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YANG Data Models for the DS-Lite
draft-ietf-softwire-dslite-yang-06

Abstract

This document defines YANG data models for the DS-Lite Address Family Transition Router (AFTR) and Basic Bridging BroadBand (B4) elements .

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DS-Lite YANG

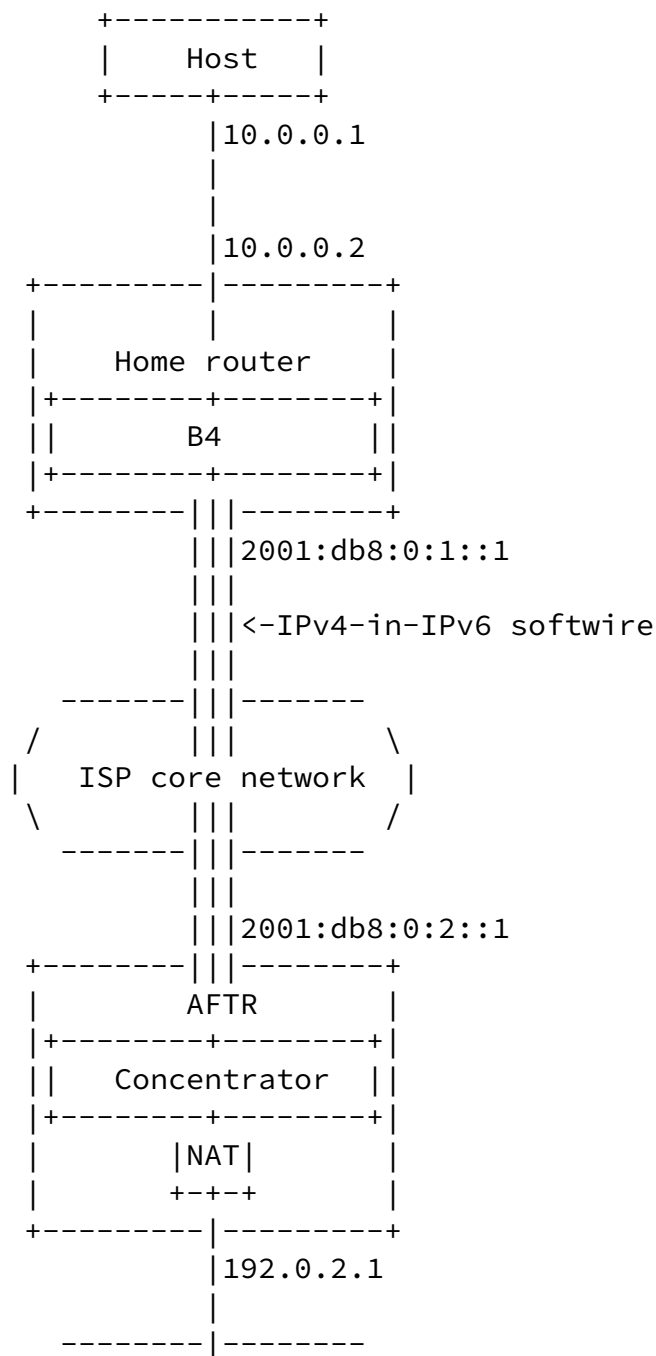
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[1.](#) Introduction

This document defines data models for DS-Lite [[RFC6333](#)], using the YANG data modeling language [[RFC6020](#)]. Both the Address Family Transition Router (AFTR) and Basic Bridging BroadBand (B4) elements are covered by this specification. As a reminder, Figure 1 illustrates an overview of the DS-Lite architecture that involves AFTR and B4 elements.



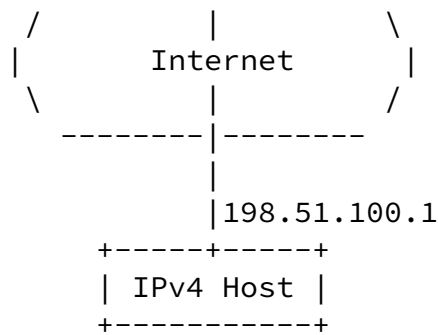


Figure 1: DS-Lite Base Architecture

DS-Lite deployment considerations are discussed in [\[RFC6908\]](#).

This document follows the guidelines of [\[RFC6087\]](#), uses the common YANG types defined in [\[RFC6991\]](#), and adopts Network Management Datastore Architecture (NMDA).

[1.1.](#) Terminology

This document makes use of the terms defined in [\[RFC6333\]](#).

The terminology for describing YANG data models is defined in [\[RFC6020\]](#).

[1.2.](#) Tree Diagrams

The meaning of the symbols in these diagrams is as follows:

- o Brackets "[" and "]" enclose list keys.
- o Curly braces "{" and "}" contain names of optional features that make the corresponding node conditional.
- o Abbreviations before data node names: "rw" means configuration (read-write), "ro" state data (read-only).
- o Symbols after data node names: "?" means an optional node, "!" a container with presence, and "*" denotes a "list" or "leaf-list".
- o Parentheses enclose choice and case nodes, and case nodes are also

marked with a colon (":").

- o Ellipsis ("...") stands for contents of subtrees that are not shown.

2. DS-Lite YANG Data Models

Figure 2 depicts the YANG data model for the AFTR element, while Figure 3 shows the YANG data model for the B4 element.

As shown in Figure 1:

- o The AFTR element is a combination of an IPv4-in-IPv6 encapsulation/decapsulation function and a NAT function.
- o The B4 element is an IPv4-in-IPv6 encapsulation function.

Therefore, the AFTR YANG module is designed to augment both the Interfaces YANG module [[RFC7223](#)] and the NAT YANG module

[I-D.ietf-opsawg-nat-yang] with DS-Lite specific features. The B4 YANG module augments the interfaces YANG module.

This document assumes [[RFC4787](#)][[RFC5382](#)][[RFC5508](#)] are enabled by default. Also, the data model adheres to the recommendations in [[RFC6888](#)] and [[RFC7857](#)]. Furthermore, the data model supports state migration as per [[RFC7785](#)].

PCP-related considerations are out of scope of the document. A YANG data model for PCP is documented in [[I-D.boucadair-pcp-yang](#)].

```
module: ietf-dslite-aftr
  augment /if:interfaces/if:interface:
    +--rw aftr-ipv6-address?      inet:ipv6-address
    +--rw aftr-ipv4-address?     inet:ipv4-address
    +--rw tunnel-mtu?            uint16
    +--rw max-software-per-subscriber? uint8
    +--rw v6-v4-dscp-preservation? boolean
  augment /nat:nat-module/nat:nat-instances/nat:nat-instance:
    +--rw state-migrate?        boolean
    +--rw mss-clamping
      +--rw mss-clamping-enable? boolean
```

```

    +--rw mss-value?          uint16
augment /nat:nat-module/nat:nat-instances/nat:nat-instance/nat:mapping-table/
  +--rw b4-ipv6-address?    inet:ipv6-address
  +--rw v6-dscp?           uint8
  +--rw internal-v4-dscp?  uint8
  +--rw external-v4-dscp?  uint8

```

Figure 2: YANG Data Model for DS-Lite AFTR

Examples to illustrate the use of this module are provided in [Appendix A](#).

A B4 instance is provided with the IPv6 address of the AFTR to use, an (optional) instruction whether DSCP marking is to be preserved when encapsulating an IPv4 packet in an IPv6 packet, and other optional parameters shown in Figure 3.

```

module: ietf-dslite-b4
  augment /if:interfaces/if:interface:
    +--rw b4-ipv6-address?      inet:ipv6-address
    +--rw aftr-ipv6-addr?      inet:ipv6-address
    +--rw b4-ipv4-address?     inet:ipv4-address
    +--rw tunnel-mtu?          uint16
    +--rw v6-v4-dscp-preservation? boolean

```

Figure 3: YANG Data Model for DS-Lite B4

[3.](#) DS-Lite AFTR YANG Module

```
<CODE BEGINS> file "ietf-dslite-aftr@2017-08-10.yang"
```

```

module ietf-dslite-aftr {
  namespace "urn:ietf:params:xml:ns:yang:ietf-dslite-aftr";
  prefix dslite-aftr;

  import ietf-inet-types { prefix inet; }
  import ietf-interfaces { prefix if; }
  import iana-if-type { prefix ianaift; }
  import ietf-nat {prefix nat;}

  organization "Softwire Working Group";
  contact

```

```
"Mohamed Boucadair <mohamed.boucadair@orange.com>  
Christian Jacquenet <christian.jacquenet@orange.com>  
Senthil Sivakumar <ssenthil@cisco.com>";
```

description

```
"This module is a YANG module for DS-Lite AFTR  
implementations.
```

```
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authors of the code. All rights reserved.
```

```
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Relating to IETF Documents  
(http://trustee.ietf.org/license-info).
```

```
This version of this YANG module is part of RFC XXXX; see  
the RFC itself for full legal notices.";
```

```
revision 2017-08-10 {  
  description "The module augments also the Interface module.";  
  reference "-ietf-04";  
}
```

```
revision 2017-07-27 {  
  description "Redesign the module as an augment of the NAT YANG module.";  
  reference "-ietf-04";  
}
```

```
revision 2017-07-03 {  
  description "Fix some minor points.";
```

```
  reference "-ietf-03";  
}
```

```
revision 2017-01-03 {  
  description "Fixed a compilation error:  
  https://github.com/mbj4668/pyang/issues/296."  
  reference "-ietf-02";  
}
```

```
revision 2016-11-14 {
  description "Integrates the comments from Ian:
  add B4 module, add an MSS leaf, add more details about
  logging protocols, and other edits.";
  reference "-ietf-01";
}

revision 2016-07-27 {
  description "-00 IETF version.";
  reference "-ietf-00";
}

revision 2016-06-13 {
  description "Update the module.";
  reference "-04";
}

revision 2015-12-16 {
  description "Fix an error.";
  reference "-03";
}

revision 2015-09-01 {
  description "Add port threshold notifications.";
  reference "-02";
}

revision 2015-08-31 {
  description "Fix a timeout issue.";
  reference "-01";
}

revision 2015-08-17 {
  description "First spec.";
  reference "-00";
}
```

```
// Augment Interface module with DS-Lite Software
```

```
augment "/if:interfaces/if:interface" {
```



```

when "if:type = 'ianaift:tunnel'";

description
  "Augments Interface module with AFTR parameters.
  IANA interface types are maintained at this registry:
  https://www.iana.org/assignments/ianaifttype-mib/ianaifttype-mib.

  tunnel (131),      -- Encapsulation interface";

leaf aftr-ipv6-address {
  type inet:ipv6-address;
  description
    "IPv6 address of the DS-Lite AFTR.";

    reference
      "RFC 6333.";
}

leaf aftr-ipv4-address {
  type inet:ipv4-address;
  default "192.0.0.1";

  description
    "IPv4 address of the DS-Lite AFTR.
    192.0.0.1 is reserved for the AFTR element.
    This address can be used to report ICMP
    problems and will appear in traceroute
    outputs.";

  reference
    "RFC 6333.";
}

leaf tunnel-mtu {
  type uint16;

  description
    "Configures a tunnel MTU.
    [RFC6908] specifies that since
    fragmentation and reassembly is not
    optimal, the operator should do
    everything possible to eliminate
    the need for it. If the operator uses
    simple IPv4-in-IPv6 software, it is
    recommended that the MTU size of the IPv6
    network between the B4 and the AFTR
    accounts for the additional overhead
  
```

```
        (40 bytes).";

    reference
        "RFC 6908.";
}

leaf max-softwire-per-subscriber {
    type uint8;
    default 1;

    description
        "Configures the maximum softwire per subscriber
        feature.

        A subscriber is uniquely identified by means
        of subscriber-mask.

        This policy aims to prevent a misbehaving
        subscriber from mounting several DS-Lite
        softwires that would consume additional AFTR
        resources (e.g., get more external ports if
        the quota were enforced on a per-softwire basis,
        consume extra processing due to a large number
        of active softwires).";

    reference
        "Section 4 of RFC 7785.";
}

leaf v6-v4-dscp-preservation {
    type boolean;

    description
        "Copies the DSCP value from the IPv6 header
        and vice versa.

        According to Section 2.10 of \[RFC6908\],
        operators should use this model
        by provisioning the network such that
        the AFTR copies the DSCP value in the IPv4
        header to the Traffic Class field in
        the IPv6 header, after the encapsulation
        for the downstream traffic.";

    reference
        "Section 2.10 of RFC 6908.";
```

```
}  
}
```

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```
// Augment NAT module with AFTR parameters
```

```
augment "/nat:nat-module/nat:nat-instances/nat:nat-instance" {
```

```
  description
```

```
    "Augments NAT module with AFTR parameters.";
```

```
  leaf state-migrate {
```

```
    type boolean;
```

```
    default true;
```

```
    description
```

```
      "State migration is enabled by default.
```

```
  
      In the event a new IPv6 address is assigned to the B4 element,  
      the AFTR should migrate existing state to be bound to the new  
      IPv6 address. This operation ensures that traffic destined to  
      the previous B4's IPv6 address will be redirected to the newer  
      B4's IPv6 address. The destination IPv6 address for tunneling  
      return traffic from the AFTR should be the last seen as the B4's  
      IPv6 source address from the CPE.
```

```
  
      The AFTR uses the subscriber-mask to determine whether two  
      IPv6 addresses belong to the same CPE (e.g., if the  
      subscriber-mask is set to 56, the AFTR concludes that  
      2001:db8:100:100::1 and 2001:db8:100:100::2 belong to the same  
      CPE assigned with 2001:db8:100:100::/56).";
```

```
  reference
```

```
    "RFC 7785.";
```

```
}
```

```
  container mss-clamping {
```

```
    description
```

```
      "MSS rewriting configuration to avoid IPv6  
      fragmentation.";
```

```
    leaf mss-clamping-enable {
```

```
      type boolean;
```

```
        description
            "Enable/disable MSS rewriting feature.";
    }

    leaf mss-value {
        type uint16;
        units "octets";
    }
```

```
        description
            "Sets the MSS value to be used for
            MSS rewriting.";
    }
}

// Augment NAT mapping entry: Extended NAT44 mapping Entry
augment "/nat:nat-module/nat:nat-instances/nat:nat-instance/nat:mapping-table/nat:mapping-table" {
    description
        "Augments the NAT mapping tables with DS-Lite specifics.";

    leaf b4-ipv6-address {
        type inet:ipv6-address;

        description
            "Corresponds to the IPv6 address
            used by the B4 element.";

        reference
            "RFC 6333.";
    }

    leaf v6-dscp {
        type uint8;

        description
            "DSCP value used at the software level
            (i.e., IPv6 header).";
    }
}
```

```

leaf internal-v4-dscp {
    type uint8;

    description
        "DSCP value of the encapsulated IPv4 packet.";
}

leaf external-v4-dscp {
    type uint8;

    description
        "DSCP value of the translated IPv4 packet
        as marked by the AFTR.";
}
}
}
}

```

<CODE ENDS>

[4.](#) DS-Lite B4 YANG Module

<CODE BEGINS> file "ietf-dslite-b4@2017-08-10.yang"

```

module ietf-dslite-b4 {
    namespace "urn:ietf:params:xml:ns:yang:ietf-dslite-b4";
    prefix dslite-b4;

    import ietf-inet-types { prefix inet; }
    import ietf-interfaces { prefix if; }
    import iana-if-type { prefix ianaift; }

    organization "Softwire Working Group";
    contact
        "Mohamed Boucadair <mohamed.boucadair@orange.com>
        Christian Jacquenet <christian.jacquenet@orange.com>
        Senthil Sivakumar <ssenthil@cisco.com>";

    description
        "This module is a YANG module for DS-Lite B4 implementations.

        Copyright (c) 2017 IETF Trust and the persons identified as
        authors of the code. All rights reserved."

```

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This version of this YANG module is part of RFC XXXX; see the RFC itself for full legal notices.";

```
revision 2017-08-10 {  
  description "Augment the interfaces YANG module.";  
  reference "-ietf-05";  
}
```

```
revision 2017-07-27 {  
  description "Separate B4 from AFTR.";  
  reference "-ietf-04";  
}
```

```
// Augment Interface module with DS-Lite Software
```

```
augment "/if:interfaces/if:interface" {  
  when "if:type = 'ianaift:tunnel'";  
  
  description  
    "Augments Interface module with B4 parameters.  
    IANA interface types are maintained at this registry:  
    https://www.iana.org/assignments/ianaifttype-mib/ianaifttype-mib.  
  
    tunnel (131),      -- Encapsulation interface";  
  
  leaf b4-ipv6-address {  
    type inet:ipv6-address;  
  
    description  
      "The IPv6 address used by the B4 element.";  
  
    reference  
      "RFC 6333.";
```

```

}

leaf aftr-ipv6-addr {
    type inet:ipv6-address;

    description
        "The AFTR's IPv6 address.";

    reference
        "RFC 6333";
}

leaf b4-ipv4-address {
    type inet:ipv4-address;
    default "192.0.0.2";

    description
        "IPv4 address of the DS-Lite B4.
        192.0.0.0/29 is reserved for the B4 element
        [RFC6333].
        This address can be used to report ICMP
        problems and will appear in traceroute
        outputs.";

    reference
        "RFC 6333";
}

leaf tunnel-mtu {
    type uint16;

```

```

description
    "Configures a tunnel MTU.
    [RFC6908] specifies that since
    fragmentation and reassembly is not
    optimal, the operator should do
    everything possible to eliminate
    the need for it. If the operator uses
    simple IPv4-in-IPv6 software, it is
    recommended that the MTU size of the IPv6
    network between the B4 and the AFTR
    accounts for the additional overhead

```

```

        (40 bytes).";

        reference
            "RFC 6908.";
    }

    leaf v6-v4-dscp-preservation {
        type boolean;

        description
            "Copies the DSCP value from the IPv6 header
            and vice versa.
            According to Section 2.10 of \[RFC6908\],
            operators should use this model
            by provisioning the network such that
            the AFTR copies the DSCP value in the IPv4
            header to the Traffic Class field in
            the IPv6 header, after the encapsulation
            for the downstream traffic.";
    }
}
}
}
}
}
}
<CODE ENDS>

```

5. Security Considerations

The YANG module defined in this memo is designed to be accessed via the NETCONF protocol [[RFC6241](#)]. The lowest NETCONF layer is the secure transport layer and the support of SSH is mandatory to implement secure transport [[RFC6242](#)]. The NETCONF access control model [[RFC6536](#)] provides means to restrict access for particular NETCONF users to a pre-configured subset of all available NETCONF protocol operations and contents.

All data nodes defined in the YANG module which can be created, modified and deleted (i.e., config true, which is the default). These data nodes are considered sensitive. Write operations (e.g., edit-config) applied to these data nodes without proper protection

can negatively affect network operations.

[6.](#) IANA Considerations

This document requests IANA to register the following URIs in the "IETF XML Registry" [[RFC3688](#)]:

```
URI: urn:ietf:params:xml:ns:yang:ietf-dslite-aftr
Registrant Contact: The IESG.
XML: N/A; the requested URI is an XML namespace.
```

```
URI: urn:ietf:params:xml:ns:yang:ietf-dslite-b4
Registrant Contact: The IESG.
XML: N/A; the requested URI is an XML namespace.
```

This document requests IANA to register the following YANG modules in the "YANG Module Names" registry [[RFC6020](#)].

```
name: ietf-dslite-aftr
namespace: urn:ietf:params:xml:ns:yang:ietf-dslite-aftr
prefix: dslite-aftr
reference: RFC XXXX
```

```
name: ietf-dslite-b4
namespace: urn:ietf:params:xml:ns:yang:ietf-dslite-b4
prefix: dslite-b4
reference: RFC XXXX
```

[7.](#) Acknowledgements

Thanks to Q. Wu for identifying a compiling error.

Many thanks to Ian Farrer for the review and comments.

[8.](#) References

[8.1.](#) Normative references

- [I-D.ietf-opsawg-nat-yang]
Boucadair, M., Sivakumar, S., Jacquenet, C., Vinapamula, S., and Q. Wu, "A YANG Data Model for Network Address Translation (NAT) and Network Prefix Translation (NPT)", [draft-ietf-opsawg-nat-yang-01](#) (work in progress), August 2017.
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- [RFC7223] Bjorklund, M., "A YANG Data Model for Interface Management", [RFC 7223](#), DOI 10.17487/RFC7223, May 2014, <<https://www.rfc-editor.org/info/rfc7223>>.

[8.2.](#) Informative references

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[I-D.boucadair-pcp-yang]

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[RFC5382] Guha, S., Ed., Biswas, K., Ford, B., Sivakumar, S., and P. Srisuresh, "NAT Behavioral Requirements for TCP", [BCP 142](#), [RFC 5382](#), DOI 10.17487/RFC5382, October 2008, <<https://www.rfc-editor.org/info/rfc5382>>.

[RFC5508] Srisuresh, P., Ford, B., Sivakumar, S., and S. Guha, "NAT Behavioral Requirements for ICMP", [BCP 148](#), [RFC 5508](#), DOI 10.17487/RFC5508, April 2009, <<https://www.rfc-editor.org/info/rfc5508>>.

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- [RFC7857] Penno, R., Perreault, S., Boucadair, M., Ed., Sivakumar, S., and K. Naito, "Updates to Network Address Translation (NAT) Behavioral Requirements", [BCP 127](#), [RFC 7857](#), DOI 10.17487/RFC7857, April 2016, <<https://www.rfc-editor.org/info/rfc7857>>.

[Appendix A](#). Examples

The following example shows an AFTR that is reachable at 2001:db8::2. Also, this XML snippet indicates that the AFTR is provided with an IPv4 address (192.0.0.1) to be used for troubleshooting purposes such as reporting problems to B4s. Moreover, the AFTR is instructed to limit the number of softwires per subscriber to '1'.

```
<interface>
  <name>myAFTR</name>
  <type>ianaift:tunnel</type>
  <enabled>>true</enabled>
  <aftr-ipv6-address>2001:db8::2</aftr-ipv6-address>
  <aftr-ipv4-address>192.0.0.1</aftr-ipv4-address>
  <max-softwire-per-subscriber>1</max-softwire-per-subscriber>
</interface>
```

The following shows an XML excerpt depicting a dynamic UDP mapping entry maintained by a DS-Lite AFTR. In reference to this example, the UDP packet received with a source IPv6 address (2001:db8::1), a source IPv4 address (192.0.2.1) and source port number (1568) is translated into a UDP packet having a source IPv4 address (198.51.100.1) and source port (15000). The lifetime of this mapping is 300 seconds.

```
<mapping-entry>
  <index>15</index>
  <type>
    dynamic-explicit
  </type>
  <transport-protocol>
    17
  </transport-protocol>
  <b4-ipv6-address>
    192.0.2.1
  </b4-ipv6-address>
  <internal-src-address>
    192.0.2.1
  </internal-dst-address>
  <internal-src-port>
    <single-port-number>
      1568
    </single-port-number>
  </internal-dst-port>
  <external-dst-address>
    198.51.100.1
  </external-dst-address>
  <external-dst-port>
    <single-port-number>
      15000
    </single-port-number>
```

```
</external-dst-port>  
<lifetime>  
  300  
</lifetime>  
</mapping-entry>
```

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