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**Dynamic Link Exchange Protocol (DLEP)**  
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Abstract

When routing devices rely on modems to effect communications over wireless links, they need timely and accurate knowledge of the characteristics of the link (speed, state, etc.) in order to make forwarding decisions. In mobile or other environments where these characteristics change frequently, manual configurations or the inference of state through routing or transport protocols does not allow the router to make the best decisions. A bidirectional, event-driven communication channel between the router and the modem is necessary.

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## [1. Introduction](#)

There exist today a collection of modem devices that control links of variable datarate and quality. Examples of these types of links include line-of-sight (LOS) terrestrial radios, satellite terminals, and cable/DSL modems. Fluctuations in speed and quality of these links can occur due to configuration (in the case of cable/DSL modems), or on a moment-to-moment basis, due to physical phenomena like multipath interference, obstructions, rain fade, etc. It is also quite possible that link quality and datarate varies with respect to individual destinations on a link, and with the type of traffic being sent. As an example, consider the case of an 802.11g access point, serving 2 associated laptop computers. In this environment, the answer to the question "What is the datarate on the 802.11g link?" is "It depends on which associated laptop we're talking about, and on what kind of traffic is being sent." While the first laptop, being physically close to the access point, may have a datarate of 54Mbps for unicast traffic, the other laptop, being relatively far away, or obstructed by some object, can simultaneously have a datarate of only 32Mbps for unicast. However, for multicast traffic sent from the access point, all traffic is sent at the base transmission rate (which is configurable, but depending on the model of the access point, is usually 24Mbps or less).

In addition to utilizing variable datarate links, mobile networks are challenged by the notion that link connectivity will come and go over time, without an effect on a router's interface state (Up or Down). Effectively utilizing a relatively short-lived connection is problematic in IP routed networks, as routing protocols tend to rely



on interface state and independent timers at OSI Layer 3 to maintain network convergence (e.g., HELLO messages and/or recognition of DEAD routing adjacencies). These dynamic connections can be better utilized with an event-driven paradigm, where acquisition of a new neighbor (or loss of an existing one) is signaled, as opposed to a paradigm driven by timers and/or interface state.

Another complicating factor for mobile networks are the different methods of physically connecting the modem devices to the router. Modems can be deployed as an interface card in a router's chassis, or as a standalone device connected to the router via Ethernet or serial link. In the case of Ethernet or serial attachment, with existing protocols and techniques, routing software cannot be aware of convergence events occurring on the radio link (e.g., acquisition or loss of a potential routing neighbor), nor can the router be aware of the actual capacity of the link. This lack of awareness, along with the variability in datarate, leads to a situation where finding the (current) best route through the network to a given destination is difficult to establish and properly maintain. This is especially true of demand-based access schemes such as Demand Assigned Multiple Access (DAMA) implementations used on some satellite systems. With a DAMA-based system, additional datarate may be available, but will not be used unless the network devices emit traffic at a rate higher than the currently established rate. Increasing the traffic rate does not guarantee additional datarate will be allocated; rather, it may result in data loss and additional retransmissions on the link.

Addressing the challenges listed above, the authors have developed the Data Link Exchange Protocol, or DLEP. The DLEP protocol runs between a router and its attached modem devices, allowing the modem to communicate link characteristics as they change, and convergence events (acquisition and loss of potential routing destinations). The following diagrams are used to illustrate the scope of DLEP packets.

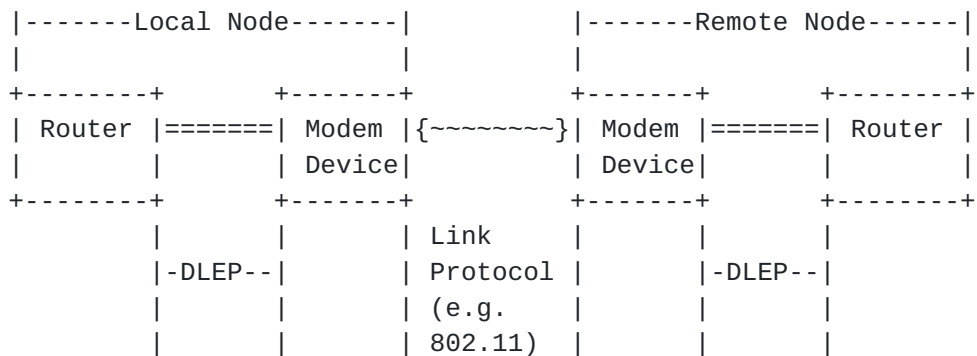


Figure 1: DLEP Network





In Figure 1, when the local modem detects the presence of a remote node, it (the local modem) sends a signal to its router via the DLEP protocol. Upon receipt of the signal, the local router may take whatever action it deems appropriate, such as initiating discovery protocols, and/or issuing HELLO messages to converge the network. On a continuing, as-needed basis, the modem devices utilize DLEP to report any characteristics of the link (datarate, latency, etc) that have changed. DLEP is independent of the link type and topology supported by the modem. Note that the DLEP protocol is specified to run only on the local link between router and modem. Some over the air signaling may be necessary between the local and remote modem in order to provide some parameters in DLEP signals between the local modem and local router, but DLEP does not specify how such over the air signaling is carried out. Over the air signaling is purely a matter for the modem implementer.

Figure 2 shows how DLEP can support a configuration where routers are connected with different link types. In this example, Modem A implements a point-to-point link, and Modem B is connected via a shared medium. In both cases, the DLEP protocol is used to report the characteristics of the link (datarate, latency, etc.) to routers. The modem is also able to use the DLEP session to notify the router when the remote node is lost, shortening the time required to re-converge the network.



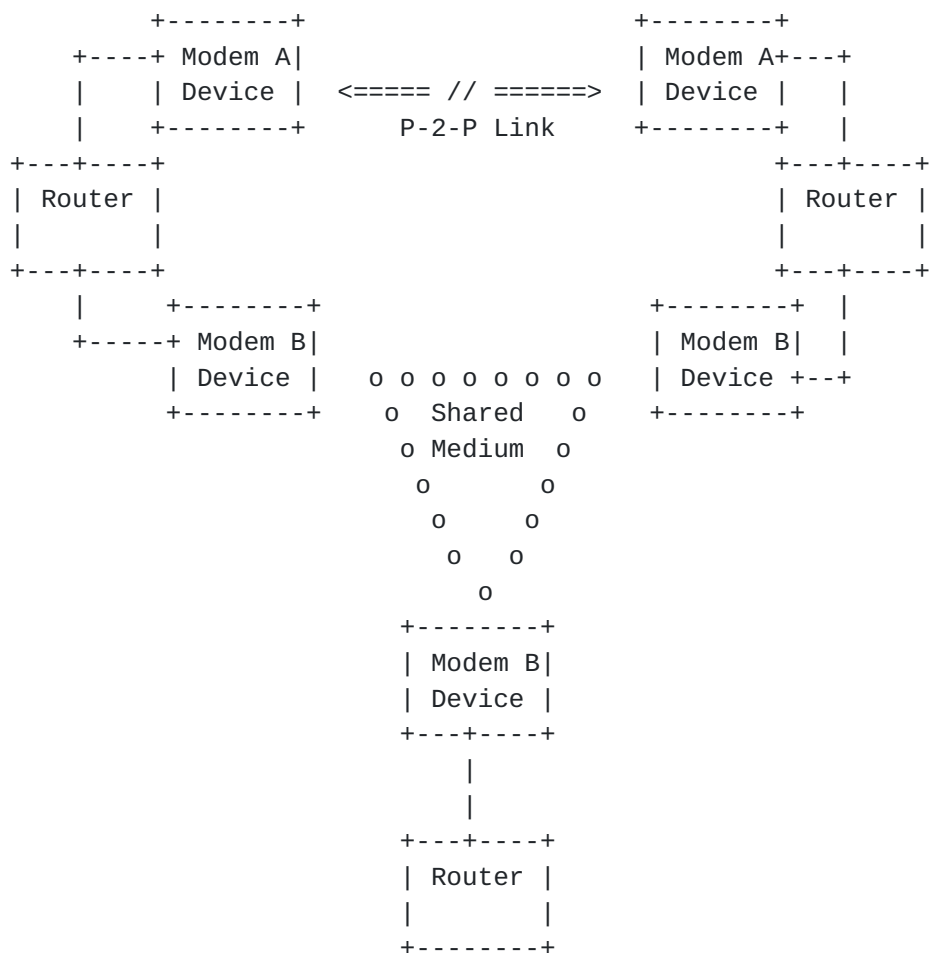


Figure 2: DLEP Network with Multiple Modem Devices

DLEP defines a set of signals used by modems and their attached routers. The signals are used to communicate events that occur on the physical link(s) managed by the modem: for example, a remote node entering or leaving the network, or that the link has changed. Associated with these signals are a set of data items - information that describes the remote node (e.g., address information), and/or the characteristics of the link to the remote node.

The protocol is defined as a collection of type-length-value (TLV) based formats, specifying the signals that are exchanged between a router and a modem, and the data items associated with the signal. This document specifies transport of DLEP signals and data items via the TCP transport, with a UDP-based discovery mechanism. Other transports for the protocol are possible, but are outside the scope of this document.

DLEP uses a session-oriented paradigm between the modem device and its associated router. If multiple modem devices are attached to a



router (as in Figure 2), a separate DLEP session **MUST** exist for each modem. If a modem device supports multiple connections to a router (via multiple logical or physical interfaces), or supports connections to multiple routers, a separate DLEP session **MUST** exist for each connection. This router/modem session provides a carrier for information exchange concerning 'destinations' that are available via the modem device. A 'destination' can be either physical (as in the case of a specific far-end router), or a logical destination (as in a Multicast group). As such, all of the destination-level exchanges in DLEP can be envisioned as building an information base concerning the remote nodes, and the link characteristics to those nodes.

Any DLEP signal that is **NOT** understood by a receiver **MUST** result in an error indication being sent to the originator, and also **MUST** result in termination of the session between the DLEP peers. Any data item that is **NOT** understood by a receiver **MUST** be ignored.

Multicast traffic destined for the variable-quality network (the network accessed via the DLEP modem) is handled in IP networks by deriving a Layer 2 MAC address based on the Layer 3 address. Leveraging on this scheme, Multicast traffic is supported in DLEP simply by treating the derived MAC address as any other 'destination' (albeit a logical one) in the network. To support these logical destinations, one of the DLEP participants (typically, the router) informs the other as to the existence of the logical neighbor. The modem, once it is aware of the existence of this logical neighbor, reports link characteristics just as it would for any other destination in the network. The specific algorithms a modem would use to report metrics on multicast (or logical) destinations is outside the scope of this specification, and is left to specific implementations to decide.

### **1.1. Requirements**

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 [BCP 14](#), [RFC 2119](#) [[RFC2119](#)].

## **2. Assumptions**

Routers and modems that exist as part of the same node (e.g., that are locally connected) can utilize a discovery technique to locate each other, thus avoiding a-priori configuration. The router is responsible for initializing the discovery process, using the Peer Discovery signal ([Section 7.1](#)).



DLEP utilizes a session-oriented paradigm. A router and modem form a session by completing the discovery process. This router-modem session persists unless or until it either (1) times out, based on the timeout values supplied, or (2) is explicitly torn down by one of the participants. Note that while use of timers in DLEP is OPTIONAL, it is strongly recommended that implementations choose to run with timers enabled.

DLEP assumes that the MAC address for delivering data traffic is the MAC specified in the Destination Up signal ([Section 7.9](#)). No manipulation or or substitution is performed; the MAC address supplied in Destination Up is used as the OSI Layer 2 Destination MAC address. DLEP also assumes that MAC addresses MUST be unique within the context of a router-modem session.

DLEP utilizes UDP multicast for single-hop discovery, and TCP for transport of the control signals. Therefore, DLEP assumes that the modem and router have topologically consistent IP addresses assigned. It is recommended that DLEP implementations utilize IPv6 link-local addresses to reduce the administrative burden of address assignment.

This document refers to a remote node as a 'Destination'. Destinations can be identified by either the router or the modem, and represent a specific destination (e.g., an address) that exists on the link(s) managed by the modem. A destination MUST contain a MAC address, it MAY optionally include a Layer 3 address (or addresses). Note that since a destination is a MAC address, the MAC could reference a logical destination, as in a derived multicast MAC address, as well as to a physical device. As destinations are discovered, DLEP routers and modems build an information base on destinations accessible via the modem. Changes in link characteristics are then reported as being 'modem-wide' (effecting ALL destinations accessed via the modem, reported via the Peer Update signal, [Section 7.5](#)) or reported for a specific neighbor (via the Destination Update signal, [Section 7.13](#)).

The DLEP signals concerning destinations thus become the way for routers and modems to maintain, and notify each other about, an information base representing the physical and logical (e.g., multicast) destinations accessible via the modem device. The information base would contain addressing information (i.e., MAC address, and OPTIONALLY, Layer 3 addresses), link characteristics (metrics), and OPTIONALLY, flow control information (credits).

DLEP assumes that security on the session (e.g., authentication of session partners, encryption of traffic, or both) is dealt with by the underlying transport mechanism (e.g., by using a transport such as TLS [[RFC5246](#)]).





This document specifies an implementation of the DLEP signals and data items running over the TCP transport. It is assumed that DLEP running over other transport mechanisms would be documented separately.

### **3. Core Features and Optional Extensions**

DLEP has a core set of signals and data items that **MUST** be processed without error by an implementation in order to guarantee interoperability and therefore make the implementation DLEP compliant. This document defines the core set of signals and data items, listing them as 'mandatory'. It should be noted that some core signals and data items might not be used during the lifetime of a single DLEP session, but a compliant implementation **MUST** support them.

While this document represents the best efforts of the co-authors, and the working group, to be functionally complete, it is recognized that extensions to DLEP will in all likelihood be necessary as more link types are utilized. To support future extension of DLEP, this document describes an extension negotiation capability to be used during session initialization via the Extensions Supported data item, documented in [Section 8.6](#) of this document.

All extensions are considered **OPTIONAL**. Only the DLEP functionality listed as 'mandatory' is required by implementation in order to be DLEP compliant.

This specification defines one extension, Credit processing, exposed via the Extensions Supported mechanism that implementations **MAY** chose to implement, or to omit.

#### **3.1. Negotiation of Optional Extensions**

Optional extensions supported by an implementation **MUST** be declared to potential DLEP peers using the Extensions Supported data item ([Section 8.6](#)) during the session initialization sequence. Once both peers have exchanged initialization signals, an implementation **MUST NOT** emit any signal or data item associated with an optional extension that was not specified in the received initialization signal from its peer.

#### **3.2. Protocol Extensions**

If/when protocol extensions are required, they should be standardized either as an update to this document, or as an additional stand-alone specification. The requests for IANA-controlled registries in this document contain sufficient reserved space, both in terms of DLEP



signals and DLEP data items, to accomodate future extensions to the protocol and the data transferred.

### **3.3. Experimental Signals and Data Items**

This document requests numbering space in both the DLEP signal and data item registries for experimental items. The intent is to allow for experimentation with new signals and/or data items, while still retaining the documented DLEP behavior. If a given experiment proves successful, it SHOULD be documented as an update to this document, or as a stand-alone specification.

Use of the experimental signals or data items MUST be announced by inclusion of an Experimental Definition data item ([Section 8.7](#)) with a value agreed upon (a-priori) between the participating peers. The exact mechanism for a-priori communication of the experimental definition formats is beyond the scope of this document.

Multiple Experimental Definition data items MAY appear in the Peer Initialization/Peer Initialization ACK sequence. However, use of multiple experiments in a single peer session could lead to interoperability issues or unexpected results (e.g., redefinition of experimental signals and/or data items), and is therefore discouraged. It is left to implementations to determine the correct processing path (e.g., a decision on whether to terminate the peer session, or to establish a precedence of the conflicting definitions) if such conflicts arise.

## **4. Metrics**

DLEP includes the ability for the router and modem to communicate metrics that reflect the characteristics (e.g., datarate, latency) of the variable-quality link in use. DLEP does NOT specify how a given metric value is to be calculated, rather, the protocol assumes that metrics have been calculated with a 'best effort', incorporating all pertinent data that is available to the modem device.

As mentioned in the introduction section of this document, metrics have to be used within a context - for example, metrics to a unicast address in the network. DLEP allows for metrics to be sent within two contexts - metrics for a specific destination within the network (e.g., a specific router), and 'modem-wide' (those that apply to all destinations accessed via the modem). Metrics can be further subdivided into transmit and receive metrics. Metrics supplied on DLEP Peer signals are, by definition, modem-wide; metrics supplied on Destination signals are, by definition, used for the specific neighbor only.



DLEP modem implementations MUST announce all supported metric items, and provide default values for those metrics, in the Peer Initialization signal ([Section 7.3](#)). In order to introduce a new metric type, DLEP modem implementations MUST terminate the session with the router (via the Peer Terminate signal, [Section 7.7](#)), and re-establish the session.

It is left to implementations to choose sensible default values based on their specific characteristics. Modems having static (non-changing) link metric characteristics MAY report metrics only once for a given neighbor (or once on a modem-wide basis, if all connections via the modem are of this static nature).

The approach of allowing for different contexts for metric data increases both the flexibility and the complexity of using metric data. This document details the mechanism whereby the data is transmitted, however, the specific algorithms (precedence, etc) for utilizing the dual-context metrics is out of scope and not addressed by this document.

#### **[4.1.](#) Mandatory Metrics**

As mentioned above, DLEP modem implementations MUST announce all supported metric items during session initialization. However, an implementation MUST include the following list of metrics:

- o Maximum Data Rate (Receive) ([Section 8.13](#))
- o Maximum Data Rate (Transmit) ([Section 8.14](#))
- o Current Data Rate (Receive) ([Section 8.15](#))
- o Current Data Rate (Transmit) ([Section 8.16](#))
- o Latency ([Section 8.17](#))

#### **[5.](#) Normal Session Flow**

Normal session flow for a DLEP router has two sub-cases, depending on whether the implementation supports the discovery process. Modem implementations MUST support the Discovery case; router implementations MAY support discovery, or rely on a-priori configuration to define the address(es) of attached modems.



### **5.1. DLEP Router session flow - Discovery case**

If the DLEP router implementation is utilizing the optional discovery mechanism, then the implementation will initialize a UDP socket, binding it to an arbitrary port. This UDP socket is used to send the Peer Discovery signal ([Section 7.1](#)) to the DLEP link-local multicast address and port (TBD). The implementation then waits on receipt of a Peer Offer signal ([Section 7.2](#)), which MUST contain the unicast address and port for TCP-based communication with a DLEP modem. The Peer Offer signal MAY contain multiple address/port combinations. If more than one address/port combination is in the Peer Offer, the DLEP router implementation SHOULD consider the list to be in priority sequence, with the 'most desired' address/port combination listed first. However, router implementations MAY use their own heuristics to determine the best address/port combination. At this point, the router implementation MAY either destroy the UDP socket, or continue to issue Peer Discovery signals to the link-local address/port combination. In either case, the TCP session initialization occurs as in the configured case.

### **5.2. DLEP Router session flow - Configured case**

When a DLEP router implementation has the address and port information for a TCP connection to a modem (obtained either via configuration or via the discovery process described above), the router will initialize and bind a TCP socket. This socket is used to connect to the DLEP modem software. After a successful TCP connect, the modem implementation MUST issue a Peer Initialization signal ([Section 7.3](#)) to the DLEP router. The Peer Initialization signal MUST contain data items for ALL supported metrics from this modem, along with the default values of those metrics. After sending the Peer Initialization, the modem implementation MUST wait for receipt of a Peer Initialization ACK signal ([Section 7.4](#)) from the router. Receipt of the Peer Initialization ACK signal indicates that the router has received and processed the Peer Initialization, and the session MUST transition to the 'in session' state. At this point, signals regarding destinations in the network, and/or Peer Update signals ([Section 7.5](#)), can flow on the DLEP session between modem and router. The 'in session' state is maintained until one of the following conditions occur:

- o The session is explicitly terminated (using Peer Termination), or
- o The session times out, based on supplied timeout values.





### **5.3. DLEP Modem session flow**

DLEP modem implementations MUST support the discovery mechanism. Therefore, the normal flow is as follows:

The implementation will initialize a UDP socket, binding that socket to the DLEP link-local multicast address (TBD) and the DLEP well-known port number (also TBD). The implementation will then initialize a TCP socket, on a unicast address and port. This socket is used to listen for incoming TCP connection requests.

When the modem implementation receives a Peer Discovery signal ([Section 7.1](#)) on the UDP socket, it responds by issuing a Peer Offer signal ([Section 7.2](#)) to the sender of the Peer Discovery signal. The Peer Offer signal MUST contain the unicast address and port of the TCP listen socket, described above. A DLEP modem implementation MAY respond with ALL address/port combinations that have an active TCP listen posted. If multiple address/port combinations are listed, the receiver of the Peer Offer signal MAY connect on any available address/port pair. Anything other than Peer Discovery signals received on the UDP socket MUST be silently dropped.

When the DLEP modem implementation accepts a connection via TCP, it MUST send a Peer Initialization signal ([Section 7.3](#)). The Peer Initialization signal MUST contain metric data items for ALL supported metrics. If an additional metric is to be introduced, the DLEP session between router and modem MUST be terminated and restarted, and the new metric described in a Peer Initialization signal.

### **5.4. Common Session Flow**

In order to maintain the session between router and modem, periodic Heartbeat signals ([Section 7.14](#)) MAY be exchanged. These signals are intended to keep the session alive, and to verify bidirectional connectivity between the two participants. DLEP also provides a Peer Update signal ([Section 7.5](#)), intended to communicate some change in status (e.g., a change of layer 3 address parameters, or a modem-wide link change).

In addition to the local (Peer level) signals above, the participants will transmit DLEP signals concerning destinations in the network. These signals trigger creation/maintenance/deletion of destinations in the information base of the recipient. For example, a modem will inform its attached router of the presence of a new destination via the Destination Up signal ([Section 7.9](#)). Receipt of a Destination Up causes the router to allocate the necessary resources, creating an entry in the information base with the specifics (i.e., MAC Address,



Latency, Data Rate, etc) of the neighbor. The loss of a destination is communicated via the Destination Down signal ([Section 7.11](#)), and changes in status to the destination (e.g., varying link quality, or addressing changes) are communicated via the Destination Update signal ([Section 7.13](#)). The information on a given neighbor will persist in the router's information base until (1) a Destination Down signal is received, indicating that the modem has lost contact with the remote node, or (2) the router/modem session terminates, indicating that the router has lost contact with its own local modem.

Metrics can be expressed within the context of a specific neighbor via the Destination Update signal, or on a modem-wide basis via the Peer Update signal. In cases where metrics are provided on the router/modem session, the receiver **MUST** propagate the metrics to all destinations in its information base that are accessed via the originator. A DLEP participant **MAY** send metrics both in a router/modem session context (via the Peer Update signal) and a specific neighbor context (via Destination Update) at any time. The heuristics for applying received metrics is left to implementations.

In addition to receiving metrics about the link, DLEP provides a signal allowing a router to request a different datarate, or latency, from the modem. This signal is referred to as the Link Characteristics Request signal ([Section 7.15](#)), and gives the router the ability to deal with requisite increases (or decreases) of allocated datarate/latency in demand-based schemes in a more deterministic manner.

## **6. DLEP Message Processing**

Communication between DLEP peers consists of a bidirectional stream of signals, each signal consisting of a signal header and an unordered list of data items. Both signal headers and data items are encoded as TLV (Type-Length-Value) structures. In this document, the data items following the signal header are described as being 'contained in' the signal.

All integer values in all TLV structures **MUST** be in network byte-order.

There is no restriction on the order of data items following a signal, and the multiplicity of duplicate data items is defined by the definition of the signal declared by the type in the signal header.

If an unrecognized, or unexpected signal is received, or a received signal contains unrecognized, invalid or disallowed duplicate data items, the receiving peer **MUST** terminate the session by issuing a



Peer Termination signal ([Section 7.7](#)) with a Status data item ([Section 8.2](#)) containing the most relevant status code, and then close the TCP connection:

### 6.1. DLEP Signal Header

The DLEP signal header contains the following fields:

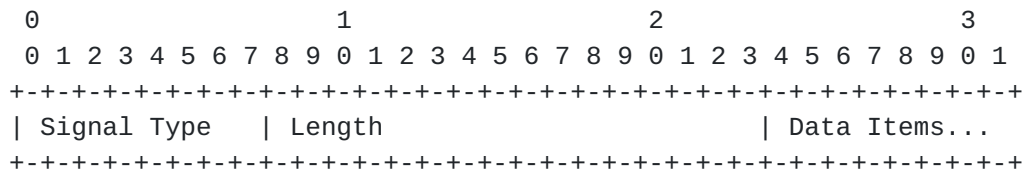


Figure 3: DLEP Signal Header

Signal Type: One of the DLEP Signal Type values defined in this document.

Length: The length, expressed as a 16-bit unsigned integer, of all of the DLEP data items associated with this signal. This length does not include the length of the header itself

Data Items: One or more DLEP data items, encoded in TLVs, as defined in this document.

### 6.2. DLEP Generic Data Item

All DLEP data items contain the following fields:

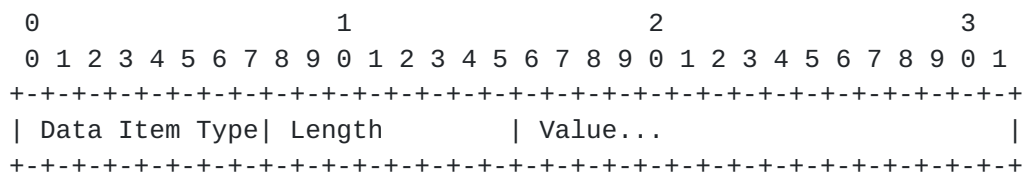


Figure 4: DLEP Generic Data Item

Data Item Type: An 8-bit unsigned integer field specifying the data item being sent.

Length: An 8-bit length of the value field of the data item.

Value: A field of length <Length> which contains data specific to a particular data item.



## 7. DLEP Signals

As mentioned above, all DLEP signals begin with the DLEP signal header structure. Therefore, in the following descriptions of specific signals, this header structure is assumed, and will not be replicated.

Following is the set of MANDATORY signals that must be recognized by a DLEP compliant implementation. As mentioned before, not all signals may be used during a session, but an implementation **MUST** correctly process these signals when received.

The mandatory DLEP signals are:

Signal	Description	Section
TBD	Peer Discovery	<a href="#">Section 7.1</a>
TBD	Peer Offer	<a href="#">Section 7.2</a>
TBD	Peer Initialization	<a href="#">Section 7.3</a>
TBD	Peer Initialization ACK	<a href="#">Section 7.4</a>
TBD	Peer Update	<a href="#">Section 7.5</a>
TBD	Peer Update ACK	<a href="#">Section 7.6</a>
TBD	Peer Termination	<a href="#">Section 7.7</a>
TBD	Peer Termination ACK	<a href="#">Section 7.8</a>
TBD	Destination Up	<a href="#">Section 7.9</a>
TBD	Destination Up ACK	<a href="#">Section 7.10</a>
TBD	Destination Down	<a href="#">Section 7.11</a>
TBD	Destination Down ACK	<a href="#">Section 7.12</a>
TBD	Destination Update	<a href="#">Section 7.13</a>
TBD	Heartbeat	<a href="#">Section 7.14</a>
TBD	Link Characteristics Request	<a href="#">Section 7.15</a>
TBD	Link Characteristics ACK	<a href="#">Section 7.16</a>

### 7.1. Peer Discovery Signal

A Peer Discovery signal **SHOULD** be sent by a router to discover DLEP routers in the network. The Peer Offer signal ([Section 7.2](#)) is required to complete the discovery process. Implementations **MAY** implement their own retry heuristics in cases where it is determined the Peer Discovery signal has timed out.

To construct a Peer Discovery signal, the Signal Type value in the signal header is set to DLEP\_PEER\_DISCOVERY (value TBD).

The Peer Discovery signal **MUST** contain one of each of the following data items:





- o DLEP Version ([Section 8.1](#))
- o Heartbeat Interval ([Section 8.5](#))

## **[7.2.](#) Peer Offer Signal**

A Peer Offer signal MUST be sent by a DLEP modem in response to a Peer Discovery signal ([Section 7.1](#)). Upon receipt, and processing, of a Peer Offer signal, the router responds by issuing a TCP connect to the address/port combination specified in the received Peer Offer.

The Peer Offer signal MUST be sent to the unicast address of the originator of Peer Discovery.

To construct a Peer Offer signal, the Signal Type value in the signal header is set to DLEP\_PEER\_OFFER (value TBD).

The Peer Offer signal MUST contain one of each of the following data items:

- o DLEP Version ([Section 8.1](#))
- o Heartbeat Interval ([Section 8.5](#))

The Peer Offer signal MAY contain one of each of the following data items:

- o Peer Type ([Section 8.4](#))
- o DLEP Port ([Section 8.3](#))

The Peer Offer signal MAY contain one or more of any of the following data items, with different values:

- o IPv4 Address ([Section 8.9](#)), with Add/Drop indicator = 1
- o IPv6 Address ([Section 8.10](#)), with Add/Drop indicator = 1

If the Peer Offer signal includes a DLEP Port data item, the port number specified MUST be used to establish the TCP session. If the DLEP Port number is omitted, the receiver MUST use the DLEP well-known port number ([Section 11.7](#)) to establish the TCP connection.

The IP Address data items indicate the unicast address the receiver of Peer Offer MUST use when connecting the DLEP TCP session. If multiple IP Address items are present in the Peer Offer signal, implementations MAY use their own heuristics to select the address to connect to. If no IP Address data items are included in the Peer



Offer signal, the receiver MUST use the origin address of the signal as the IP address to establish the TCP connection.

### **7.3. Peer Initialization Signal**

A Peer Initialization signal MUST be sent by a router as the first signal of the DLEP TCP session. It is sent by the router after a TCP connect to an address/port combination that was obtained either via receipt of a Peer Offer, or from a-priori configuration.

If any optional extensions are supported by the implementation, they MUST be enumerated in the Extensions Supported data item. If an Extensions Supported data item does NOT exist in a Peer Initialization signal, the receiver of the signal MUST conclude that there is NO support for extensions in the sender.

If any experimental signals or data items are used by the implementation, they MUST be enumerated in one or more Experimental Definition data items. If there are no Experimental Definition data items in a Peer Initialization signal, the receiver of the signal MUST conclude that NO experimental definitions are in use by the sender.

To construct a Peer Initialization signal, the Signal Type value in the signal header is set to DLEP\_PEER\_INITIALIZATION (value TBD).

The Peer Initialization signal MUST contain one of each of the following data items:

- o DLEP Version ([Section 8.1](#))
- o Heartbeat Interval ([Section 8.5](#))

The Peer Initialization signal MAY contain one of each of the following data items:

- o Peer Type ([Section 8.4](#))
- o Extensions Supported ([Section 8.6](#))

The Peer Initialization signal MAY contain one or more of any of the following data items, with different values:

- o Experimental Definition ([Section 8.7](#))



#### **7.4. Peer Initialization ACK Signal**

A Peer Initialization ACK signal MUST be sent in response to a received Peer Initialization signal ([Section 7.3](#)). The Peer Initialization ACK signal completes the TCP-level DLEP session establishment; the sender of the signal should transition to an 'in-session' state when the signal is sent, and the receiver should transition to the 'in-session' state upon receipt (and successful parsing) of a Peer Initialization ACK signal.

All supported metric data items MUST be included in the Peer Initialization ACK signal, with default values to be used on a 'modem-wide' basis. This can be viewed as the modem 'declaring' all supported metrics at DLEP session initialization. Receipt of any DLEP signal containing a metric data item NOT included in the Peer Initialization ACK signal MUST be treated as an error, resulting in the termination of the DLEP session between router and modem.

If any optional extensions are supported by the modem, they MUST be enumerated in the Extensions Supported data item. If an Extensions Supported data item does NOT exist in a Peer Initialization ACK signal, the receiver of the signal MUST conclude that there is NO support for extensions in the sender.

If any experimental signals or data items are used by the implementation, they MUST be enumerated in one or more Experimental Definition data items. If there are no Experimental Definition data items in a Peer Initialization ACK signal, the receiver of the signal MUST conclude that NO experimental definitions are in use by the sender.

After the Peer Initialization/Peer Initialization ACK signals have been successfully exchanged, implementations MUST only utilize extensions and experimental definitions that are supported by BOTH peers.

To construct a Peer Initialization ACK signal, the Signal Type value in the signal header is set to DLEP\_PEER\_INIT\_ACK (value TBD).

The Peer Initialization ACK signal MUST contain one of each of the following data items:

- o DLEP Version ([Section 8.1](#))
- o Heartbeat Interval ([Section 8.5](#))
- o Maximum Data Rate (Receive) ([Section 8.13](#))



- o Maximum Data Rate (Transmit) ([Section 8.14](#))
- o Current Data Rate (Receive) ([Section 8.15](#))
- o Current Data Rate (Transmit) ([Section 8.16](#))
- o Latency ([Section 8.17](#))

The Peer Initialization ACK signal MAY contain one of each of the following data items:

- o Status ([Section 8.2](#))
- o Peer Type ([Section 8.4](#))
- o Resources (Receive) ([Section 8.18](#))
- o Resources (Transmit) ([Section 8.19](#))
- o Relative Link Quality (Receive) ([Section 8.20](#))
- o Relative Link Quality (Transmit) ([Section 8.21](#))
- o Extensions Supported ([Section 8.6](#))

The Peer Initialization ACK signal MAY contain one or more of any of the following data items, with different values:

- o Experimental Definition ([Section 8.7](#))

### **7.5. Peer Update Signal**

A Peer Update signal MAY be sent by a DLEP peer to indicate local Layer 3 address changes, or for metric changes on a modem-wide basis. For example, addition of an IPv4 address to the router MAY prompt a Peer Update signal to its attached DLEP modems. Also, a modem that changes its Maximum Data Rate for all destinations MAY reflect that change via a Peer Update signal to its attached router(s).

Concerning Layer 3 addresses, if the modem is capable of understanding and forwarding this information (via proprietary mechanisms), the address update would prompt any remote DLEP modems (DLEP-enabled modems in a remote node) to issue a Destination Update signal ([Section 7.13](#)) to their local routers with the new (or deleted) addresses. Modems that do not track Layer 3 addresses SHOULD silently parse and ignore the Peer Update signal. Modems that track Layer 3 addresses MUST acknowledge the Peer Update with a Peer Update ACK signal ([Section 7.6](#)). Routers receiving a Peer Update





with metric changes MUST apply the new metric to all destinations (remote nodes) accessible via the modem. Supporting implementations are free to employ heuristics to retransmit Peer Update signals. The sending of Peer Update signals for Layer 3 address changes SHOULD cease when a either participant (router or modem) determines that the other implementation does NOT support Layer 3 address tracking.

If metrics are supplied with the Peer Update signal (e.g., Maximum Data Rate), these metrics are considered to be modem-wide, and therefore MUST be applied to all destinations in the information base associated with the router/modem session.

To construct a Peer Update signal, the Signal Type value in the signal header is set to DLEP\_PEER\_UPDATE (value TBD).

The Peer Update signal MAY contain one of each of the following data items:

- o Maximum Data Rate (Receive) ([Section 8.13](#))
- o Maximum Data Rate (Transmit) ([Section 8.14](#))
- o Current Data Rate (Receive) ([Section 8.15](#))
- o Current Data Rate (Transmit) ([Section 8.16](#))
- o Latency ([Section 8.17](#))
- o Resources (Receive) ([Section 8.18](#))
- o Resources (Transmit) ([Section 8.19](#))
- o Relative Link Quality (Receive) ([Section 8.20](#))
- o Relative Link Quality (Transmit) ([Section 8.21](#))

The Peer Update signal MAY contain one or more of the following data items, with different values:

- o IPv4 Address ([Section 8.9](#))
- o IPv6 Address ([Section 8.10](#))

#### **[7.6.](#) Peer Update ACK Signal**

A Peer Update ACK signal MUST be sent by implementations supporting Layer 3 address tracking and/or modem-wide metrics to indicate whether a Peer Update signal ([Section 7.5](#)) was successfully



processed. If the Peer Update ACK is issued, it MUST contain a Status data item, indicating the success or failure of processing the received Peer Update.

To construct a Peer Update ACK signal, the Signal Type value in the signal header is set to DLEP\_PEER\_UPDATE\_ACK (value TBD).

The Peer Update ACK signal MAY contain one of each of the following data items:

- o Status ([Section 8.2](#))

A receiver of a Peer Update ACK signal without a Status data item MUST behave as if a Status data item with code 'Success' had been received.

### **7.7. Peer Termination Signal**

A Peer Termination signal MUST be sent by a DLEP participant when the router/modem session needs to be terminated. Implementations receiving a Peer Termination signal MUST send a Peer Termination ACK signal ([Section 7.8](#)) to confirm the termination process. The sender of a Peer Termination signal is free to define its heuristics in event of a timeout. The receiver of a Peer Termination signal MUST release all resources allocated for the router/modem session, and MUST eliminate all destinations in the information base accessible via the router/modem pair represented by the session. Router and modem state machines are returned to the 'discovery' state. No Destination Down signals ([Section 7.11](#)) are sent.

To construct a Peer Termination signal, the Signal Type value in the signal header is set to DLEP\_PEER\_TERMINATION (value TBD).

The Peer Termination signal MAY contain one of each of the following data items:

- o Status ([Section 8.2](#))

A receiver of a Peer Termination signal without a Status data item MUST behave as if a Status data item with status code 'Success' had been received.

### **7.8. Peer Termination ACK Signal**

A Peer Termination ACK signal MUST be sent by a DLEP peer in response to a received Peer Termination signal ([Section 7.7](#)). Receipt of a Peer Termination ACK signal completes the teardown of the router/modem session.



To construct a Peer Termination ACK signal, the Signal Type value in the signal header is set to DLEP\_PEER\_TERMINATION\_ACK (value TBD).

The Peer Termination ACK signal MAY contain one of each of the following data items:

- o Status ([Section 8.2](#))

A receiver of a Peer Termination ACK signal without a Status data item MUST behave as if a Status data item with status code 'Success' had been received.

### **7.9. Destination Up Signal**

A DLEP participant MUST send a Destination Up signal to report that a new destination has been detected. A Destination Up ACK signal ([Section 7.10](#)) is required to confirm a received Destination Up. A Destination Up signal can be sent either by the modem, to indicate that a new remote node has been detected, or by the router, to indicate the presence of a new logical destination (e.g., a Multicast group) exists in the network.

The sender of the Destination Up signal is free to define its retry heuristics in event of a timeout. When a Destination Up signal is received and successfully processed, the receiver should add knowledge of the new destination to its information base, indicating that the destination is accessible via the modem/router pair.

To construct a Destination Up signal, the Signal Type value in the signal header is set to DLEP\_DESTINATION\_UP (value TBD).

The Destination Up signal MUST contain one of each of the following data items:

- o MAC Address ([Section 8.8](#))

The Destination Up signal MAY contain one of each of the following data items:

- o Maximum Data Rate (Receive) ([Section 8.13](#))
- o Maximum Data Rate (Transmit) ([Section 8.14](#))
- o Current Data Rate (Receive) ([Section 8.15](#))
- o Current Data Rate (Transmit) ([Section 8.16](#))
- o Latency ([Section 8.17](#))



- o Resources (Receive) ([Section 8.18](#))
- o Resources (Transmit) ([Section 8.19](#))
- o Relative Link Quality (Receive) ([Section 8.20](#))
- o Relative Link Quality (Transmit) ([Section 8.21](#))

The Destination Up signal MAY contain one or more of the following data items, with different values:

- o IPv4 Address ([Section 8.9](#))
- o IPv6 Address ([Section 8.10](#))
- o IPv4 Attached Subnet ([Section 8.11](#))
- o IPv6 Attached Subnet ([Section 8.12](#))

If the sender has IPv4 and/or IPv6 address information for a destination it SHOULD include the relevant data items in the Destination Up signal, reducing the need for the receiver to probe for any address.

#### **[7.10](#). Destination Up ACK Signal**

A DLEP participant MUST send a Destination Up ACK signal to indicate whether a Destination Up signal ([Section 7.9](#)) was successfully processed.

To construct a Destination Up ACK signal, the Signal Type value in the signal header is set to DLEP\_DESTINATION\_UP\_ACK (value TBD).

The Destination Up ACK signal MUST contain one of each of the following data items:

- o MAC Address ([Section 8.8](#))

The Destination Up ACK signal MAY contain one of each of the following data items:

- o Status ([Section 8.2](#))

A receiver of a Destination Up ACK signal without a Status data item MUST behave as if a Status data item with status code 'Success' had been received.





### **7.11. Destination Down Signal**

A DLEP peer MUST send a Destination Down signal to report when a destination (a remote node or a multicast group) is no longer reachable. A Destination Down ACK signal ([Section 7.12](#)) MUST be sent by the recipient of a Destination Down signal to confirm that the relevant data has been removed from the information base. The sender of the Destination Down signal is free to define its retry heuristics in event of a timeout.

To construct a Destination Down signal, the Signal Type value in the signal header is set to DLEP\_DESTINATION\_DOWN (value TBD).

The Destination Down signal MUST contain one of each of the following data items:

- o MAC Address ([Section 8.8](#))

### **7.12. Destination Down ACK Signal**

A DLEP participant MUST send a Destination Down ACK signal to indicate whether a received Destination Down signal ([Section 7.11](#)) was successfully processed. If successfully processed, the sender of the ACK MUST have removed all entries in the information base that pertain to the referenced destination.

To construct a Destination Down ACK signal, the Signal Type value in the signal header is set to DLEP\_DESTINATION\_DOWN\_ACK (value TBD).

The Destination Down ACK signal MUST contain one of each of the following data items:

- o MAC Address ([Section 8.8](#))

The Destination Down ACK signal MAY contain one of each of the following data items:

- o Status ([Section 8.2](#))

A receiver of a Destination Down ACK signal without a Status data item MUST behave as if a Status data item with status code 'Success' had been received.

### **7.13. Destination Update Signal**

A DLEP participant SHOULD send the Destination Update signal when it detects some change in the information base for a given destination



(remote node or multicast group). Some examples of changes that would prompt a Destination Update signal are:

- o Change in link metrics (e.g., Data Rates)
- o Layer 3 addressing change (for implementations that support it)

To construct a Destination Update signal, the Signal Type value in the signal header is set to DLEP\_DESTINATION\_UPDATE (value TBD).

The Destination Update signal MUST contain one of each of the following data items:

- o MAC Address ([Section 8.8](#))

The Destination Update signal MAY contain one of each of the following data items:

- o Maximum Data Rate (Receive) ([Section 8.13](#))
- o Maximum Data Rate (Transmit) ([Section 8.14](#))
- o Current Data Rate (Receive) ([Section 8.15](#))
- o Current Data Rate (Transmit) ([Section 8.16](#))
- o Latency ([Section 8.17](#))
- o Resources (Receive) ([Section 8.18](#))
- o Resources (Transmit) ([Section 8.19](#))
- o Relative Link Quality (Receive) ([Section 8.20](#))
- o Relative Link Quality (Transmit) ([Section 8.21](#))

The Destination Update signal MAY contain one or more of the following data items, with different values:

- o IPv4 Address ([Section 8.9](#))
- o IPv6 Address ([Section 8.10](#))
- o IPv4 Attached Subnet ([Section 8.11](#))
- o IPv6 Attached Subnet ([Section 8.12](#))



#### **7.14.    Heartbeat Signal**

A Heartbeat signal SHOULD be sent by a DLEP participant every N seconds, where N is defined in the Heartbeat Interval field of the Peer Initialization signal ([Section 7.3](#)) or Peer Initialization ACK signal ([Section 7.4](#)). Note that implementations setting the Heartbeat Interval to 0 effectively set the interval to an infinite value, therefore, in those cases, this signal SHOULD NOT be sent.

The signal is used by participants to detect when a DLEP session partner (either the modem or the router) is no longer communicating. Participants SHOULD allow two (2) heartbeat intervals to expire with no traffic on the router/modem session before initiating DLEP session termination procedures.

To construct a Heartbeat signal, the Signal Type value in the signal header is set to DLEP\_PEER\_HEARTBEAT (value TBD).

There are no valid data items for the Heartbeat signal.

#### **7.15.    Link Characteristics Request Signal**

The Link Characteristics Request signal MAY be sent by the router to request that the modem initiate changes for specific characteristics of the link. The request can reference either a real (e.g., a remote node), or a logical (e.g., a multicast group) destination within the network.

The Link Characteristics Request signal contains either a Current Data Rate (CDRR or CDRT) data item to request a different datarate than what is currently allocated, a Latency data item to request that traffic delay on the link not exceed the specified value, or both. A Link Characteristics ACK signal ([Section 7.16](#)) is required to complete the request. Issuing a Link Characteristics Request with ONLY the MAC Address data item is a mechanism a peer MAY use to request metrics (via the Link Characteristics ACK) from its partner.

The sender of a Link Characteristics Request signal MAY attach a timer to the request using the Link Characteristics ACK Timer data item. If a Link Characteristics ACK signal is received after the timer expires, the sender MUST assume that the request failed. Implementations are free to define their retry heuristics in event of a timeout.

To construct a Link Characteristics Request signal, the Signal Type value in the signal header is set to DLEP\_LINK\_CHAR\_REQ (value TBD).



The Link Characteristics Request signal MUST contain one of each of the following data items:

- o MAC Address ([Section 8.8](#))

The Link Characteristics Request signal MAY contain one of each of the following data items:

- o Link Characteristics ACK Timer ([Section 8.22](#))
- o Current Data Rate (Receive) ([Section 8.15](#))
- o Current Data Rate (Transmit) ([Section 8.16](#))
- o Latency ([Section 8.17](#))

#### **[7.16.](#) Link Characteristics ACK Signal**

A DLEP participant MUST send a Link Characteristics ACK signal to indicate whether a received Link Characteristics Request signal ([Section 7.15](#)) was successfully processed. The Link Characteristics ACK signal SHOULD contain a complete set of metric data items. It MUST contain the same metric types as the request. The values in the metric data items in the Link Characteristics ACK signal MUST reflect the link characteristics after the request has been processed.

If an implementation is not able to alter the characteristics of the link in the manner requested, then a Status data item with status code 'Request Denied' MUST be added to the signal.

To construct a Link Characteristics Request ACK signal, the Signal Type value in the signal header is set to DLEP\_LINK\_CHAR\_ACK (value TBD).

The Link Characteristics ACK signal MUST contain one of each of the following data items:

- o MAC Address ([Section 8.8](#))

The Link Characteristics ACK signal MAY contain one of each of the following data items:

- o Current Data Rate (Receive) ([Section 8.15](#))
- o Current Data Rate (Transmit) ([Section 8.16](#))
- o Latency ([Section 8.17](#))





- o Resources (Receive) ([Section 8.18](#))
- o Resources (Transmit) ([Section 8.19](#))
- o Relative Link Quality (Receive) ([Section 8.20](#))
- o Relative Link Quality (Transmit) ([Section 8.21](#))
- o Status ([Section 8.2](#))

A receiver of a Link Characteristics ACK signal without a Status data item MUST behave as if a Status data item with status code 'Success' had been received.

## **8. DLEP Data Items**

Following is the list of MANDATORY data items that must be recognized by a DLEP compliant implementation. As mentioned before, not all data items need be used during a session, but an implementation MUST correctly process these data items when correctly associated with a signal.

The mandatory DLEP data items are:



[illegible]



Data Item Type:    TBD

Length:    4

Major Version:    Major version of the DLEP protocol.

Minor Version:    Minor version of the DLEP protocol.

Support of this draft is indicated by setting the Major Version to '0', and the Minor Version to '8' (i.e., Version 0.8).

## 8.2. Status

The Status data item is MAY appear in the Peer Initialization ACK ([Section 7.4](#)), Peer Termination ([Section 7.7](#)), Peer Termination ACK ([Section 7.8](#)), Peer Update ACK ([Section 7.6](#)), Destination Up ACK ([Section 7.10](#)), Destination Down ACK ([Section 7.12](#)) and Link Characteristics ACK ([Section 7.16](#)) signals as part of an acknowledgement from either the modem or the router, to indicate the success or failure of the previously received signal.

The Status data item contains the following fields:

0	1	2											
0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3											
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+													
Data Item Type  Length = 1										Code			
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+													

Data Item Type:    TBD

Length:    1

Status Code:    One of the codes defined below.



Status Code	Reason
Success	The signal was processed successfully.
Unknown Signal	The signal was not recognized by the implementation.
Invalid Signal	One or more data items in the signal are invalid, unexpected or duplicated.
Unexpected Signal	The signal was not expected while the machine was in this state, e.g., a Peer Initialization signal after session establishment.
Request Denied	The receiver has not completed the request.
Timed Out	The request could not be completed in the time allowed.

### 8.3. DLEP Port

The DLEP Port data item MAY appear in the Peer Offer signal ([Section 7.2](#)). The DLEP Port data item indicates the TCP Port number on the DLEP server available for connections. If provided, the receiver MUST use this information to perform the TCP connect to the DLEP server.

The DLEP Port data item contains the following fields:

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 = 2		TCP Port Number

Data Item Type: TBD

Length: 2

TCP Port Number: TCP Port number on the DLEP server.

### 8.4. Peer Type

The Peer Type data item MAY appear in both the Peer Discovery ([Section 7.1](#)) and Peer Offer ([Section 7.2](#)) signals. The Peer Type data item is used by the router and modem to give additional information as to its type. The peer type is a string and is envisioned to be used for informational purposes (e.g., as output in a display command).





The Peer Type data item contains the following fields:

```

      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 = peer | Peer Type |
|               | type len   |               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Data Item Type: TBD

Length: Length of peer type string.

Peer Type: UTF-8 encoded string. For example, a satellite modem might set this variable to "Satellite terminal".

An implementation MUST NOT assume the Peer Type is NUL-terminated.

## 8.5. Heartbeat Interval

The Heartbeat Interval data item MUST appear in the Peer Discovery ([Section 7.1](#)), Peer Offer ([Section 7.2](#)), Peer Initialization ([Section 7.3](#)) and Peer Initialization ACK ([Section 7.4](#)) signals to indicate the desired Heartbeat timeout window. The receiver MUST either accept the timeout interval supplied by the sender, or reject the Peer Initialization, and close the socket. Implementations MUST implement heuristics such that DLEP signals sent/received reset the timer interval.

The Interval is used to specify a period (in seconds) for Heartbeat signals ([Section 7.14](#)). By specifying an Interval value of 0, implementations MAY indicate the desire to disable Heartbeat signals entirely (i.e., the Interval is set to an infinite value), however, it is strongly recommended that implementations use non 0 timer values.

A DLEP session will be considered inactive, and MUST be torn down, by an implementation detecting that two (2) Heartbeat intervals have transpired without receipt of any DLEP signals.

The Heartbeat Interval data item contains the following fields:

```

      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 = 2 | Interval |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```



Data Item Type:    TBD

Length:    2

Interval:    0 = Do NOT use heartbeats on this peer-to-peer session.  
               Non-zero = Interval, in seconds, for heartbeat signals.

## 8.6. Extensions Supported

The Extensions Supported data item MAY be used in both the Peer Initialization and Peer Initialization ACK signals. The Extensions Supported data item is used by the router and modem to negotiate additional optional functionality they are willing to support. The Extensions List is a concatenation of the types of each supported extension, found in the IANA DLEP Extensions repository.

The Extensions Supported data item contains the following fields:

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 = No.										Extensions List																			
										of values																													

Data Item Type:    TBD

Length:    Number of Extensions supported.

Extension List:    A list of extensions supported, identified by their 1-octet value as listed in the extensions registry.

## 8.7. Experimental Definition

The Experimental Definition data item MAY be used in both the Peer Initialization and Peer Initialization ACK signals. The Experimental Definition data item is used by the router and modem to indicate the formats to be used for experimental signals and data items for the given peer session. The formats are identified by using a string that matches the 'name' given to the experiment.

The Experimental Definition item contains the following fields:



```

      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 = len. | Experiment Name                |
|               | of Experiment |                               |
|               |   name       |                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Data Item Type: TBD

Length: Length of the name string for the Experiment.

Experiment Name: UTF-8 encoded string, containing the name of the experiment being utilized.

An implementation receiving this data item MUST compare the received string to a list of experiments that it supports. An implementation MUST NOT assume the Experiment Name is NUL-terminated.

## 8.8. MAC Address

The MAC address data item MUST appear in all destination-oriented signals (i.e., Destination Up ([Section 7.9](#)), Destination Up ACK ([Section 7.10](#)), Destination Down ([Section 7.11](#)), Destination Down ACK ([Section 7.12](#)), Destination Update ([Section 7.13](#)), Link Characteristics Request ([Section 7.15](#)), and Link Characteristics ACK ([Section 7.16](#))). The MAC Address data item contains the address of the destination on the remote node. The MAC address MAY be either a physical or a virtual destination. Examples of a virtual destination would be a multicast MAC address, or the broadcast MAC (FF:FF:FF:FF:FF:FF).

```

      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 = 6   |          MAC Address          |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|               |          MAC Address          |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Data Item Type: TBD

Length: 6

MAC Address: MAC Address of the destination (either physical or virtual).



### 8.9. IPv4 Address

The IPv4 Address data item MUST appear in the Peer Offer signal ([Section 7.2](#)), and MAY appear in the Peer Update ([Section 7.5](#)), Destination Up ([Section 7.9](#)) and Destination Update ([Section 7.13](#)) signals. When included in Destination signals, this data item contains the IPv4 address of the destination. In the Peer Offer signal, it contains the IPv4 address of the originating peer to be used to establish a DLEP session. In either case, the data item also contains an indication of whether this is a new or existing address, or is a deletion of a previously known address. When used in a Peer Offer signal the Add/Drop Indicator MUST be 1 (i.e. Add).

The IPv4 Address data item contains the following fields:

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
+--+																					

Data Item Type: TBD

Length: 5

Add/Drop: Value indicating whether this is a new or existing address (1), or a withdrawal of an address (0).

IPv4 Address: The IPv4 address of the destination or peer.

### 8.10. IPv6 Address

The IPv6 Address data item MUST appear in the Peer Offer signal ([Section 7.2](#)), and MAY appear in the Peer Update ([Section 7.5](#)), Destination Up ([Section 7.9](#)) and Destination Update ([Section 7.13](#)) signals. When included in Destination signals, this data item contains the IPv6 address of the destination. In the Peer Offer signal, it contains the IPv6 address of the originating peer to be used to establish a DLEP session. In either case, the data item also contains an indication of whether this is a new or existing address, or is a deletion of a previously known address. When used in a Peer Offer signal the Add/Drop Indicator MUST be 1 (i.e. Add).

The IPv6 Address data item contains the following fields:





```

      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 = 17 | Add/Drop | IPv6 Address |
|                |             | Indicator |              |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                | IPv6 Address |              |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                | IPv6 Address |              |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                | IPv6 Address |              |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                | IPv6 Address |              |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Data Item Type: TBD

Length: 17

Add/Drop: Value indicating whether this is a new or existing address (1), or a withdrawal of an address (0).

IPv6 Address: IPv6 Address of the destination or peer.

#### **8.11. IPv4 Attached Subnet**

The DLEP IPv4 Attached Subnet allows a device to declare that it has an IPv4 subnet (e.g., a stub network) attached. Once an IPv4 Subnet has been declared on a device, the declaration can NOT be withdrawn without terminating the destination (via the Destination Down signal) and re-issuing the Destination Up signal.

The DLEP IPv4 Attached Subnet data item data item contains the following fields:

```

      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 = 5 | IPv4 Attached Subnet |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| IPv4 Attached Subnet | Subnet Mask |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Data Item Type: TBD

Length: 5

IPv4 Subnet: The IPv4 subnet reachable at the destination.



Subnet Mask: A subnet mask (0-32) to be applied to the IPv4 subnet.

### 8.12. IPv6 Attached Subnet

The DLEP IPv6 Attached Subnet allows a device to declare that it has an IPv6 subnet (e.g., a stub network) attached. As in the case of the IPv4 attached Subnet data item above, once an IPv6 attached subnet has been declared, it can NOT be withdrawn without terminating the destination (via Destination Down) and re-issuing the Destination Up signal.

The DLEP IPv6 Attached Subnet data item data item contains the following fields:

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 = 17																	IPv6 Attached Subnet																																	
IPv6 Attached Subnet																	IPv6 Attached Subnet																	IPv6 Attached Subnet																																	
IPv6 Attached Subnet																	IPv6 Attached Subnet																	IPv6 Attached Subnet																																	
IPv6 Attached Subnet																	Subnet Mask																																																		

Data Item Type: TBD

Length: 17

IPv4 Subnet: The IPv6 subnet reachable at the destination.

Subnet Mask: A subnet mask (0-128) to be applied to the IPv6 subnet.

### 8.13. Maximum Data Rate (Receive)

The Maximum Data Rate (Receive) (MDRR) data item MUST appear in the Peer Initialization ACK signal ([Section 7.4](#)), and MAY appear in the Peer Update ([Section 7.5](#)), Destination Up ([Section 7.9](#)) and Destination Update ([Section 7.13](#)) signals to indicate the maximum theoretical data rate, in bits per second, that can be achieved while receiving data on the link.

The Maximum Data Rate (Receive) data item contains the following fields:



[illegible]

Data Item Type: TBD

Length: 8

Maximum Data Rate (Receive): A 64-bit unsigned integer, representing the maximum theoretical data rate, in bits per second (bps), that can be achieved while receiving on the link.

#### 8.14. Maximum Data Rate (Transmit)

The Maximum Data Rate (Transmit) (MDRT) data item **MUST** appear in the Peer Initialization ACK signal ([Section 7.4](#)), and **MAY** appear in the Peer Update ([Section 7.5](#)), Destination Up ([Section 7.9](#)) and Destination Update ([Section 7.13](#)) signals to indicate the maximum theoretical data rate, in bits per second, that can be achieved while transmitting data on the link.

The Maximum Data Rate (Transmit) data item contains the following fields:

[illegible]

Data Item Type: TBD

Length: 8

Maximum Data Rate (Transmit): A 64-bit unsigned integer, representing the maximum theoretical data rate, in bits per second (bps), that can be achieved while transmitting on the link.



### **8.15. Current Data Rate (Receive)**

The Current Data Rate (Receive) (CDRR) data item MUST appear in the Peer Initialization ACK signal ([Section 7.4](#)), and MAY appear in the Peer Update ([Section 7.5](#)), Destination Up ([Section 7.9](#)), Destination Update ([Section 7.13](#)), Link Characteristics Request ([Section 7.15](#)) and Link Characteristics ACK ([Section 7.16](#)) signals to indicate the rate at which the link is currently operating for receiving traffic. When used in the Link Characteristics Request signal, CDRR represents the desired receive rate, in bits per second, on the link.

The Current Data Rate (Receive) data item contains the following fields:

[illegible]

Data Item Type: TBD

Length: 8

Current Data Rate (Receive): A 64-bit unsigned integer, representing the current data rate, in bits per second, that is currently being achieved while receiving traffic on the link.

If there is no distinction between current and maximum receive data rates, current data rate receive MUST be set equal to the maximum data rate receive.

### 8.16. Current Data Rate (Transmit)

The Current Data Rate Receive (CDRT) data item MUST appear in the Peer Initialization ACK signal ([Section 7.4](#)), and MAY appear in the Peer Update ([Section 7.5](#)), Destination Up ([Section 7.9](#)), Destination Update ([Section 7.13](#)), Link Characteristics Request ([Section 7.15](#)) and Link Characteristics ACK ([Section 7.16](#)) signals to indicate the rate at which the link is currently operating for transmitting traffic. When used in the Link Characteristics Request signal, CDRT represents the desired transmit rate, in bits per second, on the link.





The Current Data Rate (Transmit) data item contains the following fields:

```

      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 = 8      | CDRT (bps)                        |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                                     CDRT (bps)                       |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|          CDRT (bps)              |
+---+---+---+---+---+---+---+---+

```

Data Item Type: TBD

Length: 8

Current Data Rate (Transmit): A 64-bit unsigned integer, representing the current data rate, in bits per second, that is currently be achieved while transmitting traffic on the link.

If there is no distinction between current and maximum transmit data rates, current data rate transmit MUST be set equal to the maximum data rate transmit.

### 8.17. Latency

The Latency data item data item MUST appear in the Peer Initialization ACK signal ([Section 7.4](#)), and MAY appear in the Peer Update ([Section 7.5](#)), Destination Up ([Section 7.9](#)), Destination Update ([Section 7.13](#)), Link Characteristics Request ([Section 7.15](#)) and Link Characteristics ACK ([Section 7.16](#)) signals to indicate the amount of latency, in microseconds, on the link, or in the case of the Link Characteristics Request, to indicate the maximum latency required on the link.

The Latency value is reported as delay. The calculation of latency is implementation dependent. For example, the latency may be a running average calculated from the internal queuing.

```

      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 = 4      | Latency in microseconds          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Latency (cont.) microsecs      |
+---+---+---+---+---+---+---+---+

```



Data Item Type:    TBD

Length:    4

Latency:    A 32-bit unsigned value, representing the transmission delay that a packet encounters as it is transmitted over the link.

#### **8.18. Resources (Receive)**

The Resources (Receive) (RESR) data item MAY appear in the Peer Initialization ACK signal ([Section 7.4](#)), Peer Update ([Section 7.5](#)), Destination Up ([Section 7.9](#)), Destination Update ([Section 7.13](#)) and Link Characteristics ACK ([Section 7.16](#)) signals to indicate the amount of resources for reception (with 0 meaning 'no resources available', and 100 meaning 'all resources available') at the destination. The list of resources that might be considered is beyond the scope of this document, and is left to implementations to decide.

The Resources (Receive) data item contains the following fields:

0										1										2									
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3						
Data Item Type										Length = 1										RESR									

Data Item Type:    TBD

Length:    1

Resources (Receive):    A percentage, 0-100, representing the amount of resources allocated to receiving data.

If a device cannot calculate RESR, this data item SHOULD NOT be issued.

#### **8.19. Resources (Transmit)**

The Resources (Receive) (RESR) data item MAY appear in the Peer Initialization ACK signal ([Section 7.4](#)), Peer Update ([Section 7.5](#)), Destination Up ([Section 7.9](#)), Destination Update ([Section 7.13](#)) and Link Characteristics ACK ([Section 7.16](#)) signals to indicate the amount of resources for transmission (with 0 meaning 'no resources available', and 100 meaning 'all resources available') at the destination. The list of resources that might be considered is beyond the scope of this document, and is left to implementations to decide.



The Resources (Transmit) data item contains the following fields:

```

0                               1                               2
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| Data Item Type| Length = 1      |      REST      |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Data Item Type: TBD

Length: 1

Resources (Transmit): A percentage, 0-100, representing the amount of resources allocated to transmitting data.

If a device cannot calculate REST, this data item SHOULD NOT be issued.

## 8.20. Relative Link Quality (Receive)

The Relative Link Quality (Receive) (RLQR) data item MAY appear in the Peer Initialization ACK signal ([Section 7.4](#)), Peer Update ([Section 7.5](#)), Destination Up ([Section 7.9](#)), Destination Update ([Section 7.13](#)) and Link Characteristics ACK ([Section 7.16](#)) signals to indicate the quality of the link for receiving data as calculated by the originating peer.

The Relative Link Quality (Receive) data item contains the following fields:

```

0                               1                               2
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| Data Item Type| Length = 1      |      RLQR      |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Data Item Type: TBD

Length: 1

Relative Link Quality (Receive): A non-dimensional integer, 1-100, representing relative link quality. A value of 100 represents a link of the highest quality.

If a device cannot calculate the RLQR, this data item SHOULD NOT be issued.



### 8.21. Relative Link Quality (Transmit)

The Relative Link Quality (Transmit) (RLQT) data item MAY appear in the Peer Initialization ACK signal ([Section 7.4](#)), Peer Update ([Section 7.5](#)), Destination Up ([Section 7.9](#)), Destination Update ([Section 7.13](#)) and Link Characteristics ACK ([Section 7.16](#)) signals to indicate the quality of the link for transmitting data as calculated by the originating peer.

The Relative Link Quality (Transmit) data item contains the following fields:

```

0                               1                               2
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Data Item Type| Length = 1      |      RLQT      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Data Item Type: TBD

Length: 1

Relative Link Quality (Transmit): A non-dimensional integer, 1-100, representing relative link quality. A value of 100 represents a link of the highest quality.

If a device cannot calculate the RLQT, this data item SHOULD NOT be issued.

### 8.22. Link Characteristics ACK Timer

The Link Characteristics ACK Timer data item MAY appear in the Link Characteristics Request signal ([Section 7.15](#)) to indicate the desired number of seconds to the sender will wait for a response to the request. If this data item is omitted, implementations supporting the Link Characteristics Request SHOULD choose a default value.

The Link Characteristics ACK Timer data item contains the following fields:

```

0                               1                               2
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Data Item Type| Length = 1      | Interval      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Data Item Type: TBD





Length: 1

Interval: 0 = Do NOT use timeouts for Link Characteristics requests on this router/modem session. Non-zero = Interval, in seconds, to wait before considering a Link Characteristics Request has been lost.

## **9. Credit-Windowing**

DLEP includes an OPTIONAL credit-windowing scheme analogous to the one documented in [[RFC5578](#)]. In this scheme, traffic between the router and modem is treated as two unidirectional windows. This document identifies these windows as the 'Modem Receive Window', or MRW, and the 'Router Receive Window', or RRW.

If the OPTIONAL credit-windowing scheme is used, credits MUST be granted by the receiver on a given window - that is, on the 'Modem Receive Window' (MRW), the modem is responsible for granting credits to the router, allowing it (the router) to send data to the modem. Likewise, the router is responsible for granting credits on the RRW, which allows the modem to send data to the router.

DLEP expresses all credit data in number of octets. The total number of credits on a window, and the increment to add to a grant, are always expressed as a 64-bit unsigned integer quantity.

If used, credits are managed on a neighbor-specific basis; that is, separate credit counts are maintained for each neighbor requiring the service. Credits do not apply to the DLEP session that exists between routers and modems.

If a peer is able to support the OPTIONAL credit-windowing scheme then it MUST include a Extensions Supported data item ([Section 8.6](#)) including the value DLEP\_EXT\_CREDITS (value TBD) in the appropriate Peer Initialization or Peer Initialization ACK signal.

### **9.1. Credit-Windowing Signals**

The credit-windowing scheme introduces no additional DLEP signals. However, if a peer has advertised during session initialization that it supports the credit-windowing scheme then the following DLEP signals may contain additional credit-windowing data items:

#### **9.1.1. Destination Up Signal**

The Destination Up signal MAY contain one of each of the following data items:



- o Credit Grant ([Section 9.2.2](#))

### **9.1.2. Destination Up ACK Signal**

The Destination Up ACK signal MAY contain one of each of the following data items:

- o Credit Window Status ([Section 9.2.1](#))

### **9.1.3. Destination Update Signal**

The Destination Update signal MAY contain one of each of the following data items:

- o Credit Window Status ([Section 9.2.1](#))
- o Credit Grant ([Section 9.2.2](#))
- o Credit Request ([Section 9.2.3](#))

## **9.2. Credit-Windowing Data Items**

The credit-windowing scheme introduces 3 additional data items. If a peer has advertised during session initialization that it supports the credit-windowing scheme then it MUST correctly process the following data items without error.

+-----+-----+-----+			
Data Item	Description	Section	
+-----+-----+-----+			
TBD	Credit Window Status	<a href="#">Section 9.2.1</a>	
TBD	Credit Grant	<a href="#">Section 9.2.2</a>	
TBD	Credit Request	<a href="#">Section 9.2.3</a>	
+-----+-----+-----+			

### **9.2.1. Credit Window Status**

If the credit-window scheme is supported by the DLEP participants (both the router and the modem), the Credit Window Status data item MUST be sent by the participant receiving a Credit Grant for a given destination.

The Credit Window Status data item contains the following fields:



```

      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 = 16   | Modem Receive Window Value   |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                               |                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| Modem Receive Window Value   | Router Receive Window Value   |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                               |                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
| Router Receive Window Value   |                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

Data Item Type: TBD

Length: 16

Modem Receive Window Value: A 64-bit unsigned integer, indicating the current (or initial) number of credits available on the Modem Receive Window.

Router Receive Window Value: A 64-bit unsigned integer, indicating the current (or initial) number of credits available on the Router Receive Window.

### **9.2.2. Credit Grant**

The Credit Grant data item is sent from a DLEP participant to grant an increment to credits on a window. The Credit Grant data item MAY appear in the Destination Up ([Section 7.9](#)) or Destination Update ([Section 7.13](#)) signals. The value in a Credit Grant data item represents an increment to be added to any existing credits available on the window. Upon successful receipt and processing of a Credit Grant data item, the receiver MUST respond with a signal containing a Credit Window Status data item to report the updated aggregate values for synchronization purposes.

In the Destination Up signal, when credits are desired, the originating peer MUST set the initial credit value of the window it controls (i.e., the Modem Receive Window, or Router Receive Window) to an initial, non-zero value. If the receiver of a Destination Up signal with a Credit Grant data item supports credits, the receiver MUST either reject the use of credits, via a Destination Up ACK response containing a Status data item ([Section 8.2](#)) with a status code of 'Request Denied', or set the initial value from the data contained in the Credit Window Status data item. If the initialization completes successfully, the receiver MUST respond to



the Destination Up signal with a Destination Up ACK signal that contains a Credit Window Status data item, initializing its receive window.

The Credit Grant data item contains the following fields:

```

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 = 8   |           Credit Increment       |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|           Credit Increment           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|           Credit Increment           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Data Item Type: TBD

Length: 8

Reserved: A 64-bit unsigned integer representing the additional credits to be assigned to the credit window.

Since credits can only be granted by the receiver on a window, the applicable credit window (either the MRW or the RRW) is derived from the sender of the grant. The Credit Increment MUST NOT cause the window to overflow; if this condition occurs, implementations MUST set the credit window to the maximum value contained in a 64-bit quantity.

### **9.2.3. Credit Request**

The Credit Request data item MAY be sent from either DLEP participant, via the Destination Update signal ([Section 7.13](#)), to indicate the desire for the partner to grant additional credits in order for data transfer to proceed on the session. If the corresponding Destination Up signal ([Section 7.9](#)) for this session did NOT contain a Credit Window Status data item, indicating that credits are to be used on the session, then the Credit Request data item MUST be rejected by the receiver via a Destination Update ACK signal containing a Status data item ([Section 8.2](#)) with status code 'Request Denied'.

The Credit Request data item contains the following fields:





```

      0                               1                               2
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Data Item Type| Length = 1      | Reserved, MUST|
|               |                 | be set to 0    |
+---+---+---+---+---+---+---+---+---+---+---+---+

```

Data Item Type: TBD

Length: 1

Reserved: This field is currently unused and MUST be set to 0.

## **10. Security Considerations**

The protocol does not contain any mechanisms for security (e.g., authentication or encryption). The protocol assumes that any security would be implemented in the underlying transport (for example, by use of DTLS or some other mechanism), and is therefore outside the scope of this document.

## **11. IANA Considerations**

This section specifies requests to IANA.

### **11.1. Registrations**

This specification defines:

- o A new repository for DLEP signals, with sixteen values currently assigned.
- o Reservation of numbering space for Experimental DLEP signals.
- o A new repository for DLEP data items, with twenty-three values currently assigned.
- o Reservation of numbering space in the data items repository for experimental data items.
- o A new repository for DLEP status codes.
- o A new repository for DLEP extensions, with one value currently assigned.
- o A request for allocation of a well-known port for DLEP communication.



- o A request for allocation of a multicast address for DLEP discovery.

### **11.2. Expert Review: Evaluation Guidelines**

No additional guidelines for expert review are anticipated.

### **11.3. Signal Type Registration**

A new repository must be created with the values of the DLEP signals.

All signal values are in the range [0..255].

Valid signals are:

- o Peer Discovery
- o Peer Offer
- o Peer Initialization
- o Peer Initialization ACK
- o Peer Update
- o Peer Update ACK
- o Peer Termination
- o Peer Termination ACK
- o Destination Up
- o Destination Up ACK
- o Destination Down
- o Destination Down ACK
- o Destination Update
- o Heartbeat
- o Link Characteristics Request
- o Link Characteristics ACK



It is also requested that the repository contain space for experimental signal types.

#### **11.4. DLEP Data Item Registrations**

A new repository for DLEP data items must be created.

All data item values are in the range [0..255].

Valid data items are:

- o DLEP Version
- o Status
- o DLEP Port
- o Peer Type
- o Heartbeat Interval
- o Extensions Supported
- o Experimental Definition
- o MAC Address
- o IPv4 Address
- o IPv6 Address
- o IPv4 Attached Subnet
- o IPv6 Attached Subnet
- o Maximum Data Rate (Receive)
- o Maximum Data Rate (Transmit)
- o Current Data Rate (Receive)
- o Current Data Rate (Transmit)
- o Latency
- o Resources (Receive)
- o Resources (Transmit)



- o Relative Link Quality (Receive)
- o Relative Link Quality (Transmit)
- o Link Characteristics ACK Timer
- o Credit Window Status
- o Credit Grant
- o Credit Request

It is also requested that the registry allocation contain space for experimental data items.

#### **11.5. DLEP Status Code Registrations**

A new repository for DLEP status codes must be created.

All status codes are in the range [0..255].

Valid status codes are:

- o Success (value 0)
- o Unknown Signal
- o Invalid Signal
- o Unexpected Signal
- o Request Denied
- o Timed Out

#### **11.6. DLEP Extensions Registrations**

A new repository for DLEP extensions must be created.

All extension values are in the range [0..255].

Valid extensions are:

- o DLEP\_EXT\_CREDITS - Credit windowing





### **11.7. DLEP Well-known Port**

It is requested that IANA allocate a well-known port number for DLEP communication.

### **11.8. DLEP Multicast Address**

It is requested that IANA allocate a multicast address for DLEP discovery signals.

## **12. Acknowledgements**

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## **13. References**

### **13.1. Normative References**

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.
- [RFC5578] Berry, B., Ratliff, S., Paradise, E., Kaiser, T., and M. Adams, "PPP over Ethernet (PPPoE) Extensions for Credit Flow and Link Metrics", [RFC 5578](#), February 2010.

### **13.2. Informative References**

- [RFC5246] Dierks, T. and E. Rescorla, "The Transport Layer Security (TLS) Protocol Version 1.2", [RFC 5246](#), August 2008.

## **Appendix A. Peer Level Signal Flows**

\_NB\_ The following diagrams are possibly out of date. If there is a discrepancy with the text, then the text is correct.

### **A.1. Router Device Restarts Discovery**



Router	Modem	Signal Description
=====		
-----Peer Discovery----->		Router initiates discovery
<-----Peer Offer----- w/ Non-zero Status TLV		Modem detects a problem, sends Peer Offer w/Status TLV indicating the error.  Router accepts failure, restarts discovery process.
-----Peer Discovery----->		Router initiates discovery
<-----Peer Offer-----		Modem accepts, sends Peer Offer w/Zero Status TLV indicating success.  Discovery completed.

#### [A.2.](#) Router Device Detects Peer Offer Timeout

Router	Modem	Signal Description
=====		
-----Peer Discovery----->		Router initiates discovery, starts a guard timer.  Router guard timer expires. Router restarts discovery process.
-----Peer Discovery----->		Router initiates discovery, starts a guard timer.
<-----Peer Offer-----		Modem accepts, sends Peer Offer w/Zero Status TLV indicating success.  Discovery completed.

#### [A.3.](#) Router Peer Offer Lost



Router	Modem	Signal Description
=====		
<-----Peer Discovery-----		Modem initiates discovery, starts a guard timer.
-----Peer Offer-----		Router offers availability
		Modem times out on Peer Offer, restarts discovery process.
<-----Peer Discovery-----		Modem initiates discovery
-----Peer Offer----->		Router detects subsequent discovery, internally terminates the previous, accepts the new association, sends Peer Offer w/Status TLV indicating success.
		Discovery completed.

#### [A.4.](#) Discovery Success

Router	Modem	Signal Description
=====		
<-----Peer Discovery-----		Modem initiates discovery
-----Peer Offer----->		Router offers availability
<-----Peer Initialization-----		Modem Connects on TCP Port
<-----Peer Heartbeat-----		
-----Peer Heartbeat----->		
<=====		Signal flow about destinations (i.e. Destination Up, Destination Down, Destination update)
<-----Peer Heartbeat-----		
-----Peer Heartbeat----->		
-----Peer Term Req----->		Terminate Request
<-----Peer Term Res-----		Terminate Response



#### [A.5.](#) Router Detects a Heartbeat timeout

Router	Modem	Signal Description
=====		
<-----Peer Heartbeat-----		
-----Peer Heartbeat----->		
---Peer Heartbeat-----		
~ ~ ~ ~ ~ ~ ~		
-----Peer Heartbeat----->		
---Peer Heartbeat-----		Router Heartbeat Timer expires, detects missing heartbeats. Router takes down all destination sessions and terminates the Peer association.
-----Peer Terminate ----->		Peer Terminate Request
		Modem takes down all destination sessions, then acknowledges the Peer Terminate
<----Peer Terminate ACK-----		Peer Terminate ACK

#### [A.6.](#) Modem Detects a Heartbeat timeout





Router	Modem	Signal Description
=====		
<-----Peer Heartbeat-----		
-----Peer Heartbeat-----		
<-----Peer Heartbeat-----		
~ ~ ~ ~ ~ ~ ~		
-----Peer Heartbeat-----		
<-----Peer Heartbeat-----		Modem Heartbeat Timer expires, detects missing heartbeats. Modem takes down all destination sessions
<-----Peer Terminate-----		Peer Terminate Request
		Router takes down all destination sessions, then acknowledges the Peer Terminate
-----Peer Terminate ACK----->		Peer Terminate ACK

#### [A.7.](#) Peer Terminate (from Modem) Lost

Router	Modem	Signal Description
=====		
-----Peer Terminate-----		Modem Peer Terminate Request
		Router Heartbeat times out, terminates association.
-----Peer Terminate----->		Router Peer Terminate
<-----Peer Terminate ACK-----		Modem sends Peer Terminate ACK

#### [A.8.](#) Peer Terminate (from Router) Lost



Router	Modem	Signal Description
-----Peer Terminate----->		Router Peer Terminate Request
		Modem HB times out, terminates association.
<-----Peer Terminate-----		Modem Peer Terminate
-----Peer Terminate ACK----->		Peer Terminate ACK

## Appendix B. Destination Specific Signal Flows

### **B.1. Modem Destination Up Lost**

Router	Modem	Signal Description
=====		
-----Destination Up -----		Modem sends Destination Up
		Modem timesout on ACK
<-----Destination Up -----		Modem sends Destination Up
-----Destination Up ACK----->		Router accepts the destination session
<-----Destination Update-----		Modem Destination Metrics
. . . . .		
<-----Destination Update-----		Modem Destination Metrics

## B.2. Router Detects Duplicate Destination Ups



Router	Modem	Signal Description
=====		
<-----Destination Up -----		Modem sends Destination Up
-----Destination Up ACK-----		Router accepts the destination session
		Modem timesout on ACK
<-----Destination Up -----		Modem resends Destination Up
		Router detects duplicate Destination, takes down the previous, accepts the new Destination.
-----Destination Up ACK----->		Router accepts the destination session
<-----Destination Update-----		Modem Destination Metrics
. . . . .		
<-----Destination Update-----		Modem Destination Metrics

### **B.3. Destination Up, No Layer 3 Addresses**

Router	Modem	Signal Description
=====		
<-----Destination Up -----		Modem sends Destination Up
-----Destination Up ACK----->		Router accepts the destination session
		Router ARPs for IPv4 if defined. Router drives ND for IPv6 if defined.
<-----Destination Update-----		Modem Destination Metrics
. . . . .		
<-----Destination Update-----		Modem Destination Metrics

### **B.4. Destination Up with IPv4, No IPv6**



Router	Modem	Signal Description
=====		
<-----Destination Up ----->		Modem sends Destination Up with the IPv4 TLV
-----Destination Up ACK----->		Router accepts the destination session
		Router drives ND for IPv6 if defined.
<-----Destination Update----->		Modem Destination Metrics
. . . . .		
<-----Destination Update----->		Modem Destination Metrics

### **B.5. Destination Up with IPv4 and IPv6**

Router	Modem	Signal Description
=====		
<-----Destination Up -----		Modem sends Destination Up with the IPv4 and IPv6 TLVs
-----Destination Up ACK----->		Router accepts the destination session
<-----Destination Update-----		Modem Destination Metrics
. . . . .		

### **B.6. Destination Session Success**





Router	Modem	Signal Description
=====		
-----Peer Offer----->		Router offers availability
-----Peer Heartbeat----->		
<-----Destination Up -----	Modem	
-----Destination Up ACK----->	Router	
<-----Destination Update-----	Modem	
. . . . .		
<-----Destination Update-----	Modem	
		Modem initiates the terminate
<-----Destination Down -----	Modem	
-----Destination Down ACK----->	Router	
		or
		Router initiates the terminate
-----Destination Down ----->	Router	
<-----Destination Down ACK-----	Modem	

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