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RFC 9893
Dynamic Link Exchange Protocol (DLEP) Credit-Based Flow Control Messages and Data Items

Abstract

This document defines new Dynamic Link Exchange Protocol (DLEP) Data Items that are used to support credit-based flow control. Credit window control is used to regulate when data may be sent to an associated virtual or physical queue. These Data Items are extensible and reusable.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at https://www.rfc-editor.org/info/rfc9893.

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1. Introduction

The Dynamic Link Exchange Protocol (DLEP), defined in [RFC8175], provides the exchange of link-related control information between DLEP peers. DLEP peers are comprised of a modem and a router. DLEP defines a base set of mechanisms as well as support for future extensions. DLEP defines Data Items, which are sets of information that can be reused in DLEP messaging. The DLEP specification does not include any flow identification beyond DLEP endpoints, nor does it address flow control capability. Various flow control techniques are theoretically possible with DLEP. For example, a credit-window scheme for destination-specific flow control that provides aggregate flow control for both modems and routers has been proposed in [Credit-Window-Extension], and a mechanism referred to as the Control-Plane-Based Pause Extension is defined in [RFC8651]. The use of other flow control mechanisms simultaneously with credit-based flow control is not within the scope of this document.

Credit-based flow control, as a result of its proactive nature, may offer some advantages over a pause mechanism. Packet loss resulting from insufficient buffer space is less likely, as a transmitter does not send packets until the receiver has indicated that there is sufficient buffer space available.

Figure 1 illustrates a local node consisting of a router and a modem implementing DLEP. DLEP messages optionally contain a number of Data Items and Sub-Data Items. Traffic Classification Data Items provided by the modem are defined in [RFC9892]. In this case, a flow is identified based on information found in a data plane header, and one or more matches are associated with a single flow. Refer to Section 2.3 of [RFC2475] for general background on traffic classification.

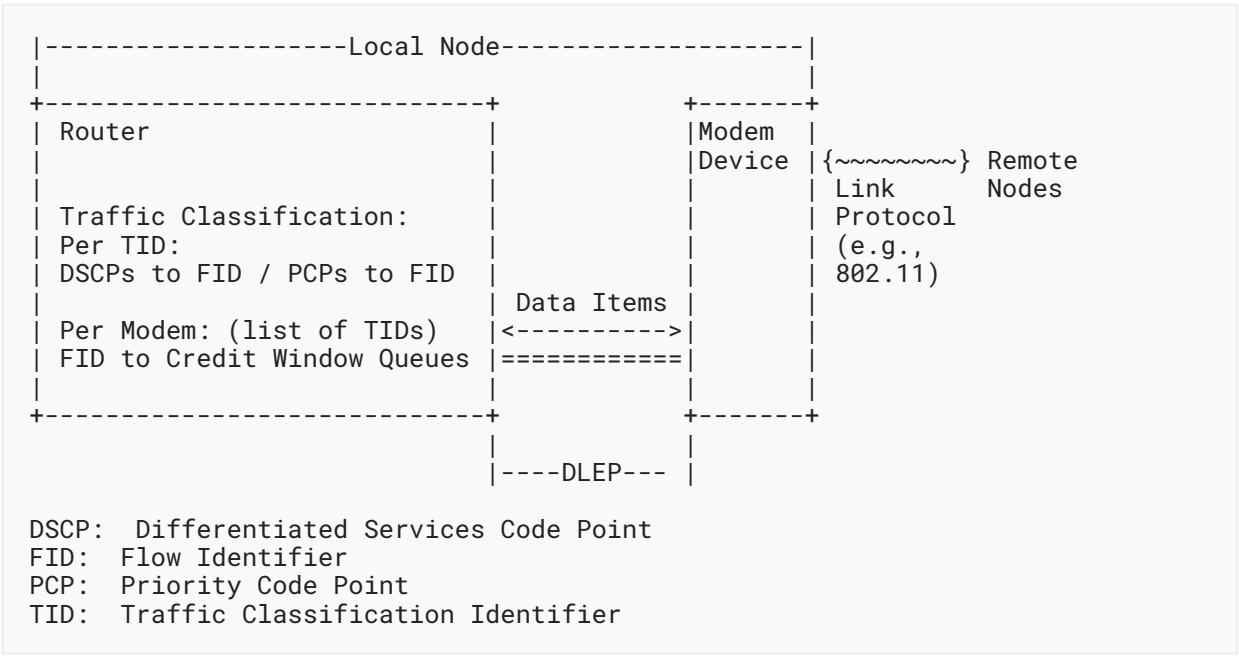


Figure 1: Router and Modem DLEP Exchange

This document defines DLEP Data Items that provide a flow control mechanism for traffic sent from a router to a modem. Flow control is provided using one or more logical "Credit Windows", each of which will typically be supported by an associated virtual or physical queue. Credit windows may be shared or dedicated on a per-flow basis. The Data Items are structured to allow for the reuse of the defined credit-window-based flow control with different traffic classification techniques. A router logically consumes credits for each credit window matching packet sent.

Note that this document defines common messages, Data Items, and mechanisms that are reusable. They are expected to be required by DLEP extensions defined in other documents, such as the extension defined in [RFC9894].

This document introduces support for credit window control by defining two new DLEP messages (Section 2.2) and five new DLEP Data Items (Section 2.3).

Various conditions described in this document cause a message to be logged. In all cases, the log message results from the contents of a received Data Item defined here. No messages are logged in response to activity in the data plane.

1.1. Key Words

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2. Credit Window Control

This section defines additions to DLEP used in credit-based flow control. The use of credit window control impacts the data plane.

The credit window control mechanisms defined in this document support credit-based flow control of traffic sent from a router to a modem. The mapping of specific flows to a particular credit window is based on the Traffic Classification Data Item defined in [RFC9892]. Both types of DLEP peers -- router and modem -- negotiate the use of an extension employing this mechanism during session initialization as required; for example, see [RFC9894]. When using credit windows, data traffic is only allowed to be sent by the router to the modem when there are credits available.

Credits are managed on a 'per logical "Credit Window"' basis. Each credit window can be thought of as corresponding to a queue within a modem. Credit windows may be shared across, or dedicated to, destinations and data plane identifiers -- for example, DSCPs -- at a granularity that is appropriate for a modem's implementation and its attached transmission technology. As specified in Section 2.3.1, there is a direct one-to-one mapping of credit windows to flows as identified by Flow Identifiers (FIDs) carried within the Traffic Classification Data Item. Modems pass to the router information on their credit windows and FIDs prior to a router being able to send data when an extension requiring the use of credit window control is used. Note that Traffic Classification Identifier (TID) values and FID values are significant only to the issuing modem. There is no relationship implied by the same TID or FID value being issued by more than one modem. In addition to the traffic classification information associated with a FID, modems provide an initial credit window size, as well as the maximum size of the logical queue associated with each credit window. The maximum size is included for informative and potential future uses.

Modems provide an initial credit window size at the time of "Credit Window Initialization". Such initialization can take place during session initiation or any point thereafter. It can also take place when rate information changes. An increment to a credit window size, specified in a Credit Grant Data Item, is provided in a Destination Up Message (Section 2.3.2) or Credit Control Message (Section 2.2.1). A router provides its view of the Credit Window, which is known as "Status", in Destination Up Response Messages (Section 2.3.3) and Credit Control Response Messages (Section 2.2.2). Routers can also request credits using the Credit Control Message.

When modems provide credits to a router, they will need to take into account any overhead of their attached transmission technology and map it into the credit semantics defined in this document. In particular, the credit window is defined below to include per-frame (per-packet) Media Access Control (MAC) headers, and this may not match the actual overhead of the modems' attached transmission technology. In that case, a direct mapping or an approximation will need to be made by the modem to provide appropriate credit values.

Actual flows of traffic are mapped to credit windows based on flow identification information provided by modems in the Traffic Classification Data Item defined in [RFC9892]. This Data Item supports traffic classification on a per-destination or more fine-grained level. Routers use the combination of the DLEP-identified destination and flow information associated with a credit window in order to match traffic they send to specific credit windows. In some cases, the Traffic Classification Data Item allows the modem to specify a wildcard to match any packets that do not match other Data Items; for example, see [RFC9895]. In the absence of a wildcard, a packet may not match any of the Data Items and, in this case, **MUST** be dropped by the router.

When a destination becomes reachable, a modem "associates" (identifies) the appropriate traffic classification information via the TID to be used for traffic sent by the router to that destination. This is supported by the Credit Window Association Data Item, which is carried in Destination Up and Destination Update Messages; see Section 2.3.2. The TID provides the information to support router traffic classification, based on the FIDs contained in the TID; see [RFC9892]. As defined, each credit window has a corresponding FID, so traffic is mapped to a credit window by locating a matching FID that is contained in the TID that is associated with the traffic's destination. This means that the use of FIDs and TIDs, and the association of a TID to a DLEP destination, enable a modem to share or dedicate resources as needed to match the specifics of its implementation and its attached transmission technology.

Credit window control as defined in this document has objectives similar to the control technique described in [Credit-Window-Extension]. One notable difference from that type of credit control is that in this document, credits are never provided by the router to the modem.

2.1. Data Plane Considerations

When credit windowing is used, a router **MUST NOT** send data traffic to a modem for forwarding if there is no matching classifier. If a matching classifier is found, a router **MUST NOT** send data traffic to a modem when there are no credits available in the associated Credit Window. Section 2 describes how classifiers are associated with destinations and how credit windows are associated with classifiers. Additionally, a router **MUST** ensure that sufficient credits are available in the associated Credit Window for the current data packet before sending that data packet to the modem. The count of octets in the packet includes MAC overhead. Taking Ethernet as an example, framing, header, and trailer are all included in this count. This document defines credit windows in octets, and the credit window is decremented by the number of sent octets.

A router **MUST** identify the credit window associated with traffic to be sent to a modem based on the traffic classification information provided in the Data Items defined in this document.

2.2. Credit Window Messages

This document defines two new messages that support credit window control: Credit Control Messages and Credit Control Response Messages. Sending and receiving both message types is **REQUIRED** to support the credit window control mechanisms defined in this document.

2.2.1. Credit Control Message

Credit Control Messages are sent by modems and routers. Each sender is only permitted to have one message outstanding at one time. That is, a sender (either modem or router) **MUST NOT** send a subsequent Credit Control Message until a Credit Control Response Message has been received from its peer.

Credit Control Messages are sent by modems to provide credit window increases. Modems send credit increases when their transmission or local queue availability exceeds the credit window value previously provided to the router. Modems will need to balance the load generated by sending and processing credit window increases against a router having data traffic available to send, but no credits available.

Credit Control Messages **MAY** be sent by routers to request credits and provide window status. Routers will need to balance the load generated by sending and processing credit window requests against having data traffic available to send, but no credits available.

The Message Type value in the DLEP Message Header is set to 17.

A Credit Control Message sent by a modem **MUST** contain one or more Credit Window Grant Data Items as defined in Section 2.3.3. A router receiving this message **MUST** respond with a Credit Control Response Message.

A Credit Control Message sent by a router **MUST** contain one or more Credit Window Request Data Items as defined in Section 2.3.5 and **SHOULD** contain a Credit Window Status Data Item, defined in Section 2.3.4, corresponding to each credit window request. A modem receiving this message **MUST** respond with a Credit Control Response Message based on the received message and Data Item and the processing defined in Section 2.2.2, which will typically result in credit window increments being provided.

Specific processing associated with each Credit Data Item is provided in Section 2.3.

2.2.2. Credit Control Response Message

Credit Control Response Messages are sent by routers to report the current Credit Window for a destination. A Credit Control Response Message sent by a router **MUST** contain one or more Credit Window Status Data Items as defined in Section 2.3.4. Specific receive processing associated with the Credit Window Status Data Item is provided in Section 2.3.4.

Credit Control Response Messages sent by modems **MUST** contain one or more Credit Window Grant Data Items. A Data Item for every Credit Window Request Data Item contained in the corresponding Credit Control Message received by the modem **MUST** be included. Each Credit Grant Data Item **MAY** provide zero or more additional credits based on the modem's transmission or local queue availability. Specific receive processing associated with each Grant Data Item is provided in Section 2.3.3.

The Message Type value in the DLEP Message Header is set to 18.

2.3. Credit Window Control Data Items

Five new Data Items are defined to support credit window control:

- The Credit Window Initialization Data Item (Section 2.3.1) is used by a modem to identify a credit window and set its size.
- The Credit Window Association Data Item (Section 2.3.2) is used by a modem to identify which TIDs (flows) should be used when sending traffic to a particular DLEP-identified destination.
- The Credit Window Grant Data Item (Section 2.3.3) is used by a modem to provide additional credits to a router.
- The Credit Window Status Data Item (Section 2.3.4) is used to advertise the sender's view of the number of available credits for state synchronization purposes.
- The Credit Window Request Data Item (Section 2.3.5) is used by a router to request additional credits.

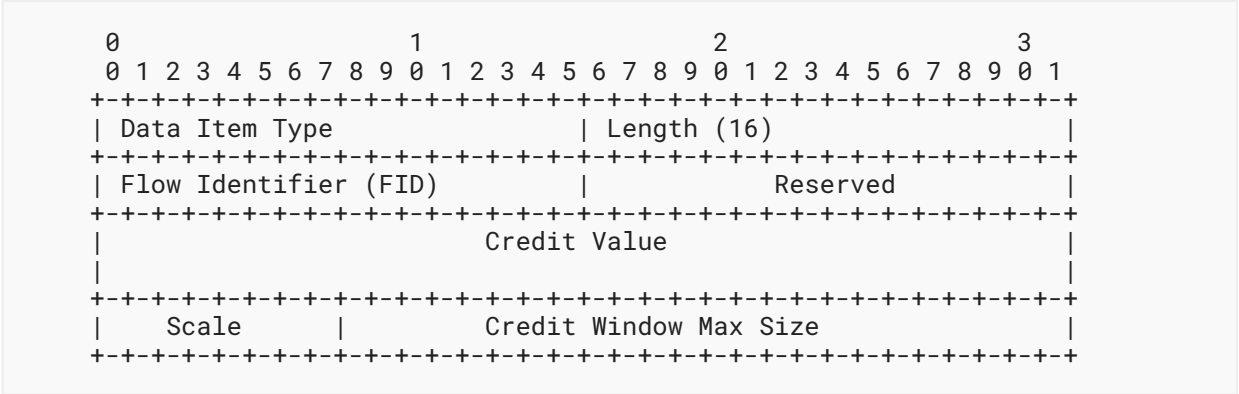
Any errors or inconsistencies encountered in parsing Data Items are handled in the same fashion as any other Data Item parsing error encountered in DLEP; see [RFC8175]. In particular, the node parsing the Data Item **MUST** terminate the session with a Status Data Item indicating "Invalid Data".

2.3.1. Credit Window Initialization

As noted above, the Credit Window Initialization Data Item is used by a modem to identify a credit window and set its size. In order to avoid errors caused by the use of undefined FIDs or uninitialized credit windows, this Data Item **SHOULD** be included in any Session Initialization Response Message that indicates support for any such extension. Updates to previously identified credit windows or new credit windows **MAY** be sent by a modem by including the Data Item in Session Update Messages. More than one Data Item **MAY** be included in a message to provide information on multiple credit windows.

The Credit Window Initialization Data Item identifies a credit window using a FID. It also provides the size of the identified credit window. To be used, a FID must be defined within a Traffic Classification Data Item, and the associated TID must be provided via a Credit Window Association Data Item.

The format of the Credit Window Initialization Data Item is as follows:



Data Item Type:
: 30

Length:
: 16

  As specified in [RFC8175], Length is the number of octets in the Data Item. It **MUST** be equal to sixteen (16). If it is some other value, the Data Item is corrupt, so the message in which it appears cannot be reliably parsed and is ignored.

Flow Identifier (FID):
: A 2-octet flow identifier as defined by the Traffic Classification Data Item [RFC9892]. The FID also uniquely identifies a credit window for a specific DLEP session.

Reserved:
: For the Credit Window Initialization Data Item, this reserved field is currently unused. It **MUST** be set to all zeros for this version of the Data Item and is currently ignored on reception. This allows for future extensions of the Data Item if needed.

Credit Value:
: A 64-bit unsigned integer representing the credits, in octets, to be added to the Credit Window. This value includes MAC headers as seen on the link between the modem and router.

Scale:
: An 8-bit unsigned integer indicating the scale used in the Credit Window Max Size field. The valid values are as follows:

Value	Scale
0	B: Bytes (Octets)
1	KB: Kilobytes (B/1024)
2	MB: Megabytes (KB/1024)

Value	Scale
3	GB: Gigabytes (MB/1024)

Table 1: Valid Scale Field Values

Credit Window Max Size:
: A 24-bit unsigned integer representing the maximum size, in the octet scale indicated by the Scale field, of the associated credit window.

A router that receives a Credit Window Initialization Data Item **MUST** ensure that the FID field value has been provided by the modem in a Traffic Classification Data Item carried in either the current message or a previous message. If the FID cannot be found, the router **SHOULD** log this information. The method of logging is left to the router implementation. Note that no traffic will be associated with the credit window in this case. After FID validation, the router **MUST** locate the credit window that is associated with the FID indicated in each received Data Item. If no associated credit window is found, the router **MUST** initialize a new credit window using the values carried in the Data Item. When an associated credit window is found, the router **MUST** update the credit window and associated data plane state using the values carried in the Data Item. If the resultant Credit Value in turn results in the credit window exceeding the represented Credit Window Max Size, the Credit Window Max Size field value is used as the new credit window size.

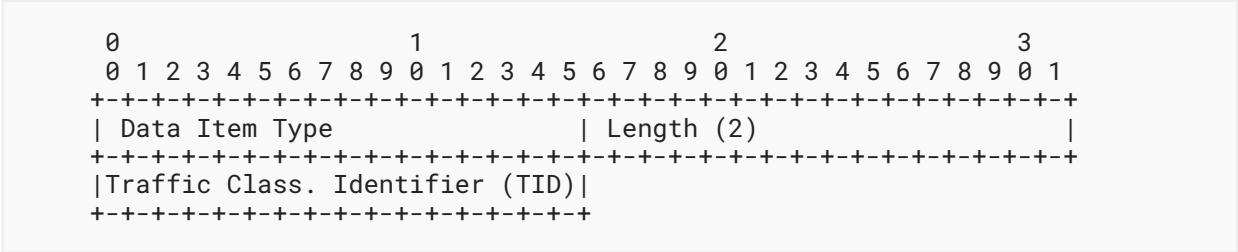
It is worth noting that such updates can result in a credit window size being reduced -- for example, due to a transmission rate change on the modem. After sending the Session Update Message with one or more Credit Window Initialization Data Items that decrease the Credit Window Max Size, the modem **SHOULD** continue processing received packets that match the indicated FIDs, fit within the window for the unmodified Credit Window Max Size, and arrive before the modem receives the corresponding Session Update Response Message. The modem **SHOULD NOT** issue additional credits for any affected FID until that FID's associated window has drained to be less than the new Credit Window Max Size, regardless of when the corresponding Session Update Response Message is received.

2.3.2. Credit Window Association

The Credit Window Association Data Item is used by a modem to associate traffic classification information with a destination. The traffic classification information is identified using a TID value that has been previously sent by the modem or is listed in a Traffic Classification Data Item carried in the same message as the Credit Window Association Data Item. TIDs in different credit windows must not overlap.

A single Credit Window Association Data Item **MUST** be included in every Destination Up and Destination Update Message sent by a modem when a credit window control mechanism defined in this document is used. Note that a TID will not be used unless it is listed in a Credit Window Association Data Item.

The format of the Credit Window Association Data Item is as follows:



Data Item Type:
31

Length:
2

As specified in [RFC8175], Length is the number of octets in the Data Item. It **MUST** be equal to two (2). If it is some other value, the Data Item is corrupt, so the message in which it appears cannot be reliably parsed and is ignored.

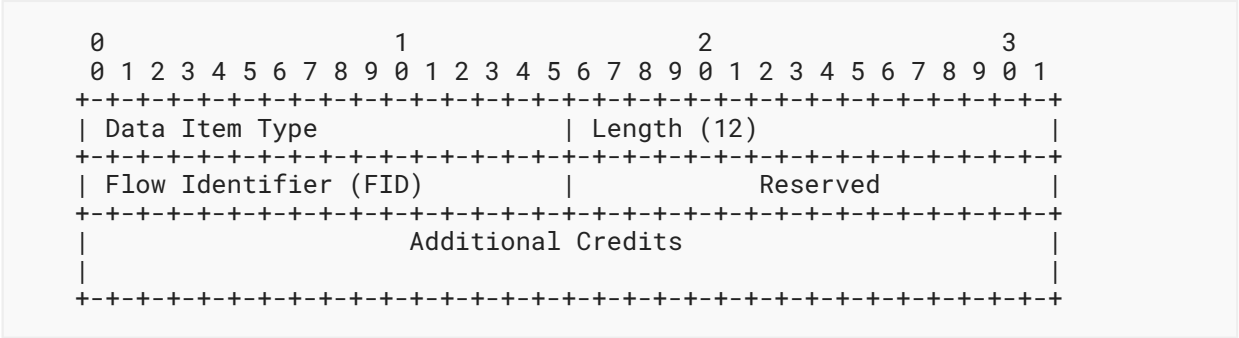
Traffic Classification Identifier (TID):
A 16-bit unsigned integer identifying a traffic classification set that has been identified in a Traffic Classification Data Item; see [RFC9892].

A router that receives a Credit Window Association Data Item **MUST** locate the traffic classification information indicated by the received TID. If no corresponding information is found, the Credit Window Association Data Item **MUST** be treated as an error as described above. If the traffic classification information is located, the router **MUST** ensure that any data plane state that is associated with the TID and its corresponding FIDs is updated as needed (per Section 2.1). If a router determines that a newly received Data Item results in credit windows with overlapping TIDs, the Data Item **MUST** be treated as an error as described above.

2.3.3. Credit Window Grant

The Credit Window Grant Data Item is used by a modem to provide credits to a router. One or more Credit Window Grant Data Items **MAY** be carried in the DLEP Destination Up, Destination Announce Response, Destination Update, Credit Control, and Credit Control Response Messages. Multiple Credit Window Grant Data Items may be present in a single message. Each item grants credits to a different credit window and therefore references a different FID. In all message types, this Data Item provides an additional number of octets to be added to the indicated credit window. Credit windows are identified using FID values that have been previously sent by the modem or are listed in a Credit Window Initialization Data Item carried in the same message as the Data Item.

The format of the Credit Window Grant Data Item is as follows:



Data Item Type:
: 32

Length:
: 12

  As specified in [RFC8175], Length is the number of octets in the Data Item. It **MUST** be equal to twelve (12). If it is some other value, the Data Item is corrupt, so the message in which it appears cannot be reliably parsed and is ignored.

Flow Identifier (FID):
: A 2-octet flow identifier as defined by the Traffic Classification Data Item. The FID also uniquely indicates a credit window.

Reserved:
: For the Credit Window Grant Data Item, this reserved field is currently unused. It **MUST** be set to all zeros for this version of the Data Item and is currently ignored on reception. This allows for future extensions of the Data Item if needed.

Additional Credits:
: A 64-bit unsigned integer representing the credits, in octets, to be added to the Credit Window. This value includes MAC headers as seen on the link between the modem and router. A value of zero indicates that no additional credits are being provided.

When receiving this Data Item, a router **MUST** identify the credit window indicated by the FID. If the FID is not known to the router, it **SHOULD** log this information and discard the Data Item. The method of logging is left to the router implementation. It is important to note that while this Data Item can be received in a destination-specific message, credit windows are managed independently of the destination identified in the message carrying this Data Item, and the indicated FID **MAY** even be disjoint from the identified destination.

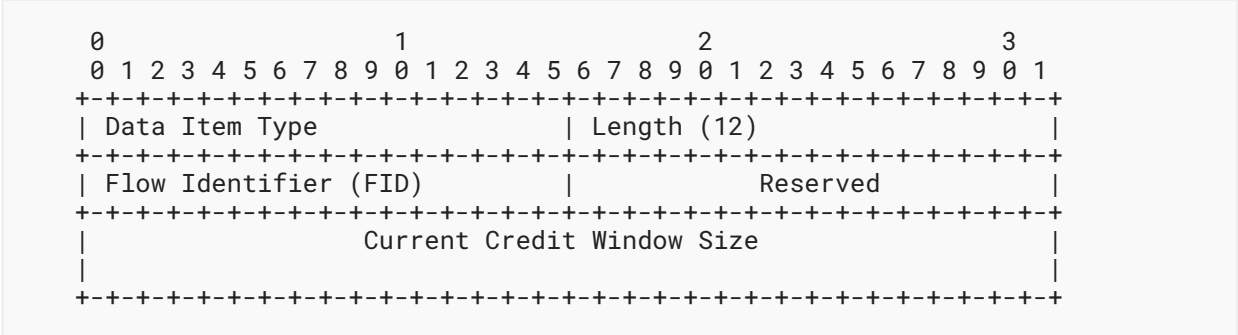
Once the credit window is identified, the credit window size **MUST** be increased by the value contained in the Additional Credits field. If the increase results in a window overflow, the Credit Window must be set to its maximum as defined by the Credit Window Max Size carried in the Credit Window Initialization Data Item.

No response is sent by the router to a modem after processing a Credit Window Grant Data Item received in a Credit Control Response Message. When a Credit Window Grant Data Item is received in other message types, the receiving router **MUST** send a Credit Window Status Data Item or items reflecting the resultant Credit Window value of the updated credit window. When the Credit Grant Data Item is received in a Destination Up Message, the Credit Window Status Data Item(s) **MUST** be sent in the corresponding Destination Up Response Message. Otherwise, a Credit Control Message **MUST** be sent.

2.3.4. Credit Window Status

The Credit Window Status Data Item is used by a router to report the current credit window size to its peer modem. One or more Credit Window Status Data Items **MAY** be carried in a Destination Up Response Message or a Credit Control Response Message. As discussed in Section 2.3.3, the Destination Up Response Message is used when the Data Item is sent in response to a Destination Up Message, and the Credit Control Response Message is sent in response to a Credit Control Message. Multiple Credit Window Status Data Items in a single message are used to indicate different sizes of different credit windows. Similar to the Credit Window Grant Data Item, credit windows are identified using FID values that have been previously sent by the modem.

The format of the Credit Window Status Data Item is as follows:



Data Item Type:
: 33

Length:
: 12

  As specified in [RFC8175], Length is the number of octets in the Data Item. It **MUST** be equal to twelve (12). If it is some other value, the Data Item is corrupt, so the message in which it appears cannot be reliably parsed and is ignored.

Flow Identifier (FID):
: A 2-octet flow identifier as defined by the Traffic Classification Data Item. The FID also uniquely identifies a credit window.

Reserved:
: For the Credit Window Status Data Item, this reserved field is currently unused. It **MUST** be set to all zeros for this version of the Data Item and is currently ignored on reception. This allows for future extensions of the Data Item if needed.

Current Credit Window Size:
: A 64-bit unsigned integer indicating the current number of credits, in octets, available for the router to send to the modem. This is referred to as the Modem Receive Window in [Credit-Window-Extension].

When receiving this Data Item, a modem **MUST** identify the credit window indicated by the FID. If the FID is not known to the modem, it **SHOULD** log this information and discard the Data Item. The method of logging is left to the modem implementation. As with the Credit Window Grant Data Item, the FID **MAY** be unrelated to the destination indicated in the message carrying the Data Item.

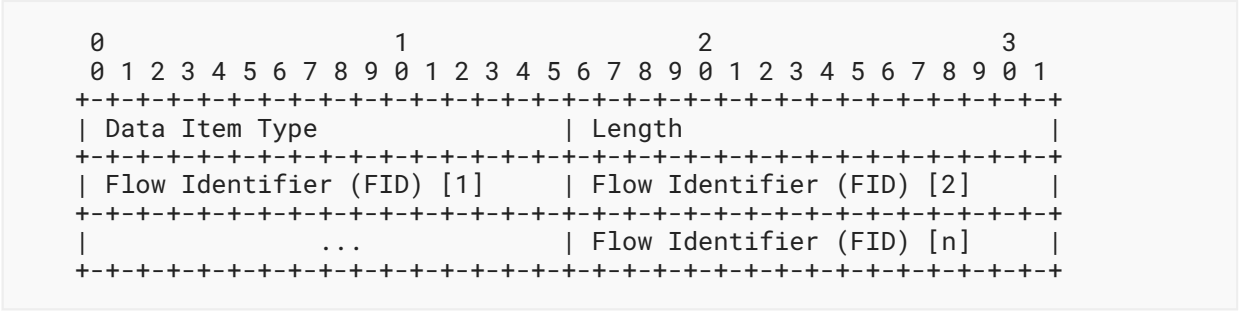
Once the credit window is identified, the modem **SHOULD** check the received Current Credit Window Size field value against the outstanding credit window's available credits at the time the most recent Credit Window Initialization or Grant Data Item associated with the indicated FID was sent. If the difference in values is greater than what can be accounted for based on observed data frames, then the modem **SHOULD** send a Credit Window Initialization Data Item to reset the associated credit window size to the modem's current view of the available credits. As specified in Section 2.3.1, Credit Window Initialization Data Items are sent in Session Update Messages. When multiple Data Items need to be sent, they **SHOULD** be combined into a single message when possible. Alternatively, and also in cases where there are small differences, the modem **MAY** adjust the values sent in Credit Window Grant Data Items to account for the reported Credit Window.

2.3.5. Credit Window Request

The Credit Window Request Data Item is used by a router to request additional credits for particular credit windows. Credit Window Request Data Items are carried in Credit Control Messages, and one or more Credit Window Request Data Items **MAY** be present in a message.

Credit windows are identified using a FID as defined in Section 2.3.1. Multiple FIDs **MAY** be present to allow for the case where the router determines that credits are needed in multiple credit windows. A special FID value, as defined below, is used to indicate that a credit request is being made across all queues.

The format of the Credit Window Request Data Item is as follows:



Data Item Type:
: 34

Length:
: Variable

  As specified in [RFC8175], Length is the number of octets in the Data Item, excluding the Type and Length fields. It is equal to the number of FID fields carried in the Data Item times 2 and **MUST** be at least 2. If it is less than 2, the Data Item is corrupt, so the message in which it appears cannot be reliably parsed and is ignored.

Flow Identifier (FID):
: A 2-octet flow identifier as defined by the Traffic Classification Data Item. The FID also uniquely identifies a credit window. The special value 0xFFFF indicates that the request applies to all FIDs. When this special value is included, all other FID values included in the Data Item are redundant, as the special value indicates all FIDs.

A modem receiving this Data Item **MUST** provide a credit window increment for the indicated credit windows via Credit Window Grant Data Items carried in a new Credit Control Message. Multiple values and queue indexes **SHOULD** be combined into a single Credit Control Message when possible. Unknown FID values **SHOULD** be logged and then ignored by the modem. The method of logging is left to the modem implementation.

2.4. Management Considerations

This section provides several network management guidelines for implementations supporting the credit window mechanisms defined in this document.

Modems **MAY** support the configuration of the number of credit windows (queues) to advertise to a router.

Routers may have limits on the number of queues that they can support. They may even have limits on supported credit window combinations. For example, per-destination queues may not be supported at all. When credit window information provided by a modem exceeds the capabilities of a router, the router **SHOULD** use a subset of the provided credit windows. Alternatively, a router **MAY** reset the session and indicate that the extension is not supported. In either case, any mismatch in capabilities **SHOULD** be reported to the user via normal network management mechanisms, such as the user interface or error logging.

In all cases, if credit windows are in use, traffic for which credits are not available **MUST NOT** be sent to the modem by the router.

3. Compatibility

The messages and Data Items defined in this document will only be used when extensions require their use.

The DLEP specification [RFC8175] defines the handling of unexpected appearances of any Data Items, including those defined in this document.

4. Security Considerations

This document introduces credit window control and flow mechanisms for DLEP. These mechanisms expose vulnerabilities similar to existing DLEP messages. An example of a threat to which flow control might be susceptible is where a malicious actor masquerading as a DLEP peer could inject a Credit Window Initialization Data Item that resizes a credit window to a value that results in a denial of service. Other possible threats are discussed in the Security Considerations section of [RFC8175] and are also applicable, but not specific, to flow control. The transport-layer security mechanisms documented in [RFC8175], with some updated references to external documents listed below, can be applied to this document. Implementations following the "networked deployment" model described in Section 4 ("Implementation Scenarios") of [RFC8175] **SHOULD** refer to [BCP195] for additional details. The Layer 2 security mechanisms documented in [RFC8175] can also, with some updates, be applied to the mechanisms defined in this document. Examples of technologies that can be deployed to secure the Layer 2 link include [IEEE-802.1AE] and [IEEE-8802-1X].

5. IANA Considerations

5.1. Message Type Values

IANA has assigned two new values from the "Specification Required" range [RFC8126] in the DLEP "Message Type Values" registry:

Type Code	Description
17	Credit Control
18	Credit Control Response

Table 2: Message Type Values

5.2. Data Item Values

IANA has assigned the following values from the "Specification Required" range [RFC8126] in the DLEP "Data Item Type Values" registry:

Type Code	Description
30	Credit Window Initialization
31	Credit Window Association
32	Credit Window Grant
33	Credit Window Status
34	Credit Window Request

Table 3: Data Item Values

6. References

6.1. Normative References

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Appendix A. Example DLEP Credit Flow Control and Traffic Classification Data Item Exchange

Figure 2 illustrates a credit flow control and traffic classification exchange between a router and a modem. The modem will initialize a number of queues with Credit Window Initialization Data Items, Credit Window Association Data Item(s), and Traffic Classification Data Item(s) included in DLEP messages as outlined in this document. If the Data Items are successfully validated, traffic is mapped to the corresponding credit window on the router and forwarded when there are sufficient credits. Routers can periodically report the status of the credit window. Modems will send periodic updates with more credits as packets are transmitted. If a router requires

more credits for a particular window, it may request them. This document defines credit window flow information for FIDs that map to the queues. [RFC9892] defines the Traffic Classification Sub-Data Items, such as DSCPs, that map to the FIDs.

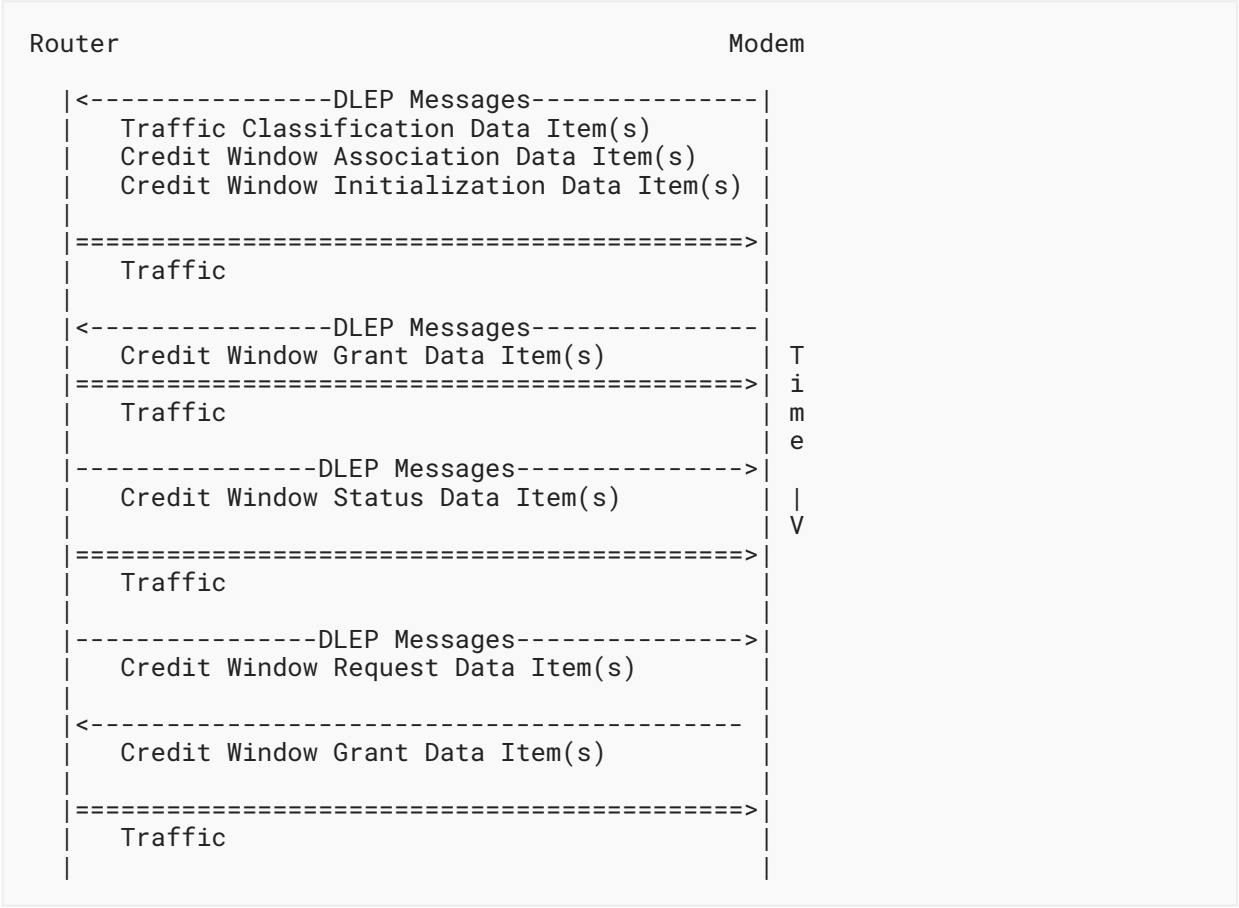

Figure 2: Example DLEP Traffic Classification / Credit Flow Exchange

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