system, a session flow control
   mechanism is necessary to provide dynamic buffering feedback to the
   router.

   From the router's perspective in the diagram, each PPPoE session
   between it and the radio transmission system represents a link to a
   routable peer. For efficient routing, a mechanism of assigning and
   dynamically updating a cost for each link (PPPoE session) is
   required. When a modified PPPoE session between the router and the
   radio is established, link metrics must be exchanged. When the RLP
   session capabilities change, link metric feedback is provided to the
   router.

2. Conventions used in this document

   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 [2].

3. Payload

   The Ethernet payload version field retains its value of 0x01. The
   extensions for credit flow control and link quality metrics are
   optional and backward compatible.

4. Overview of Protocol Extensions

   PPPoE has two distinct stages. There is a Discovery Stage and a PPP
   Session Stage. During the Discovery Stage, the Host can optionally
   request a flow controlled PPP Session Stage. Once the Access
   Concentrator acknowledges the Host flow control request, all PPP
   Session Stage traffic MUST be flow controlled.

5. Discovery Stage

   The packet exchange of the Discovery Stage is unchanged by this
   specification. The specifications of the Session Request (PADR) and
   the Session Confirmation (PADS) packets are extended to include the
   optional Credit Tag TLV.

   In addition, the optional Credit Grant (PADG) packet, the Credit
   Response (PADC) packet and the Link Quality Metric (PADQ) packets
   are introduced.

5.1 PPPoE Active Discovery Request (PADR)

   The PADR packet is extended to optionally contain a single Credit
   Tag TLV, indicating that the Host requests credit flow control for
   this session. The Credit Tag contains the Forward Credit
   Notification (FCN) and the Backward Credit Notification (BCN) to be
   applied to the PPP Session Stage. The FCN provides the initial
   credits granted to the Access Concentrator by the Host. The BCN
   value is set to 0.

   An example packet is shown in Appendix B.

5.2 PPPoE Active Discovery Session-confirmation (PADS)

   The PADS packet is extended to optionally contain a single Credit
   Tag TLV, indicating the Forward Credit Notification (FCN) and the
   Backward Credit Notification (BCN) of the PPP Session Stage.

   If the PADR contained a Credit Tag, then the Access Concentrator
   PADS packet indicates support for credit flow control by including a
   Credit Tag. The PADS Credit Tag FCN represents the number of
   credits being initially granted to the Host. The Credit Tag BCN is
   an echo of the number of credits that the Host had granted to the
   Access Concentrator in the previous PADR packet.

   Exchange of the Credit Tag TLV in the PADR and PADS indicates that
   credit flow control is supported by both the Access Concentrator and
   the Host for the designated PPP Session Stage. This is binding and
   MUST be followed for the entire duration of the PPP Session Stage.
   A sessionÆs credit binding MUST be established prior to any other
   credit indications can be exchanged.

   The Access Concentrator PADS SHOULD ONLY carry the Credit Tag in
   response to a Host PADR with Credits. If the Access Concentrator
   does not support credit flow, it should not include the Credit Tag
   in its PADS response. The Host MUST terminate a credit based
   session that can not be supported by the Access Concentrator.
   Credit Tags transmitted outside an established credit based session
   MUST be ignored.

   An example packet is shown in Appendix B.

5.3 PPPoE Active Discovery Session-Grant (PADG)

   The PPPoE Active Discovery Session-Grant (PADG) is a new packet
   defined in this specification. An Access Concentrator or Host MAY
   send a PADG at any time after the PADR/PADS exchange to grant
   incremental flow control credits. The CODE field is set to 0x0A and
   the SESSION_ID MUST be set to the unique value generated for this
   PPPoE Session.

   The peer may then transmit data until the credits are exhausted.

   When the peer receives a PADG packet, it adds the incremental
   credits to its working credit count and responds with a PPPoE Active
   Discovery Session-Credit (PADC) packet indicating the accumulated
   credits.

   The PADG packet MUST contain a single Credit Tag TLV, indicating the

Forward Credit Notification (FCN) and the Backward Credit
Notification (BCN) of the PPP Session.

The Credit Tag FCN indicates the number of incremental credits being granted to the peer. A value between 1 and 0x0ffff represent an incremental credit grant. The peer must add these credits to its accumulated transmit credit count. A value of 0x00 represents a NULL grant, meaning that there are no additional credits being granted.

The Credit Tag BCN indicates the remaining absolute credits that have been granted by the peer.

Once a credit has been granted, it MUST be honored. The largest number of outstanding credits at any time is 0xffff.

The PADG packet MUST contain a single Sequence Number Tag TLV. This tag is used to carry a unique 16-bit sequence number to uniquely identify each request. The sequence number SHOULD be initialized to zero and incremented by one for each new PADG. For re-transmitted PADGs, the same sequence number that was used in the previous packet transmission is repeated.

An example packet is shown in Appendix B.

5.4 PPPoE Active Discovery Session-Credit Response (PADC)

The PPPoE Active Discovery Session-Credit Response (PADC) is a new packet defined in this specification. An Access Concentrator or Host MUST send a PADC in response to a PADG. The CODE field is set to 0x0B and the SESSION_ID MUST be set to the unique value generated for this PPPoE session.

The PADC packet MUST contain a single Credit Tag TLV, indicating the Forward Credit Notification (FCN) and the Backward Credit Notification (BCN) of the PPPoE session, and any number of other Tag types.

The Credit Tag FCN represents the absolute credits remaining that have granted to the peer. The Credit Tag BCN represents the remaining absolute credits that have been granted to the node from the peer.

The PADG packet MUST contain a single Sequence Number Tag. The sequence number should be the sequence number associated with the PADG.

An example packet is shown in Appendix B.

5.5 PPPoE Active Discovery Quality (PADQ)

   The PPPoE Active Discovery Quality (PADQ) is a new packet defined in
   this specification. An Access Concentrator or Host MAY send an
   optional PADQ at any time to query or report link quality metrics.

   When transmitting PPP streams over wireless links through radio
   modems, the quality of the RF link directly affects the throughput.
   The PPPoE Active Discovery Quality (PADQ) packet can be used by the
   radio modem to report RF link metrics. The CODE field is set to 0x0C
   and the SESSION_ID MUST be set to the unique value generated for
   this PPPoE session.

   The PADQ MUST carry a single Metric Tag TYPE, which contains the
   following fields:

      Receive only û is a bit that indicates if the link is bi-
      directional or receive only. A value of ô1ö indicates that the
      link is receive-only.

      Maximum data rate - is the maximum theoretical data rate, in
      kilobits per second (kbps), that the RF link is capable of
      providing. When metrics are reported, the maximum data rate MUST
      be reported.

      Current data rate û is the current data rate, in kilobits per
      second (kbps), achieved on the RF link. If there is no
      distinction between maximum data rate and current data rate,
      current data rate should equal to maximum data rate.

      Latency û is the transmission delay that a packet encounters as
      it is transmitted over the RF link. This is reported in absolute
      delay, milliseconds. If latency can not be calculated, a value
      of 0 should be reported.

      Resources û is a percentage, 0-100, representing the amount of
      remaining or available resources, such as battery power. If
      resources can not be calculated, a value of 100 should be
      reported.

      Relative Link Quality (RLQ) û is a non-dimensional number, 0-100,
      representing the relative link quality. A value of 100
      represents a link of the highest quality. If the RLQ can not be
      calculated, a value of 100 should be reported.

   The PPPoE Active Discovery Quality (PADQ) packet can be used to
   query link metrics by setting the PADQ Metric Tag Length to zero.

An example packet is shown in Appendix B.

6. PPP Session Stage

   This specification defines the optional use of TLV Tags in the PPP
   Session Stage The first field following the PPP Session Stage
   LENGTH MUST be checked. If the value is equal to the PPP Protocol
   identifier (0xc021), then normal packet (payload) processing occurs.
   When the field following the PPP Session Stage LENGTH is not the PPP
   Protocol identifier (0xc021), a TLV is assumed. In this case, the
   Tag length is subtracted from the overall payload length.

   The Credit Tag is the only optional TLV permitted in the PPP Session
   Stage. The Credit Tag TLV is used to support in-band flow control.

   A PPP Session Stage packet with Credits is shown in Appendix B.

7. Credit Flow Considerations

   For a given session, credit grants exchanged in the Discovery Stage,
   PADG-PADC, are referred to as out-of-band. Credit grants exchanged
   in the PPP Session Stage are referred to as in-band. Credit
   processing is only applied to the packets transmitted in the PPP
   Session Stage.

   Out-of-band credit management is handled by periodic exchange of the
   PPPoE Active Discovery Grant PADG and PPPoE Active Discovery Credit
   (PADC) packets.

   In-band credit management allows credits to be incrementally granted
   with each PPP Session Stage packet. This offers the greatest credit
   granting efficiency when traffic rates are high.

   Once agreed upon during the Discovery Stage, credit grants are
   required to transmit packets in the PPP Session Stage. A node must
   grant credits to its peer, before the peer can transmit packets to
   the granting node.

   Credits are granted incrementally in the forward direction. Locally
   a node manages the credits that it has granted to a peer as well as
   the credits that a peer has granted to it.

   Grants received from a peer are added to a local running credit
   counter. The accumulated credits are decremented with each packet
   the node transmits to the peer. When the running counter reaches
   zero, the node stops transmitting packets to the peer.

   To manage the credits that a node has granted, the node maintains a
   running counter. With each PPP Session Stage packet received from

the peer, the running counter is decremented. When the running
counter reaches zero, no additional packets are expected. The node

incrementally grants more credits to the peer to maintain packet
flow. Packets received when granted credits have been exhausted are
discarded.

The largest possible credit limit is 0x0ffff. If an incremental
credit grant causes the accumulated count to exceed this value, the
max value is used.

One unit of credit represents 64-bytes, so a grant of 4 credits
translates to 256-bytes.

8. Other Considerations

When a node does not receive a PADC packet within a specified amount
of time, it should transmit a new PADG packet with zero credits,
using the same sequence number and double the waiting period. A PADC
response with the associated sequence number will indicate if the
previously granted credits were accumulated or not. If not, the
PADG with credits, with an incremented sequence number, should be
transmitted. This process should be repeated until granted credits
are properly acknowledged or as many times as desired.

When a node does not receive a PADQ metric packet within a specified
amount of time, it should resend the PADQ query packet and double
the waiting period. This is repeated as many times as desired.

A node may autonomously generate PADQ metric packets. The rate of
autonomously generate PADQ metric packets may need to be throttled
so not to overrun the peer.

9. Security Considerations

No new security considerations are provided in this document.

10. Appendix A: Tag Values

    Feature Tag_Types and Tag_Values

        0x0106 Credits

        This tag contains the Forward Credit Notification (FCN) and the
        Backward Credit Notification (BCN). The Credit Tag TLV is
        OPTIONAL with the PADR, PADS and the PPPoE data payload packet
        (ETHER_TYPE=8864).

        +-+
        | Tag Type = 0x0106 | Tag Length=0x04 |
        +-+
        | FCN | BCN |
        +-+

        0x0107 Metrics

        This tag is used to report the link quality and performance. The
        Metrics Tag TLV contains the Receive Only indicator, Resource
        status, Latency, Relative Link Quality (RLQ), Current data rate
        and Maximum data rate. The Metrics TLV is required by the PADQ
        packet.

        +-+
        | Tag Type = 0x0107 | Tag Length=0x0A |
        +-+
        | Reserved |R| RLQ | Resource |
        +-+
        | Latency (MS) | Current Datarate (kbps) |
        +-+
        | Maximum Datarate (kbps) |
        +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

        0x0108 Sequence Number

        This tag is used to carry a unique 16-bit sequence number in
        order to identify a specific request and the associated response.
        The sequence number SHOULD be initialized to zero and incremented
        by one for each new request sequence number. For re-transmitted
        packets, the same sequence number that was used in the previous
        packet transmission is repeated. The PADG and PADC packets
        require the Sequence Number Tag.

For example, the sequence number sent in the PADG request is
echoed in the PADC response. This ties a specific PADC response
to a specific PADG request.

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       Tag Type = 0x0108       |        Tag Length=0x02        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Sequence Number        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

11. Appendix B: Example Message Formats

   A PADR packet with OPTIONAL Credit Tag Type 0x0106:

```
                         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
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                  Access_Concentrator_mac_addr                |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |Access_Concentrator_mac_addr(c)|        Host_mac_addr         |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                      Host_mac_addr (cont)                    |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |     ETHER_TYPE = 0x8863       | v = 1 | t = 1 |  CODE = 0x19  |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |     SESSION_ID = 0x1234       |       LENGTH = 0x0C           |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |      Tag Type = 0x0101        |        Tag Length=0x00        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |      Tag Type = 0x0106        |        Tag Length=0x04        |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |            FCN                |             BCN               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

A PADS packet with OPTIONAL Credit Tag Type 0x0106:

```
                      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
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                  Access_Concentrator_mac_addr                 |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |Access_Concentrator_mac_addr(c)|       Host_mac_addr           |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                     Host_mac_addr (cont)                      |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     ETHER_TYPE = 0x8863       | v = 1 | t = 1 |  CODE = 0x65  |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |      SESSION_ID = 0x1234      |       LENGTH = 0x0C           |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |      Tag Type = 0x0101        |        Tag Length=0x00        |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |      Tag Type = 0x0106        |        Tag Length=0x04        |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |            FCN                |             BCN               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

A PADG packet with Credit Tag Type 0x0106:

```
                      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
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                     Destination_mac_addr                      |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |    Destination_mac_addr(c)    |       Source_mac_addr         |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                     Source mac_addr (cont)                    |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |    ETHER_TYPE = 0x8863        | v = 1 | t = 1 |  CODE = 0x0A  |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |    SESSION_ID = 0x1234        |     LENGTH = 0x0E             |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     Tag Type = 0x0108         |     Tag Length=0x02           |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     Sequence Number           |     Tag Type = 0x0106         |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     Tag Length=0x04           |            FCN               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |         BCN                   |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

A PADC packet with Credit Tag Type 0x0106:

```
                      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
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                      Destination_mac_addr                     |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |    Destination_mac_addr(c)    |       Source_mac_addr         |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                      Source mac_addr (cont)                   |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     ETHER_TYPE = 0x8863       | v = 1 | t = 1 |  CODE = 0x0B  |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     SESSION_ID = 0x1234       |      LENGTH = 0x0E            |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |      Tag Type = 0x0108        |       Tag Length=0x02         |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |       Sequence Number         |      Tag Type = 0x0106        |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |       Tag Length=0x04         |              FCN             |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |              BCN              |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

A PADQ packet to query for the link metrics: This is indicated by
the Metric Tag Length=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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Access_Concentrator_mac_addr               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Access_Concentrator_mac_addr(c)|        Host_mac_addr          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Host_mac_addr (cont)                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     ETHER_TYPE = 0x8863       | v = 1 | t = 1 |  CODE = 0x0C  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     SESSION_ID = 0x1234       |       LENGTH = 0x08           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Tag Type = 0x0101         |       Tag Length=0x00         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Tag Type = 0x0107         |       Tag Length=0x00         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
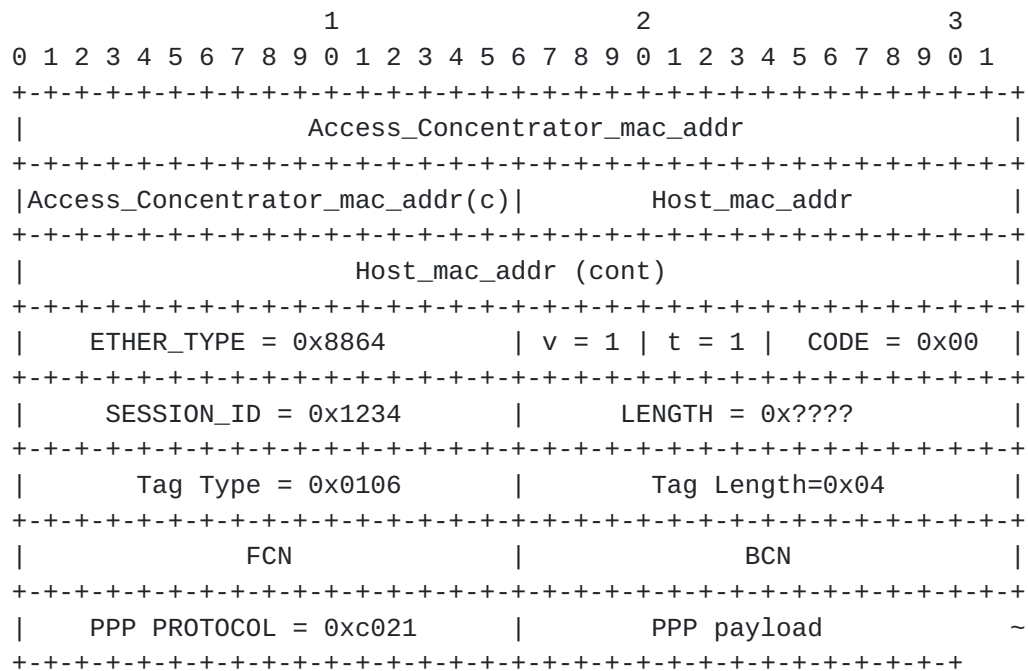
A PADQ packet with Metric Tag Type 0x0107:

```
                         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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   Access_Concentrator_mac_addr                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Access_Concentrator_mac_addr(c)|          Host_mac_addr        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Host_mac_addr (cont)                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     ETHER_TYPE = 0x8863       | v = 1 | t = 1 |  CODE = 0x0C  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     SESSION_ID = 0x1234       |       LENGTH = 0x12           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Tag Type = 0x0101        |       Tag Length=0x00         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Tag Type = 0x0107        |       Tag Length=0x0A         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Reserved            |R|      RLQ      |   Resource    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Latency (MS)          |   Current Datarate (kbps)     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    Maximum Datarate (kbps)    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

A PPP LCP packet with optional Credit Tag Type 0x0106:
While the PPP protocol value is shown (0xc021), the PPP payload is
left to the reader. This is a packet from the Host to the Access
Concentrator.

```
                      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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   Access_Concentrator_mac_addr                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Access_Concentrator_mac_addr(c)|        Host_mac_addr          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Host_mac_addr (cont)                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     ETHER_TYPE = 0x8864       | v = 1 | t = 1 |  CODE = 0x00  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     SESSION_ID = 0x1234       |      LENGTH = 0x????           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Tag Type = 0x0106         |       Tag Length=0x04          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            FCN                |           BCN                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    PPP PROTOCOL = 0xc021      |        PPP payload            ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

12. Normative References

   [1] Simpson, W., Editor, "The Point-to-Point Protocol (PPP)", STD
   51, RFC 1661, July 1994

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

   [3] Mamakos L., et. al., ôA Method for Transmitting PPP Over
   Ethernet (PPPoE)ö, RFC 2516, February 1999.

13. ContributorÆs Information

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