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RFC 8651
Dynamic Link Exchange Protocol (DLEP) Control-Plane-Based Pause Extension

Abstract

This document defines an extension to the Dynamic Link Exchange Protocol (DLEP) that enables a modem to use DLEP messages to pause and resume data traffic coming from its peer router.

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/rfc8651.

Copyright Notice

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1. Introduction

The Dynamic Link Exchange Protocol (DLEP) is defined in [RFC8175]. It provides the exchange of link-related control information between a modem and a router. DLEP defines a base set of mechanisms as well as support for possible extensions. This document defines one such extension.

The base DLEP specification does not include any data-plane flow-control capability. The extension defined in this document supports flow control of data traffic based on explicit messages sent via DLEP by a modem to indicate when a router should hold off sending traffic and when it should resume. This functionality parallels the flow-control mechanism found in PPP over Ethernet (PPPoE) per [RFC5578]. The extension also optionally supports DSCP-aware flow control ("DSCP" stands for "Differentiated Services Code Point") for use by Diffserv-aware modems. (For general background on Differentiated Services, see [RFC2475].) This functionality is very similar to that provided by Ethernet priority-based flow control; see [IEEE.802.1Q_2014]. The extension defined in this document is referred to as "Control-Plane-Based Pause". Other flow-control methods are possible with DLEP; for example, see [DLEP-DIFFSERV] and [DLEP-CREDIT].

Note that this mechanism only applies to traffic that is to be transmitted on the modem's attached data channel and not to DLEP control messages themselves. Furthermore, it applies only to the single subnetwork that is used to connect a modem and a router, and for traffic sent from a router to a modem.

This document defines a new DLEP Extension Type Value that is used to indicate the use of the extension; see Section 2. Three new DLEP Data Items are defined in Section 3.

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. Extension Usage and Identification

The use of the Control-Plane-Based Pause Extension **SHOULD** be configurable. To indicate that the implementation supports the use of the Control-Plane-Based Pause Extension, an implementation **MUST** include the Control-Plane-Based Pause Extension Type Value in the Extensions Supported Data Item. The Extensions Supported Data Item is sent and processed according to [RFC8175].

The Control-Plane-Based Pause Extension Type Value is 2; see Section 5.

3. Extension Data Items

Three Data Items are defined by this extension. The Queue Parameters Data Item is used by a modem to provide information about the DSCPs it uses in forwarding. The Pause Data Item is used by a modem to indicate when a router should cease sending packets, and the Restart Data Item is used by a modem to indicate when a router can resume sending packets.

3.1. Queue Parameters

The Queue Parameters Data Item is sent by a modem to a router to indicate DSCP values that may be independently paused. This Data Item **MUST** be included in a Session Initialization Response Message that also contains the Control-Plane-Based Pause Extension Type Value in the Extensions Supported Data Item. Updates to these parameters **MAY** be sent by a modem by including the Data Item in Session Update Messages.

The Queue Parameters Data Item groups DSCPs into logical queues, each of which is identified by a "Queue Index" field. The number of logical queues is variable, as is the number of DSCPs associated with each queue. A queue size (in bytes) is provided for informational purposes. Queue Index fields are numbered sequentially from zero, where queue index zero is a special case covering DSCPs that are not otherwise associated with a Queue Index field.

An implementation that does not support DSCPs would indicate one queue with zero DSCPs, and the number of bytes that may be in its associated link transmit queue. Additional logical queues are represented in a variable series of Queue Parameter Sub-Data Items.

The format of the Queue Parameters Data Item is:

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Data Item Type                | Length                        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   Num Queues  | Scale |              Reserved                 |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                Queue Parameter Sub-Data Item 1                |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   :                             ...                               :
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                Queue Parameter Sub-Data Item n                |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
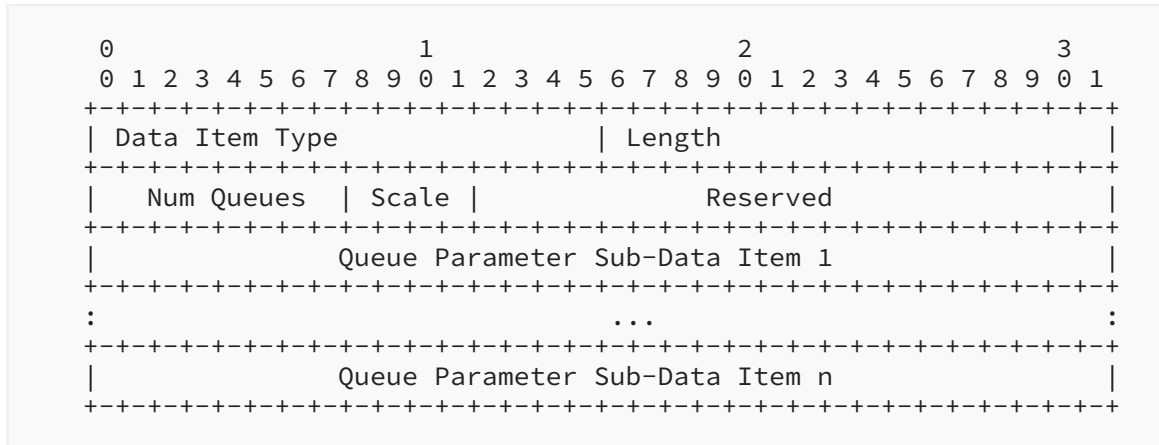
Data Item Type:
     23

Length:
     Variable

     Per [RFC8175], Length is the number of octets in the Data Item, excluding the
     Type and Length fields.

Num Queues:
     An 8-bit unsigned integer indicating the number of queues represented in the
     Data Item. This field MUST contain a value of at least one (1) and is equal to one
     greater than the number of included Queue Parameter Sub-Data Items.

Scale:
     A 4-bit unsigned integer indicating the scale used in the Queue Size Qn field. The
     valid values are:

```
        Value   Scale
        -------------------------------
           0    B - Bytes     (Octets)
           1   KB - Kilobytes (1024 B)
           2   MB - Megabytes (1024 KB)
           3   GB - Gigabytes (1024 MB)
```

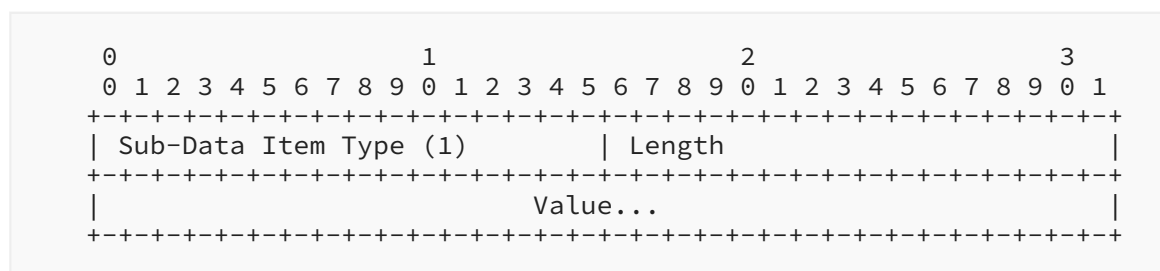Reserved:
     A 20-bit field that MUST be set to zero (0) by the sender (a modem) and ignored
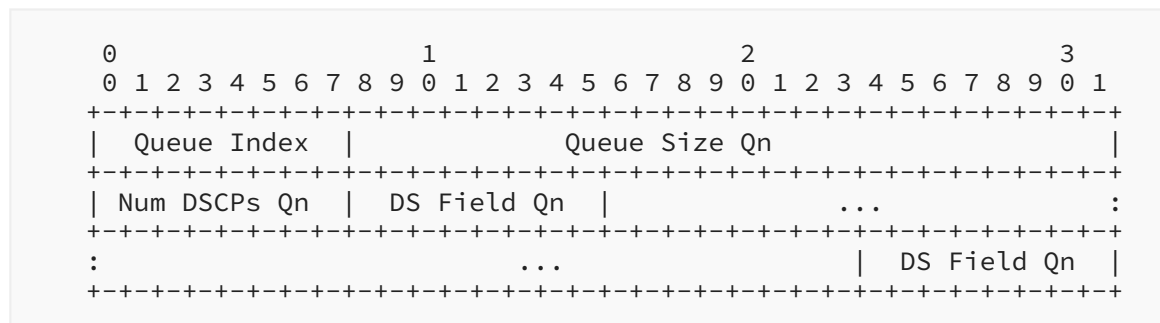   by the receiver (a router).

3.1.1. Queue Parameter Sub-Data Item

Queue Parameter Sub-Data Items are an unordered list composed of Sub-Data Items with a common format. The format of the Queue Parameter Sub-Data Item is patterned after the standard format for the DLEP Data Item; see [RFC8175], Section 11.3. Any errors or inconsistencies encountered in parsing Sub-Data Items are handled in the same fashion as any other Data Item parsing error encountered in DLEP. In particular, the receiving implementation **MUST** issue a Session Termination Message containing a Status Data Item with status code set to 130 ("Invalid Data") and transition to the Session Termination state.

The format of the Queue Parameter Sub-Data Item is:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Sub-Data Item Type (1)        | Length                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             Value...                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

and Value has the format:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Queue Index |             Queue Size Qn                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Num DSCPs Qn  | DS Field Qn   |             ...               :
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
:                      ...                      | DS Field Qn   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Sub-Data Item Type:
  A 16-bit unsigned integer that indicates the type and corresponding format of the Sub-Data Item's Value field. Sub-Data Item Types are scoped within the Data Item in which they are carried, i.e., the Sub-Data Item Type field **MUST** be used together with the Queue Parameters Data Item Type to identify the format of the Sub-Data Item. This field **MUST** be set to one (1) for the Queue Parameter Sub-Data Item.

Length:
  Variable

Length is the number of octets in the Sub-Data Item, excluding the Type and Length fields.

Queue Index:

An 8-bit field indicating the queue index of the queue parameter represented in the Sub-Data Item. Only the first instance of a particular Queue Index value is meaningful. Subsequent Sub-Data Items containing the same Queue Index values, if present, **MAY** be logged via a management interface and **MUST** otherwise be ignored. Note that the value 255 is reserved and **MUST NOT** be used in this field.

Queue Size Qn:

A 24-bit unsigned integer representing the size, in the octet scale indicated by the Scale field, of the queue that supports the traffic with the DSCPs associated with the queue index.

Num DSCPs Qn:

An 8-bit unsigned integer indicating the number of DSCPs associated with the queue index associated with the Sub-Data Item. This field **MUST** contain a value of at least one (1).

DS Field Qn:

The Data Item contains a sequence of 8-bit DS fields. The number of DS fields present **MUST** equal the Num DSCPs Qn field value.

The DS field structure is the same as the structure shown in [RFC2474].
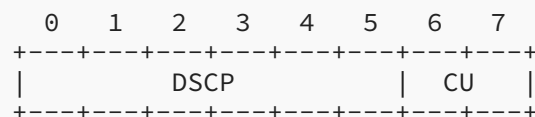
```
    0   1   2   3   4   5   6   7
  +---+---+---+---+---+---+---+---+
  |         DSCP          | CU    |
  +---+---+---+---+---+---+---+---+

  DSCP: Differentiated Services Code Point
  CU:   Currently Unused; MUST be zero
```

3.2. Pause

The Pause Data Item is sent by a modem to a router to indicate to its peer that traffic is to be suppressed, i.e., paused. The motivating use case for this Data Item is when a modem's internal queue length exceeds a particular threshold. Other use cases are possible, e.g., when there are non-queue-related congestion points within a modem. Such cases are not explicitly described in this document.
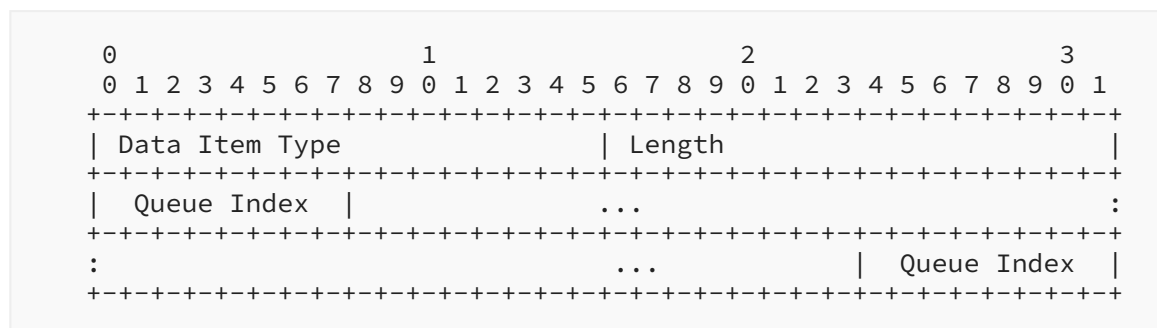
A modem can indicate that traffic is to be suppressed on a device-wide or destination-specific basis. An example of when a modem might use device-wide suppression is when output queues are shared across all destinations. Destination-specific suppression might be used when per-destination queuing is used. To indicate that suppression applies to all destinations, a modem **MUST** send the Pause Data Item in a Session Update Message. To indicate that suppression applies to a particular destination, a modem **MUST** send the Pause Data Item in a Destination Update Message.

Each Pause Data Item identifies the traffic to be suppressed by the Queue Index field (Section 3.1), which in turn indicates traffic identified by one or more DSCPs. The special value of 255 is used to indicate that all traffic is to be suppressed.

While there is no restriction on the number of messages containing Pause Data Items that may be sent by a modem, a modem **SHOULD** include multiple queue indexes in the same message when possible.

A router that receives the Pause Data Item **MUST** cease sending the identified traffic to the modem. This may of course translate into the router's queues exceeding their own thresholds. If a received Pause Data Item contains a Queue Index value other than 255 or a queue index established by a Session Initialization or Session Update Message, the router **MUST** terminate the session with a Status Data Item indicating "Invalid Data".

The format of the Pause Data Item is:

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Data Item Type                | Length                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Queue Index  |               ...                             :
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
:                               ...             |  Queue Index  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Data Item Type:
> 24

Length:
> Variable
>
> Per [RFC8175], Length is the number of octets in the Data Item, excluding the Type and Length fields. It will equal the number of Queue Index fields carried in the Data Item.

Queue Index:
> One or more 8-bit fields used to indicate a queue index defined by a Queue Parameters Data Item. The special value of 255 indicates that (1) all traffic to the modem is to be suppressed when the Data Item is carried in a Session Update Message or (2) all traffic to a particular destination is to be suppressed when the Data Item is carried in a Destination Update Message.
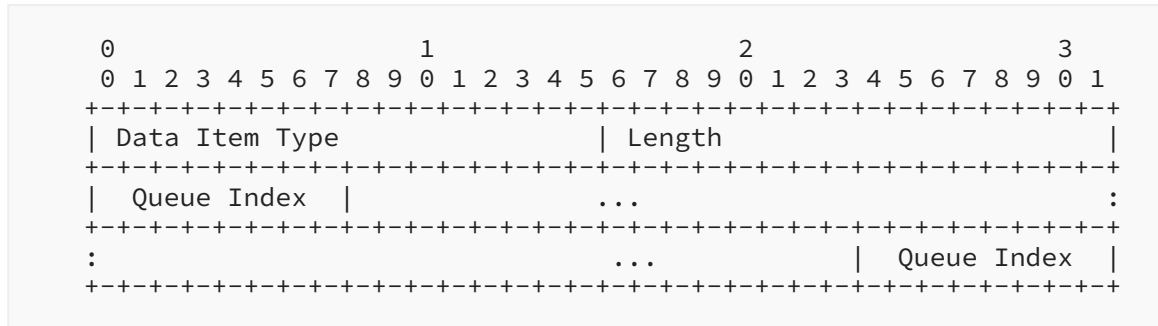
3.3. Restart

The Restart Data Item is sent by a modem to a router to indicate to its peer that transmission of previously suppressed traffic may be resumed. An example of when a modem might send this Data Item is when an internal queue length drops below a particular threshold.

The sending of this Data Item parallels the Pause Data Item (see Section 3.2) and follows the same rules. To indicate that transmission can resume to all destinations, a modem **MUST** send the Restart Data Item in a Session Update Message. To indicate that transmission can resume to a particular destination, a modem **MUST** send the Restart Data Item in a Destination Update Message. Finally, the same rules apply to queue indexes.

A router that receives the Restart Data Item **SHOULD** resume transmission of the identified traffic to the modem.

The format of the Restart Data Item matches the Pause Data Item and is:

```
    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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Data Item Type                | Length                        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |  Queue Index  |            ...                                :
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   :                            ...                | Queue Index   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Data Item Type: 25

Length: See Section 3.2.

Queue Index: See Section 3.2.

4. Security Considerations

The extension defined in this document introduces a new mechanism for flow control between a router and modem using DLEP. The extension does not introduce any vulnerabilities that are inherently different from those documented in [RFC8175]. The approach taken to security in that document applies equally when running the extension defined in this document.

Implementations of the extension defined in this document **MUST** support the configuration and use of TLS, as described in [RFC8175], in order to protect configurations where injection attacks are possible, i.e., when the link between a modem and router is not otherwise protected.

Note that this extension does allow a compromised or impersonating modem to suppress transmission by the router or a switch that interconnects the modem and router. Similar attacks are generally possible with base DLEP -- for example, an impersonating modem may cause a session reset, or a compromised modem can simply drop all traffic destined for or sent by a router. [RFC8175] defines the use of TLS to protect against such impersonating attackers.

5. IANA Considerations

This document assigns four new values and creates a new subregistry in the "Dynamic Link Exchange Protocol (DLEP) Parameters" registry.

5.1. Extension Type Value

This document adds a new assignment to the DLEP extensions registry named "Extension Type Values" [RFC8175], per the "Specification Required" policy [RFC8126]. IANA has assigned the following value:

Code	Description
2	Control-Plane-Based Pause

Table 1: Extension Type Value

5.2. Data Item Values

This document adds three new assignments to the DLEP Data Item registry named "Data Item Type Values" [RFC8175], per the "Specification Required" policy [RFC8126]. IANA has assigned the following values:

Type Code	Description
23	Queue Parameters
24	Pause
25	Restart

Table 2: Data Item Values

5.3. Queue Parameter Sub-Data Item Values

IANA has created a new DLEP registry named "Queue Parameter Sub-Data Item Type Values".

Table 3 provides initial registry values and the registration policies [RFC8126] that apply:

Type Code	Description/Policy
0	Reserved
1	Queue Parameter

Type Code	Description/Policy
2-65407	Specification Required
65408-65534	Private Use
65535	Reserved

Table 3: Initial Registry Values

6. References

6.1. Normative References

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6.2. Informative References

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