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A Method for Terminating PPP Over Ethernet (PPPoE) Sessions on Radio Modems with Optional Extensions for Credit Based Flow and Link Metrics

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Abstract

This document defines an optional credit based flow control mechanism for PPP over Ethernet (PPPoE) Discovery and PPP Session. It also defines a Link Quality Metric packet that can use to report link status, which in turn can be used to influence traffic flow.

Applicability

The application of these extensions can be employed when PPP traffic

is transported by radio modems. In this architecture, the Access Concentrator connects to a radio modem using Ethernet. Traffic across the Ethernet link can be flow controlled using the PPPoE extensions defined in this document.

The link quality metric packet provides a mechanism that the radio modem can use to report status and quality of the RF link to the concentrator.

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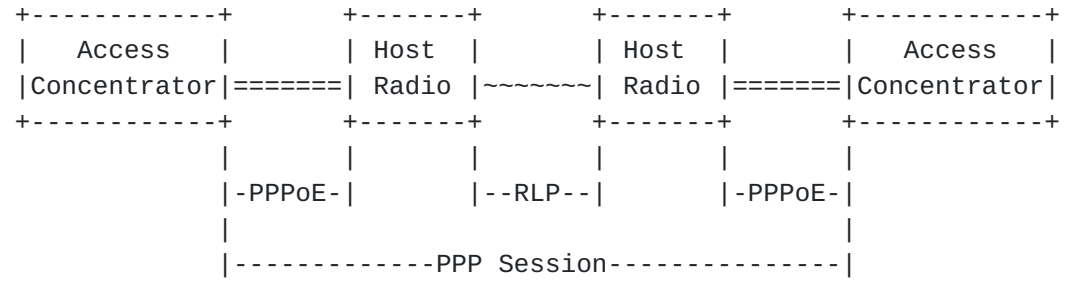
1. Introduction

PPP over Ethernet (PPPoE) provides the ability to connect a network of hosts over a simple bridging access device to a remote Access Concentrator. With this model, each host utilizes its own PPP stack and the user is presented with a familiar user interface. Access control, billing and type of service can be done on a per-user, rather than a per-site, basis. This document focuses on a point-to-point connection using radio.

PPPoE with Credit Flow Control is used between the Access Concentrator and the Radio Modem. The Radio Modem terminates the PPPoE and forwards the PPP data over the airwaves using a Radio Link Protocol (RLP). The remote radio terminates the RLP and forwards the PPP packets over the PPPoE path to its local Access Concentrator. The PPP session is Access Concentrator to Access Concentrator.



In this example, the Host Radio initiates the PPPoE session with its local Access Concentrator.

This document should be read with A Method for Transmitting PPP Over Ethernet (PPPoE)÷, RFC 2516.

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. 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. Once the Access Concentrator acknowledges the Host flow control request, all session traffic MUST be flow controlled.

The Credit Flow control feature allows proper management of resources in both the Host and Access Concentrator. This is important when throughput capabilities of one are much greater that the other.

When transmission facilities include radio modems, the quality of the radio RF link can be reported through the Link Quality Metric packet. Given this information, a node can make traffic decisions.

4. 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.

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 have been 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 may 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. 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 may optionally contain a single Credit Tag TLV, indicating the Forward Credit Notification (FCN) and the Backward Credit Notification (BCN) of the PPP Session.

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. This is binding and must be followed for the entire duration of the PPP Session. A sessionËs credit binding MUST be established prior to any other credit indications can be exchanged.

The Access Concentrator PADS SHOULD ONLY contain 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. In this case the Host should terminate the session. 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)

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 PPP 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)

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)

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 is a bit that indicates if the link is bi-directional or receive only. A value of 1÷ 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 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 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 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) 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

The packet exchange of the PPP Session Stage is unchanged by this specification. The specification does define the optional use of the Credit Tag TLV during the PPP Session. The Credit Tag TLV is used to support flow control.

When the PPP Session is a flow controlled session, the first field following the Payload Field MUST be checked. If the value of the PPP Protocol identifier is that of the Credit Tag TLV (0x0106), then

the credit tag must be processed. In this case, the Credit Tag TLV length is subtracted from the overall payload length. If the value

of the PPP Protocol identifier is not that of the Credit Tag TLV (0x0106), normal processing occurs.

The Credit Tag is the only optional tag permitted in the PPP Session Stage.

An example packet 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 must manage 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 must be 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 must stop transmitting packets to the peer.

To manage the credits that a node has granted, the node must maintain a running counter. With each PPP Session Stage packet received from the peer, the running counter must be decremented. When the running counter reaches zero, no additional packets are expected. The node must incrementally grant more credits to the peer to enable packet flow. Packets received when granted credits have been exhausted are discarded.

For a given session, credit grants exchanged in the Discovery Stage

are referred to as out-of-band. Credit grants exchanged in the PPP Session Stage are referred to as in-band. In-band credit management allows credits to be incrementally granted with each PPP Session

Stage packet. This offers the greatest efficiency with less opportunity for credit exhaust. Out-of-band credit management is handled by periodic exchange of the PPPoE Active Discovery Grant PADG and PPPoE Active Discovery Credit (PADC) packets.

The largest possible credit limit is 0x0ffff. If an incremental credit grant ever 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 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.

The rate of autonomously generated PADQ packets may need to be throttled by the radio modem so not to overrun the node.

9. Security Considerations

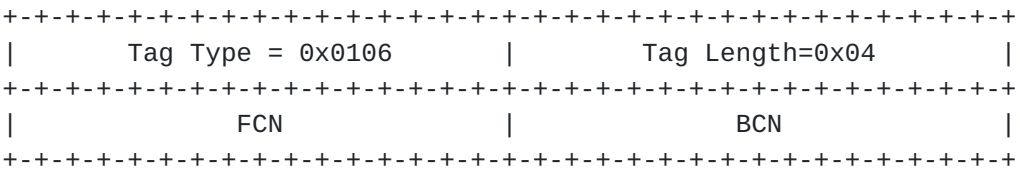
No new security considerations are provided in this document.

10 Appendix A: Tag Values

Feature Tag_Types and Tag_Values

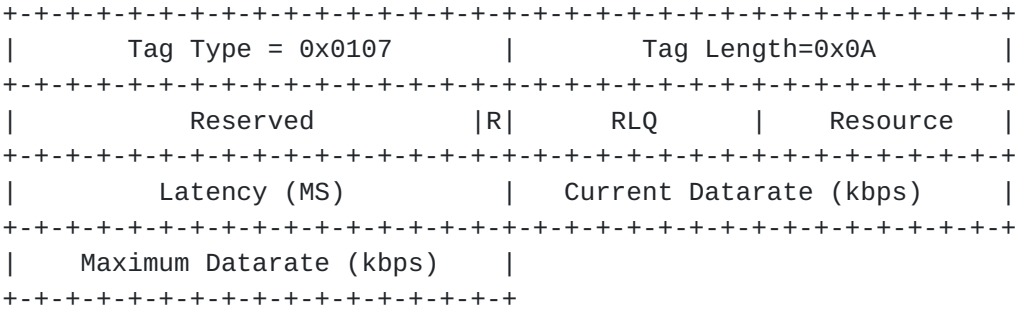
0x0106 Credits

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).



0x0107 Metrics

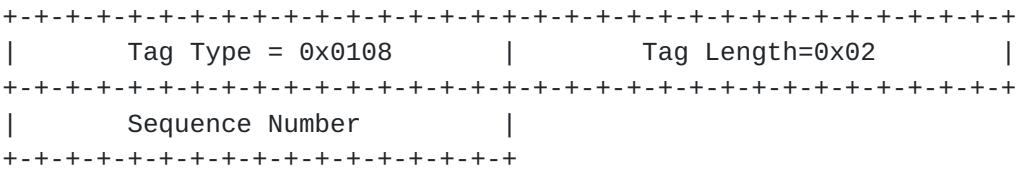
This tag is used to report the radio RF link performance. The Metrics Tag TLV contains the Receive Only indicator, Resource status, Latency, Relative Link Quality (RLQ), Current data rate and Maximum data rate. The Metrics TLV is required by the PADM packet.



0x0108 Sequence Number

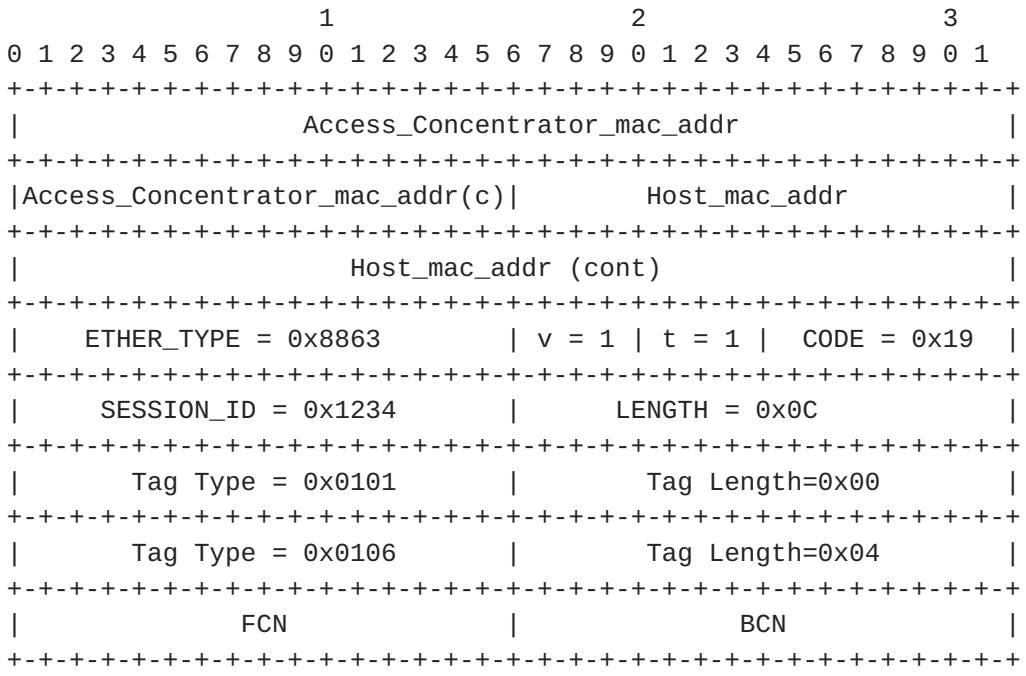
This tag is used to carry a unique 16-bit sequence number in order to identify a specific request and the associated response. The sequence number SHOULD be initialized to zero and incremented by one for each new request sequence number. For re-transmitted packets, the same sequence number that was used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

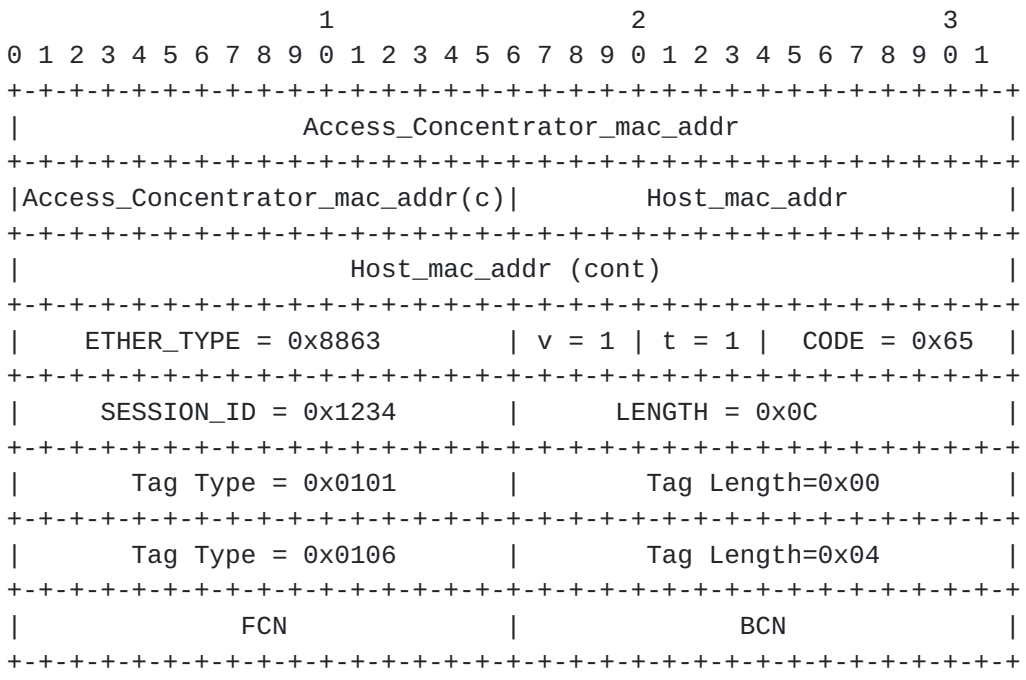


11. Appendix B: Example Message Formats

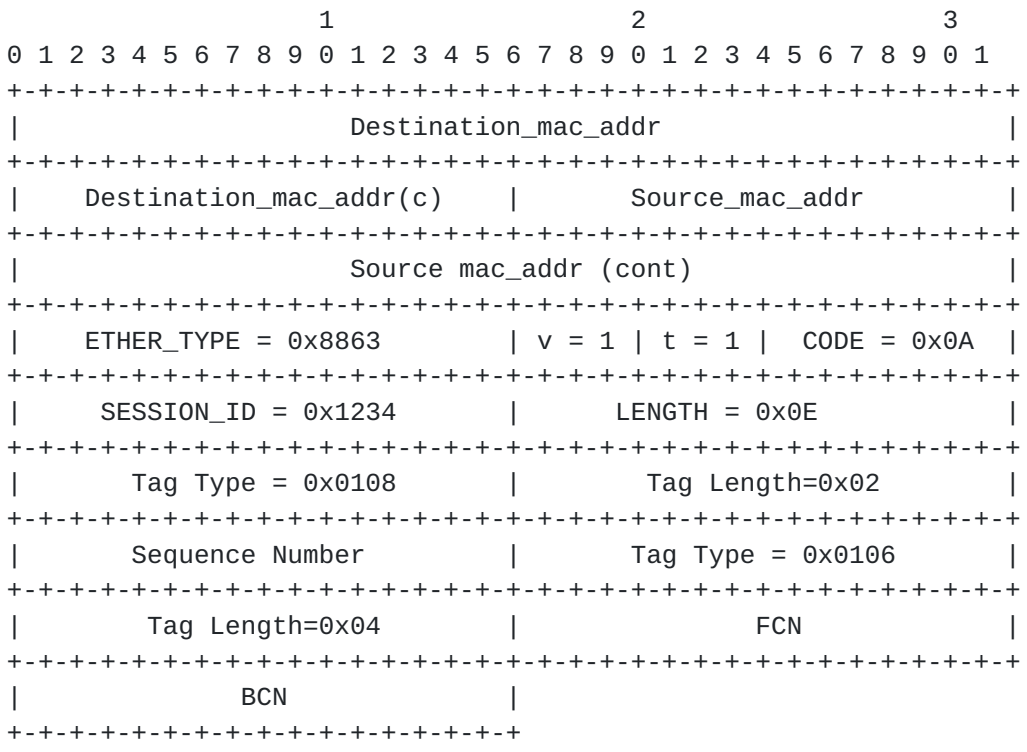
A PADR packet with OPTIONAL Credit Tag Type 0x0106:



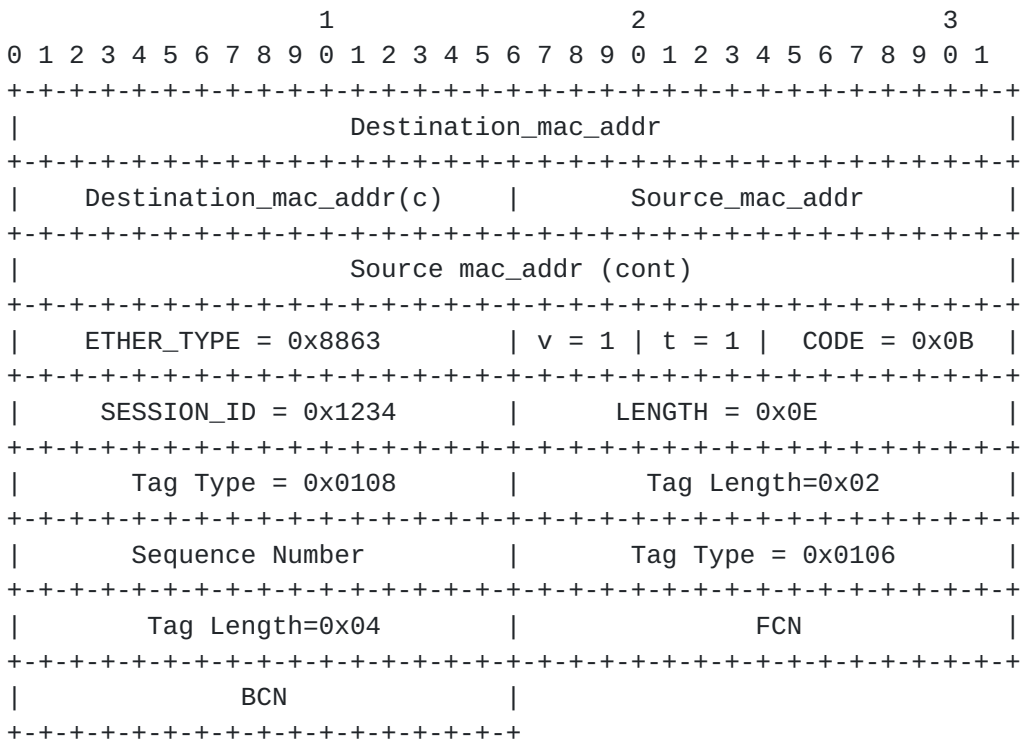
A PADS packet with OPTIONAL Credit Tag Type 0x0106:



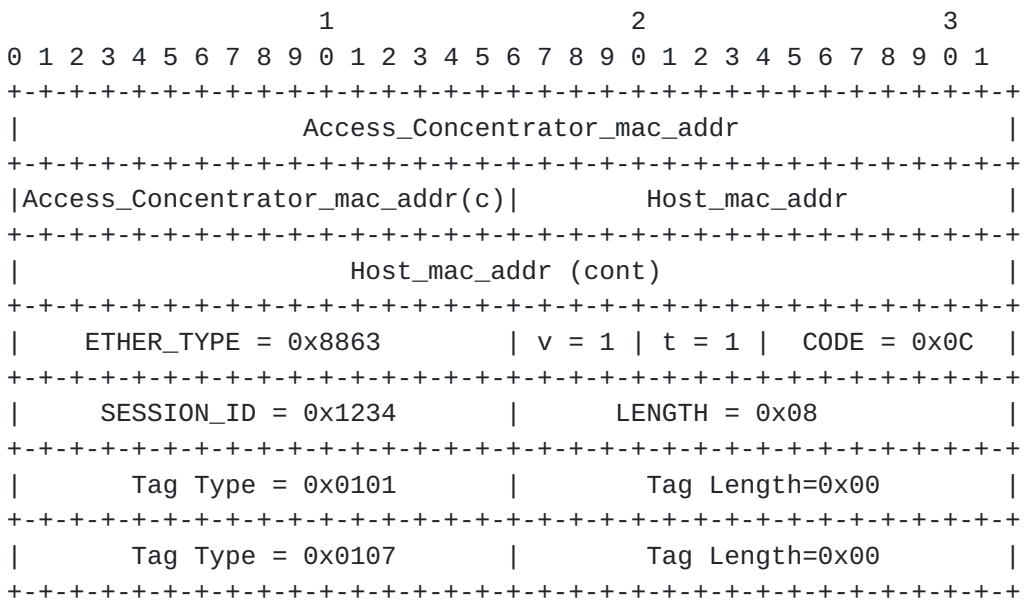
A PADG packet with Credit Tag Type 0x0106:



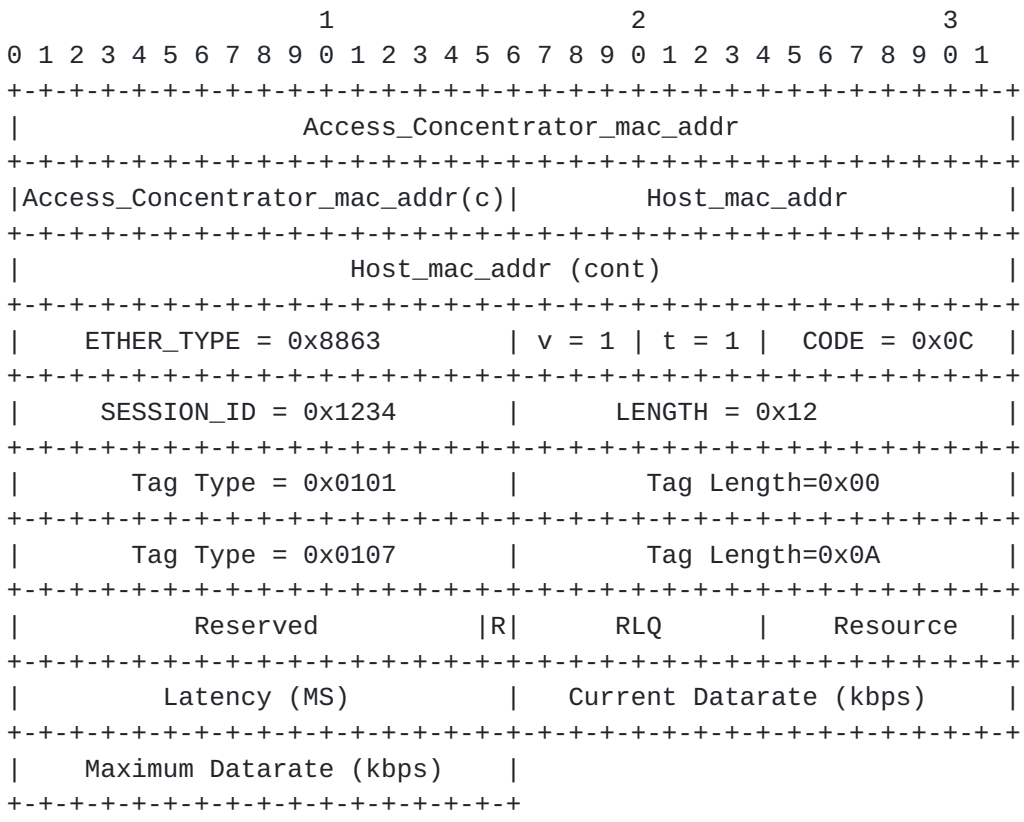
A PADC packet with Credit Tag Type 0x0106:



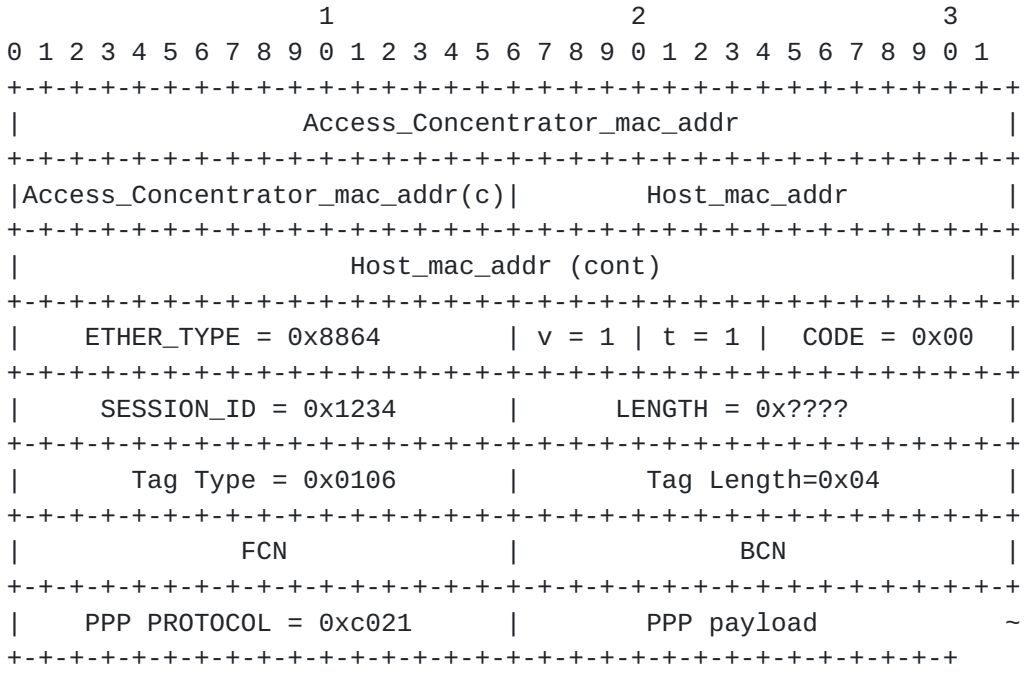
A PADQ packet to query for the RF link metrics: This is indicated by the Metric Tag Length=0.



A PADQ packet with Metric Tag Type 0x0107:



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.



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., A Method for Transmitting PPP Over Ethernet (PPPoE)÷, RFC 2516, February 1999.

13. ContributorËs Information

The authors would like to acknowledge the influence and contributions from Billy Moon and Fred Baker.

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