A YANG Data Model for MPLS Static LSPs
draft-ietf-mpls-static-yang-07

Abstract

This document contains the specification for the MPLS Static Label Switched Paths (LSPs) YANG model. The model allows for the provisioning of static LSP(s) on LER(s) and LSR(s) devices along a LSP path without the dependency on any signaling protocol. The MPLS Static LSP model augments the MPLS base YANG model with specific data to configure and manage MPLS Static LSP(s).

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at https://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on May 8, 2019.
This document describes a YANG [RFC7950] data model for configuring and managing the Multiprotocol Label Switching (MPLS) [RFC3031] Static LSPs. The model allows the configuration of LER and LSR devices with the necessary MPLS cross-connects or bindings to realize an end-to-end LSP service.

A static LSP is established by manually specifying incoming and outgoing MPLS label(s) and necessary forwarding information on each of the traversed Label Edge Router (LER) and Label Switched Router (LSR) devices (ingress, transit, or egress nodes) of the forwarding path.

For example, on an ingress LER device, the model is used to associate a specific Forwarding Equivalence Class (FEC) of packets—e.g.
matching a specific IP prefix in a Virtual Routing or Forwarding (VRF) instance- to an MPLS outgoing label imposition, next-hop(s) and respective outgoing interface(s) to forward the packet. On an LSR device, the model is used to create a binding that swaps the incoming label with an outgoing label and forwards the packet on one or multiple egress path(s). On an egress LER, it is used to create a binding that decapsulates the incoming MPLS label and performs forwarding based on the inner MPLS label (if present) or IP forwarding in the packet.

The MPLS Static LSP YANG model is broken into two modules "ietf-mpls-static" and "ietf-mpls-static-extended". The "ietf-mpls-static" module covers basic features for the configuration and management of unidirectional Static LSP(s), while "ietf-mpls-static-extended" covers extended features like the configuration and management of bidirectional Static LSP(s) and LSP admission control.

The module "ietf-mpls-static" augments the MPLS Base YANG model defined in module "ietf-mpls" in [I-D.ietf-mpls-base-yang].

1.1. Terminology

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.

The terminology for describing YANG data models is found in [RFC7950].

1.2. Acronyms and Abbreviations

MPLS: Multiprotocol Label Switching
LSP: Label Switched Path
LSR: Label Switching Router
LER: Label Edge Router
FEC: Forwarding Equivalence Class
NHLFE: Next Hop Label Forwarding Entry
ILM: Incoming Label Map
2. MPLS Static LSP Model

2.1. Model Organization

The base MPLS Static LSP model covers the core features with the minimal set of configuration parameters needed to manage and operate MPLS Static LSPs.

Additional MPLS Static LSP parameters as well as optional feature(s) are grouped in a separate MPLS Static LSP extended model. The relationship between the MPLS base and other MPLS modules are shown in Figure 1.

![Figure 1: Relationship between MPLS modules](attachment:image.png)

2.2. Model Tree Diagram

The MPLS Static and extended LSP tree diagram as per [RFC8340] is shown in Figure 2.

```plaintext
module: ietf-mpls-static
    augment /rt:routing/mpls:mpls:
        +--rw static-lsps
            +--rw static-lsp* [name]
```
module: ietf-mpls-static-extended
augment /rt:routing/mpls:mpls:
  +--rw bidir-static-lsps
     +--rw bidir-static-lsp* [name]
        +--rw name           string
        +--rw forward-lsp?   mpls-static:static-lsp-ref
        +--rw reverse-lsp?   mpls-static:static-lsp-ref
2.3. Model Overview

This document defines two YANG modules for MPLS Static LSP(s) configuration and management: ietf-mpls-static.yang and ietf-mpls-static-extended.yang.

The ietf-mpls-static module imports the following modules:

- ietf-inet-types defined in [RFC6991]
- ietf-routing defined in [RFC8349]
- ietf-routing-types defined in [RFC8294]
- ietf-interfaces defined in [RFC8343]
- ietf-mpls defined in [I-D.iotf-mpls-base-yang]
- ietf-te defined in [I-D.iotf-teas-yang-te]

The ietf-mpls-static module contains the following high-level types and groupings:

- static-lsp-ref:
  A YANG reference type for a static LSP that can be used by data models to reference a configured static LSP.

- in-segment:
  A YANG grouping that describes parameters of an incoming class of FEC associated with a specific LSP as described in the MPLS architecture document [RFC3031]. The model allows the following types of traffic to be mapped onto the static LSP on an ingress LER:
  - Unlabeled traffic destined to a specific prefix
  - Labeled traffic arriving with a specific label
  - Traffic carried on a TE tunnel whose LSP is statically created via this model.

- out-segment:
  A YANG grouping that describes parameters for the forwarding path(s) and their associated attributes for an LSP. The model allows for the following cases:
single forwarding path or NHLFE
- multiple forwarding path(s) or NHLFE(s), each of which can serve a primary, backup or both role(s).

The ietf-mpls-static-extended module imports the following modules:
- ietf-mpls defined in [I-D.ietf-mpls-base-yang]
- ietf-mpls-static defined in this document
- ietf-routing defined in [RFC8349]

The ietf-mpls-static-extended module contains the following high-level types and groupings:

bidir-static-lsp:

A YANG grouping that describes list of static bidirectional LSPs

The ietf-mpls-static-extended augments the ietf-mpls-static model with additional parameters to configure and manage:

- Bidirectional Static LSP(s)
- Defining Static LSP bandwidth allocation
- Defining Static LSP preemption priorities

2.4. Model YANG Module(s)

Configuring LSPs through an LSR/LER involves the following steps:

- Enabling MPLS on MPLS capable interfaces.
- Configuring in-segments and out-segments on LER(s) and LSR(s) traversed by the LSP.
- Setting up the cross-connect per LSP to associate segments and/or to indicate connection origination and termination.
- Optionally specifying label stack actions.
- Optionally specifying segment traffic parameters.

The objects covered by this model are derived from the Incoming Label Map (ILM) and Next Hop Label Forwarding Entry (NHLFE) as specified in the MPLS architecture document [RFC3031].
The MPLS Static LSP and Extended Static LSP modules are shown in
Figure 3 and Figure 4 below respectively.

<CODE BEGINS> file "ietf-mpls-static@2018-11-04.yang"
module ietf-mpls-static {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-mpls-static";

  prefix "mpls-static";

  import ietf-mpls {
    prefix "mpls";
    reference "draft-ietf-mpls-base-yang: MPLS Base YANG Data Model";
  }

  import ietf-routing {
    prefix "rt";
    reference "RFC8349: A YANG Data Model for Routing Management";
  }

  import ietf-routing-types {
    prefix "rt-types";
    reference "RFC6991: Common YANG Data Types";
  }

  import ietf-inet-types {
    prefix inet;
    reference "RFC6991: Common YANG Data Types";
  }

  import ietf-interfaces {
    prefix "if";
    reference "RFC7223: A YANG Data Model for Interface Management";
  }

  /* Import TE Tunnel */
  import ietf-te {
    prefix te;
    reference "draft-ietf-teas-yang-te: A YANG Data Model for Traffic
    Engineering Tunnels and Interfaces";
  }

  organization "IETF MPLS Working Group";

  contact
    "WG Web: <http://tools.ietf.org/wg/mpls/>"
    "WG List: <mailto:mpls@ietf.org>"
This YANG module augments the 'ietf-routing' module with basic configuration and operational state data for MPLS static LSPs. The model fully conforms to the Network Management Datastore Architecture (NMDA).

Copyright (c) 2018 IETF Trust and the persons identified as authors of the code. All rights reserved.

Redistribution and use in source and binary forms, with or without modification, is permitted pursuant to, and subject to the license terms contained in, the Simplified BSD License set forth in Section 4.c of the IETF Trust’s Legal Provisions Relating to IETF Documents (https://trustee.ietf.org/license-info).

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

// RFC Ed.: replace XXXX with actual RFC number and remove this note.
typedef static-lsp-ref {
type leafref {
  path "/rt:routing/mpls:mpls/mpls-static:static-lsps/" +
    "mpls-static:static-lsp/mpls-static:name";
}
description
  "This type is used by data models that need to reference
  configured static LSP."
}

grouping in-segment {
description "In-segment grouping";
container in-segment {
description "MPLS incoming segment";
container fec {
description "Forwarding Equivalence Class grouping";
  choice type {
    description "FEC type choices";
    case ip-prefix {
      leaf ip-prefix {
        type inet:ip-prefix;
        description "An IP prefix";
      }
    }
    case mpls-label {
      leaf incoming-label {
        type rt-types:mpls-label;
        description "label value on the incoming packet";
      }
    }
    case tunnel {
      leaf tunnel {
        type te:tunnel-ref;
        description "TE tunnel FEC mapping";
      }
    }
  };
}
leaf incoming-interface {

type if:interface-ref;
description
"Optional incoming interface if FEC is restricted
to traffic incoming on a specific interface";
}
}
}

augment "/rt:routing/mpls:mpls" {
    description "Augmentations for MPLS Static LSPs";
    container static-lsps {

    }
}
description
"Statically configured LSPs, without dynamic signaling";
list static-lsp {
  key name;
  description "list of defined static LSPs";
  leaf name {
    type string;
    description "name to identify the LSP";
  }
  leaf operation {
    type mpls:mpls-operations-type;
    description "The MPLS operation to be executed on the incoming packet";
  }
  uses in-segment;
  uses out-segment;
}
}

Figure 3: MPLS Static LSP YANG module

The extended MPLS Static LSP module is shown in Figure 4.

<CODE BEGINS> file "ietf-mpls-static-extended@2018-11-04.yang"
module ietf-mpls-static-extended {
  yang-version 1.1;
  prefix "mpls-static-ext";

  import ietf-mpls {
    prefix "mpls";
    reference "draft-ietf-mpls-base-yang: MPLS Base YANG Data Model";
  }

  import ietf-routing {
    prefix "rt";
    reference "RFC6991: Common YANG Data Types";
  }

  import ietf-mpls-static {
    prefix "mpls-static";
    reference "draft-ietf-mpls-static-yang: A YANG Data Model for MPLS Static LSPs";
  }

<CODE ENDS>
This YANG module contains the Extended MPLS Static LSP YANG data model. The model fully conforms to the Network Management Datastore Architecture (NMDA).

Copyright (c) 2018 IETF Trust and the persons identified as authors of the code. All rights reserved.

Redistribution and use in source and binary forms, with or without modification, is permitted pursuant to, and subject to the license terms contained in, the Simplified BSD License set forth in Section 4.c of the IETF Trust’s Legal Provisions Relating to IETF Documents (https://trustee.ietf.org/license-info).
This version of this YANG module is part of RFC XXXX; see the RFC itself for full legal notices.

// RFC Ed.: replace XXXX with actual RFC number and remove this note.

// RFC Ed.: update the date below with the date of RFC publication and remove this note.

revision "2018-11-04" {
  description "Latest revision of MPLS extended yang module.";
  reference "RFC XXXX: Extended YANG Data Model for MPLS Static LSPs";
}

grouping bidir-static-lsp {
  description "grouping for top level list of static bidirectional LSPs";
  leaf forward-lsp {
    type mpls-static:static-lsp-ref;
    description "Reference to a configured static forward LSP";
  }
  leaf reverse-lsp {
    type mpls-static:static-lsp-ref;
    description "Reference to a configured static reverse LSP";
  }
}

augment "/rt:routing/mpls:mpls/mpls-static:static-lsps" {
  description "Augmentation for static MPLS LSPs";
  leaf bandwidth {
    type uint32;
    units mbps;
    description "Bandwidth in Mbps, e.g., using offline calculation";
  }
  leaf lsp-priority-setup {
    type uint8 {
      range "0..7";
    }
    description "LSP setup priority";
  }
  leaf lsp-priority-hold {
    type uint8 {
      range "0..7";
    }
  }
}
augment "/rt:routing/mpls:mpls" {
    description "Augmentations for MPLS Static LSPs";
    container bidir-static-lsps {
        description "Statically configured bidirectional LSPs";
        list bidir-static-lsp {
            key name;
            description "List of static bidirectional LSPs";
            leaf name {
                type string;
                description "Name that identifies the bidirectional LSP";
            }
            uses bidir-static-lsp;
        }
    }
}

Figure 4: Extended MPLS Static LSP YANG module

3. IANA Considerations

This document registers the following URIs in the IETF XML registry [RFC3688]. Following the format in [RFC3688], the following registration is requested to be made.

Registrant Contact: The MPLS WG of the IETF.
XML: N/A, the requested URI is an XML namespace.

Registrant Contact: The MPLS WG of the IETF.
XML: N/A, the requested URI is an XML namespace.

This document registers two YANG modules in the YANG Module Names registry [RFC6020].
The YANG module defined in this document is designed to be accessed via the NETCONF protocol [RFC6241]. The lowest NETCONF layer is the secure transport layer and the mandatory-to-implement secure transport is SSH [RFC6242]. The NETCONF access control model [RFC8341] provides means to restrict access for particular NETCONF users to a pre-configured subset of all available NETCONF protocol operations and content.

There are certain objects or data nodes that are defined in this YANG module which are writable/creatable/deletable and that can be considered sensitive or vulnerable in some network environments. Specifically, misconfiguration or manipulations of objects or data node(s) defined in this model, including: in-segment(s), out-segment(s) and their associated parameters that collectively allow the provisioning of MPLS LSP(s) and associated parameters on a LSR can potentially have disastrous results.

5. References

5.1. Normative References

[I-D.ietf-mpls-base-yang]

[I-D.ietf-teas-yang-te]
Internet-Draft  MPLS Static LSPs YANG Data Model  November 2018


5.2. Informative References


Authors’ Addresses

Tarek Saad
Cisco Systems, Inc.
Email: tsaad@cisco.com

Kamran Raza
Cisco Systems, Inc.
Email: skraza@cisco.com

Rakesh Gandhi
Cisco Systems, Inc.
Email: rgandhi@cisco.com

Xufeng Liu
Volta Networks
Email: xufeng.liu.ietf@gmail.com