                     DLEP Link Identifier Extension
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Abstract

   The Dynamic Link Exchange Protocol (DLEP) [RFC8175] describes a
   protocol for modems to advertise the status of wireless links between
   reachable destinations to attached routers. The core specification
   of the protocol assumes that every modem in the radio network has an
   attached DLEP router, and requires that the MAC address of the DLEP
   interface on the attached router be used to identify the destination
   in the network, for purposes of reporting the state and quality of
   the link to that destination.

   This document describes a DLEP Extension allowing modems that do not
   meet the strict requirement above to use DLEP to describe link
   availability and quality to one or more destinations reachable beyond
   a device on the Layer 2 domain.

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1. Introduction

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protocol for modems to advertise the status of wireless links between
reachable destinations to attached routers. The core specification
of the protocol assumes that every modem in the radio network has an
attached DLEP router, and requires that the MAC address of the DLEP
interface on the attached router be used to identify the destination
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This document describes a DLEP Extension allowing modems that do not
meet the strict requirement above to use DLEP to describe link
availability and quality to one or more destinations reachable beyond
a device on the Layer 2 domain.

As with core DLEP, a router can use this knowledge to influence any
routing or flow-control decisions regarding traffic to this
destination, understanding that such traffic flows via Layer 3.

1.1. Terminology

Local Layer 2 domain: The Layer 2 domain that links the router and
   modem participants of the current DLEP session.

Layer 3 DLEP Destination: A DLEP Destination that is not directly
   addressable within the local Layer 2 domain, but is reachable via
   a node addressable within the local Layer 2 domain.

Gateway Node: The last device with a MAC address reachable in the
   local Layer 2 domain on the path from the DLEP router participant,
   towards the Layer 3 DLEP Destination. This device is commonly the
   DLEP peer modem but could be another DLEP Destination in the Layer
   2 domain.

1.2. Applicability

This extension was designed primarily to address the following use
cases:

1. A radio system that does not operate in Layer 2 bridge mode, but
    instead provides Layer 3 connectivity between destinations, often
    using its own embedded Layer 3 routing function.

2. A point-to-multipoint tunnel system, such as an SD-WAN
    deployment, where the tunnel provider acts as a modem, having
    knowledge of the characteristics of the underlay network, and
    providing that information as availability and metrics between
    tunnel endpoints in the overlay network.

3. A modem that provides connectivity to a remote wide-area network
    via a wireless link, but the concept of a Layer 2 reachable
    remote router does not apply. An example of such a modem would
    be an LTE device or 802.11 station that provides variable
    connectivity to the Internet.

This list of use-cases is not exhaustive, and this extension may well
be applicable to future, currently unforeseen, use-cases.

1.3. Requirements

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

2. Operation

To refer to a Layer 3 DLEP Destination, the DLEP session participant
adds a Link Identifier Data Item ([Section 3.2](#)) to the relevant
Destination Message, and (as usual) includes a MAC Address Data Item.
When paired with a Link Identifier Data Item, the MAC Address Data
Item MUST contain the MAC address of the Gateway Node.

As only modems are initially aware of Layer 3 DLEP Destinations, Link
Identifier Data Items referring to a new link MUST first appear in a
DLEP Destination Up Message from the modem to the router. Once a
link has been identified in this way, Link Identifier Data Items may
be used by either DLEP participant during the lifetime of a DLEP
session. Because of this, a router MUST NOT send a DLEP Destination
Announce Message containing a Link Identifier Data Item referring to
a link that has not been mentioned in a prior DLEP Destination Up
Message. If a modem receives such a message, it MUST terminate the
session by issuing a Session Termination Message containing a Status
Data Item with status code set to 131 'Invalid Destination' and
transition to the Session Termination state.

Because the MAC Address associated with any DLEP Destination Message
containing a Link Identifier Data Item is not the Layer 2 address of
the final destination, all DLEP Destination Up Messages containing a
Link Identifier Data Item MUST contain Layer 3 information. In the
case of modems that provide Layer 3 wide area network connectivity
between devices, this means one or more IPv4 or IPv6 Address Data
Items providing the Layer 3 address of the final destination. When
referring to some upstream backbone network infrastructure, this
means one or more IPv4 or IPv6 Attached Subnet Data Items, for
example: '0.0.0.0/0' or '::/0'. This allows the DLEP peer router to
understand the properties of the link to those routes.

When the DLEP peer router wishes to route packets to the Layer 3 DLEP
Destination, the MAC address associated with the Gateway Node MUST be
used as the Layer 2 destination of the packet, if it wishes to use
the modem network to forward the packet.

As routers populate their routing information base with the IP
address of the next hop router towards a destination, implementations
supporting this extension SHOULD announce at least one valid IPv4 or
IPv6 addresses of the Gateway Node, this removes the need for the
router to use an additional IP address resolution protocol before
adding the route to its routing information base.

2.1. Identifier Restrictions

A Link Identifier is by default 4 octets in length. If a modem
wishes to use a Link Identifier of a different length, it MUST be
announced using the Link Identifier Length Data Item (Section 3.1)
contained in the DLEP Session Initialization Response message sent by
the modem to the router.

During the lifetime of a DLEP session, the length of Link Identifiers
MUST remain constant, i.e. the Length field of the Link Identifier
Data Item MUST NOT differ between destinations.

The method for generating Link Identifiers is a modem implementation
matter and out of scope of this document. Routers must not make any
assumptions about the meaning of Link Identifiers, or how Link
Identifiers are generated.

Within a single DLEP session, all Link Identifiers MUST be unique per
MAC Address. This means that a Layer 3 DLEP Destination is uniquely
identified by the pair: {MAC Address,Link Identifier}.

Link Identifiers MUST NOT be reused, i.e. a {MAC Address,Link
Identifier} pair that has been used to refer to one Layer 3 DLEP
Destination MUST NOT be recycled to refer to a different destination
within the lifetime of a single DLEP session.

2.2. Negotiation

To use this extension, as with all DLEP extensions, the extension
MUST be announced during DLEP session initialization. A router
advertises support by including the value 'Link Identifiers', TBD1
(Section 5), in the Extension Data Item within the Session
Initialization Message. A modem advertises support by including the
value 'Link Identifiers' in the Extension Data Item within the
Session Initialization Response Message. If both DLEP peers
advertise support for this extension then Link Identifier Data Items
can be included in DLEP Messages.

If a modem requires support for this extension in order to describe
destinations, and the router does not advertise support, then the
modem MUST NOT include a Link Identifier Data Item in any DLEP
Message. However, the modem SHOULD NOT immediately terminate the
DLEP session, rather it SHOULD use a combination of DLEP Session
Messages and DLEP Attached Subnet Data Items to provide general
information.

3. New Data Items

This extension introduces two new DLEP Data Items: the Link
Identifier Data Item (Section 3.2) used to identify a Layer 3 link at
or beyond a destination, and the Link Identifier Length Data Item
(Section 3.1) used to announce the length of Link Identifiers at
session initialization.

3.1. Link Identifier Length Data Item

The Link Identifier Length Data Item is used by a DLEP modem
implementation to specify the length of Link Identifier Data Items.
It MUST be used during Session Initialization, contained in a Session
Initialization Response Message, if the specified length is not the
default value of 4 octets.

```
 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                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Link Identifier Length        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Data Item Type: TBD2 (Section 5)

Length: 2

Link Identifier Length: The length, in octets, of Link Identifiers
   used by the DLEP modem for this session.

A Link Identifier Length Data Item that specifies a Link Identifier
Length of 4 octets (the default) is valid, even if it has no effect.

3.2. Link Identifier Data Item

The Link Identifier Data Item MAY be used wherever a MAC Address Data
Item is defined as usable in core DLEP.

```
 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                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Link Identifier...                        :
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Data Item Type: TBD3 (Section 5)

Length: The length of the Data Item, by default 4, but may be
   different if a Link Identifier Length Data Item ([Section 3.1](#)) has
   been announced during session initialization.

Link Identifier: The unique identifier of the Layer 3 DLEP
   Destination. This Link Identifier has no implicit meaning and is
   only used to discriminate between multiple links.

[4](#). Security Considerations

As an extension to the core DLEP protocol, the security
considerations of that protocol apply to this extension. This
extension adds no additional security mechanisms or features.

None of the features introduced by this extension require extra
consideration by an implementation.

[5](#). IANA Considerations

Upon approval of this document, IANA is requested to:

o Assign a new DLEP Extensions Registry value (TBD1) from the
   Specification Required section, named "Link Identifiers".

o Assign a new DLEP Data Item Type Values Registry value (TBD2) from
   the Specification Required section, named "Link Identifier
   Length".

o Assign a new DLEP Data Item Type Values Registry value (TBD3) from
   the Specification Required section, named "Link Identifier".

[6](#). Normative References

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           Requirement Levels", [BCP 14](#), [RFC 2119](#),
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[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in [RFC
           2119](#) Key Words", [BCP 14](#), [RFC 8174](#), DOI 10.17487/RFC8174,
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[RFC8175] Ratliff, S., Jury, S., Satterwhite, D., Taylor, R., and B.
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