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X. Liu
Jabil
Y. Qu
Futurewei Technologies, Inc.
A. Lindem
Cisco Systems
C. Hopps
Deutsche Telekom
L. Berger
LabN Consulting, L.L.C.
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Common YANG Data Types for the Routing Area

Abstract

This document defines a collection of common data types using the YANG data modeling language. These derived common types are designed to be imported by other modules defined in the routing area.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at <https://www.rfc-editor.org/info/rfc8294>.

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1. Introduction

YANG [RFC6020] [RFC7950] is a data modeling language used to model configuration data, state data, Remote Procedure Calls, and notifications for network management protocols. The YANG language supports a small set of built-in data types and provides mechanisms to derive other types from the built-in types.

This document introduces a collection of common data types derived from the built-in YANG data types. The derived types are designed to be the common types applicable for modeling in the routing area.

1.1. Terminology

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

2. Overview

This document defines two YANG modules for common routing types: `ietf-routing-types` and `iana-routing-types`. The only module imports (`ietf-yang-types` and `ietf-inet-types`; see Section 3) are from [RFC6991]. The `ietf-routing-types` module contains common routing types other than those corresponding directly to IANA mappings. These include the following:

`router-id`

Router Identifiers are commonly used to identify nodes in routing and other control-plane protocols. An example usage of `router-id` can be found in [OSPF-YANG].

`route-target`

Route Targets (RTs) are commonly used to control the distribution of Virtual Routing and Forwarding (VRF) information (see [RFC4364]) in support of BGP/MPLS IP Virtual Private Networks (VPNs) and BGP/MPLS Ethernet VPNs [RFC7432]. An example usage can be found in [L2VPN-YANG].

`ipv6-route-target`

IPv6 Route Targets are similar to standard Route Targets, except that they are IPv6 Address Specific BGP Extended Communities as described in [RFC5701]. An IPv6 Route Target is 20 octets and includes an IPv6 address as the global administrator.

`route-target-type`

This type defines the import and export rules of Route Targets, as described in Section 4.3.1 of [RFC4364].

route-distinguisher

Route Distinguishers (RDs) are commonly used to identify separate routes in support of VPNs. For example, as described in [RFC4364], RDs are commonly used to identify independent VPNs and VRFs, and, more generally, to identify multiple routes to the same prefix.

route-origin

A Route Origin is commonly used to indicate the Site of Origin for VRF information (see [RFC4364]) in support of BGP/MPLS IP VPNs and BGP/MPLS Ethernet VPNs [RFC7432].

ipv6-route-origin

An IPv6 Route Origin would also be used to indicate the Site of Origin for VRF information (see [RFC4364]) in support of VPNs. IPv6 Route Origins are IPv6 Address Specific BGP Extended Communities as described in [RFC5701]. An IPv6 Route Origin is 20 octets and includes an IPv6 address as the global administrator.

ipv4-multicast-group-address

This type defines the representation of an IPv4 multicast group address, which is in the range of 224.0.0.0 to 239.255.255.255. An example usage can be found in [PIM-YANG].

ipv6-multicast-group-address

This type defines the representation of an IPv6 multicast group address, which is in the range of ff00::/8. An example usage can be found in [PIM-YANG].

ip-multicast-group-address

This type represents an IP multicast group address and is IP version neutral. The format of the textual representation implies the IP version. An example usage can be found in [PIM-YANG].

ipv4-multicast-source-address

This represents the IPv4 source address type for use in multicast control protocols. This type also allows the indication of wildcard sources, i.e., "*". An example of where this type may/will be used is [PIM-YANG].

ipv6-multicast-source-address

This represents the IPv6 source address type for use in multicast control protocols. This type also allows the indication of wildcard sources, i.e., "*". An example of where this type may/will be used is [PIM-YANG].

bandwidth-ieee-float32

This represents the bandwidth in IEEE 754 floating-point 32-bit binary format [IEEE754]. It is commonly used in Traffic Engineering control-plane protocols. An example of where this type may/will be used is [OSPF-YANG].

link-access-type

This type identifies the IGP link type.

timer-multiplier

This type is used in conjunction with a timer-value type. It is generally used to indicate the number of timer-value intervals that may expire before a specific event must occur. Examples of this include the arrival of any Bidirectional Forwarding Detection (BFD) packets (see [RFC5880] Section 6.8.4) or hello_interval [RFC3209].

timer-value-seconds16

This type covers timers that can be set in seconds, not set, or set to infinity. This type supports a range of values that can be represented in a uint16 (2 octets).

timer-value-seconds32

This type covers timers that can be set in seconds, not set, or set to infinity. This type supports a range of values that can be represented in a uint32 (4 octets).

timer-value-milliseconds

This type covers timers that can be set in milliseconds, not set, or set to infinity. This type supports a range of values that can be represented in a uint32 (4 octets).

percentage

This type defines a percentage with a range of 0-100%. An example usage can be found in [BGP-Model].

timeticks64

This type is based on the timeticks type defined in [RFC6991] but with 64-bit precision. It represents the time in hundredths of a second between two epochs. An example usage can be found in [BGP-Model].

uint24

This type defines a 24-bit unsigned integer. An example usage can be found in [OSPF-YANG].

`generalized-label`

This type represents a Generalized Label for Generalized Multiprotocol Label Switching (GMPLS) [RFC3471]. The Generalized Label does not identify its type, which is known from context. An example usage can be found in [TE-YANG].

`mpls-label-special-purpose`

This type represents the special-purpose MPLS label values [RFC7274].

`mpls-label-general-use`

The 20-bit label value in an MPLS label stack is specified in [RFC3032]. This label value does not include the encodings of Traffic Class and TTL (Time to Live). The label range specified by this type is for general use, with special-purpose MPLS label values excluded.

`mpls-label`

The 20-bit label value in an MPLS label stack is specified in [RFC3032]. This label value does not include the encodings of Traffic Class and TTL. The label range specified by this type covers the general-use values and the special-purpose label values. An example usage can be found in [MPLS-Base-YANG].

This document defines the following YANG groupings:

`mpls-label-stack`

This grouping defines a reusable collection of schema nodes representing an MPLS label stack [RFC3032].

`vpn-route-targets`

This grouping defines a reusable collection of schema nodes representing Route Target import-export rules used in BGP-enabled VPNs [RFC4364] [RFC4664]. An example usage can be found in [L2VPN-YANG].

The `iana-routing-types` module contains common routing types corresponding directly to IANA mappings. These include the following:

`address-family`

This type defines values for use in Address Family identifiers. The values are based on the IANA "Address Family Numbers" registry [IANA-ADDRESS-FAMILY-REGISTRY]. An example usage can be found in [BGP-Model].

`subsequent-address-family`

This type defines values for use in Subsequent Address Family Identifiers (SAFIs). The values are based on the IANA "Subsequent Address Family Identifiers (SAFI) Parameters" registry [IANA-SAFI-REGISTRY].

3. IETF Routing Types YANG Module

```
<CODE BEGINS> file "ietf-routing-types@2017-12-04.yang"

module ietf-routing-types {
  namespace "urn:ietf:params:xml:ns:yang:ietf-routing-types";
  prefix rt-types;

  import ietf-yang-types {
    prefix yang;
  }
  import ietf-inet-types {
    prefix inet;
  }

  organization
    "IETF RTGWG - Routing Area Working Group";
  contact
    "WG Web: <https://datatracker.ietf.org/wg/rtgwg/>
    WG List: <mailto:rtgwg@ietf.org>

    Editors: Xufeng Liu
              <mailto:Xufeng_Liu@jabail.com>
              Yingzhen Qu
              <mailto:yingzhen.qu@huawei.com>
              Acee Lindem
              <mailto:acee@cisco.com>
              Christian Hopps
              <mailto:chopps@chopps.org>
              Lou Berger
              <mailto:lberger@labn.com>";

  description
    "This module contains a collection of YANG data types
    considered generally useful for routing protocols.

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    identified as authors of the code. All rights reserved.

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    This version of this YANG module is part of RFC 8294; see
    the RFC itself for full legal notices.";
```



```
revision 2017-12-04 {
  description "Initial revision.";
  reference
    "RFC 8294: Common YANG Data Types for the Routing Area.
    Section 3.";
}

/*** Identities related to MPLS/GMPLS ***/

identity mpls-label-special-purpose-value {
  description
    "Base identity for deriving identities describing
    special-purpose Multiprotocol Label Switching (MPLS) label
    values.";
  reference
    "RFC 7274: Allocating and Retiring Special-Purpose MPLS
    Labels.";
}

identity ipv4-explicit-null-label {
  base mpls-label-special-purpose-value;
  description
    "This identity represents the IPv4 Explicit NULL Label.";
  reference
    "RFC 3032: MPLS Label Stack Encoding. Section 2.1.";
}

identity router-alert-label {
  base mpls-label-special-purpose-value;
  description
    "This identity represents the Router Alert Label.";
  reference
    "RFC 3032: MPLS Label Stack Encoding. Section 2.1.";
}

identity ipv6-explicit-null-label {
  base mpls-label-special-purpose-value;
  description
    "This identity represents the IPv6 Explicit NULL Label.";
  reference
    "RFC 3032: MPLS Label Stack Encoding. Section 2.1.";
}
```

```
identity implicit-null-label {
  base mpls-label-special-purpose-value;
  description
    "This identity represents the Implicit NULL Label.";
  reference
    "RFC 3032: MPLS Label Stack Encoding. Section 2.1.";
}

identity entropy-label-indicator {
  base mpls-label-special-purpose-value;
  description
    "This identity represents the Entropy Label Indicator.";
  reference
    "RFC 6790: The Use of Entropy Labels in MPLS Forwarding.
    Sections 3 and 10.1.";
}

identity gal-label {
  base mpls-label-special-purpose-value;
  description
    "This identity represents the Generic Associated Channel
    (G-ACh) Label (GAL).";
  reference
    "RFC 5586: MPLS Generic Associated Channel.
    Sections 4 and 10.";
}

identity oam-alert-label {
  base mpls-label-special-purpose-value;
  description
    "This identity represents the OAM Alert Label.";
  reference
    "RFC 3429: Assignment of the 'OAM Alert Label' for
    Multiprotocol Label Switching Architecture (MPLS)
    Operation and Maintenance (OAM) Functions.
    Sections 3 and 6.";
}

identity extension-label {
  base mpls-label-special-purpose-value;
  description
    "This identity represents the Extension Label.";
  reference
    "RFC 7274: Allocating and Retiring Special-Purpose MPLS
    Labels. Sections 3.1 and 5.";
}
```

```

/** Collection of types related to routing */
typedef router-id {
  type yang:dotted-quad;
  description
    "A 32-bit number in the dotted-quad format assigned to each
    router. This number uniquely identifies the router within
    an Autonomous System.";
}

/** Collection of types related to VPNs */
typedef route-target {
  type string {
    pattern
      '(0:(6553[0-5]|655[0-2][0-9]|65[0-4][0-9]{2})|'
      + '6[0-4][0-9]{3})|'
      + '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0):(429496729[0-5]|'
      + '42949672[0-8][0-9]|'
      + '4294967[01][0-9]{2}|429496[0-6][0-9]{3})|'
      + '42949[0-5][0-9]{4})|'
      + '4294[0-8][0-9]{5}|429[0-3][0-9]{6})|'
      + '42[0-8][0-9]{7}|4[01][0-9]{8})|'
      + '[1-3][0-9]{9}|[1-9][0-9]{0,8}|0))|'
      + '(1:(((0-9)[1-9][0-9]|1[0-9]{2}|2[0-4][0-9]|'
      + '25[0-5])\.)}{3}([0-9][1-9][0-9]|'
      + '1[0-9]{2}|2[0-4][0-9]|25[0-5])):(6553[0-5]|'
      + '655[0-2][0-9]|'
      + '65[0-4][0-9]{2}|6[0-4][0-9]{3})|'
      + '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0))|'
      + '(2:(429496729[0-5]|42949672[0-8][0-9]|'
      + '4294967[01][0-9]{2}|'
      + '429496[0-6][0-9]{3}|42949[0-5][0-9]{4}|'
      + '4294[0-8][0-9]{5}|'
      + '429[0-3][0-9]{6}|42[0-8][0-9]{7}|4[01][0-9]{8})|'
      + '[1-3][0-9]{9}|[1-9][0-9]{0,8}|0):'
      + '(6553[0-5]|655[0-2][0-9]|65[0-4][0-9]{2})|'
      + '6[0-4][0-9]{3}|'
      + '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0))|'
      + '(6(:[a-fA-F0-9]{2}){6})|'
      + '((([3-57-9a-fA-F]|1-9a-fA-F][0-9a-fA-F]{1,3}):'
      + '[0-9a-fA-F]{1,12}))';
  }
}

```

description

"A Route Target is an 8-octet BGP extended community initially identifying a set of sites in a BGP VPN (RFC 4364). However, it has since taken on a more general role in BGP route filtering. A Route Target consists of two or three fields: a 2-octet Type field, an administrator field, and, optionally, an assigned number field.

According to the data formats for types 0, 1, 2, and 6 as defined in RFC 4360, RFC 5668, and RFC 7432, the encoding pattern is defined as:

```
0:2-octet-asn:4-octet-number
1:4-octet-ipv4addr:2-octet-number
2:4-octet-asn:2-octet-number
6:6-octet-mac-address
```

Additionally, a generic pattern is defined for future Route Target types:

```
2-octet-other-hex-number:6-octet-hex-number
```

Some valid examples are 0:100:100, 1:1.1.1.1:100, 2:1234567890:203, and 6:26:00:08:92:78:00.";

reference

```
"RFC 4360: BGP Extended Communities Attribute.
RFC 4364: BGP/MPLS IP Virtual Private Networks (VPNs).
RFC 5668: 4-Octet AS Specific BGP Extended Community.
RFC 7432: BGP MPLS-Based Ethernet VPN.";
```

}

```

typedef ipv6-route-target {
  type string {
    pattern
      '((:|[0-9a-fA-F]{0,4}):)([0-9a-fA-F]{0,4}:){0,5}'
      + '(((([0-9a-fA-F]{0,4})?:|[0-9a-fA-F]{0,4}))|'
      + '(((25[0-5]|2[0-4][0-9]|1[0-9]{2}|[1-9]?[0-9])\.)}{3}'
      + '(25[0-5]|2[0-4][0-9]|1[0-9]{2}|[1-9]?[0-9])))'
      + ':'
      + '(6553[0-5]|655[0-2][0-9]|65[0-4][0-9]{2}|'
      + '6[0-4][0-9]{3}|'
      + '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0)';
    pattern '(((^[^:]+:){6}(((^[^:]+:[^:]+)|(.*\.\.*)|'
      + '(((^[^:]+:)*[^[^:]+)??:(((^[^:]+:)*[^[^:]+)?))'
      + ':'))'
      + '(6553[0-5]|655[0-2][0-9]|65[0-4][0-9]{2}|'
      + '6[0-4][0-9]{3}|'
      + '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0)';
  }
  description
    "An IPv6 Route Target is a 20-octet BGP IPv6 Address
    Specific Extended Community serving the same function
    as a standard 8-octet Route Target, except that it only
    allows an IPv6 address as the global administrator.
    The format is <ipv6-address:2-octet-number>.

    Two valid examples are 2001:db8::1:6544 and
    2001:db8::5eb1:791:6b37:17958.";
  reference
    "RFC 5701: IPv6 Address Specific BGP Extended Community
    Attribute.";
}

typedef route-target-type {
  type enumeration {
    enum import {
      value 0;
      description
        "The Route Target applies to route import.";
    }
    enum export {
      value 1;
      description
        "The Route Target applies to route export.";
    }
  }
}

```

```

enum both {
    value 2;
    description
        "The Route Target applies to both route import and
        route export.";
}
}
description
    "Indicates the role a Route Target takes in route filtering.";
reference
    "RFC 4364: BGP/MPLS IP Virtual Private Networks (VPNs).";
}

typedef route-distinguisher {
    type string {
        pattern
            '(0:(6553[0-5]|655[0-2][0-9]|65[0-4][0-9]{2})|'
            + '6[0-4][0-9]{3})|'
            + '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0):(429496729[0-5]|'
            + '42949672[0-8][0-9]|'
            + '4294967[01][0-9]{2}|429496[0-6][0-9]{3})|'
            + '42949[0-5][0-9]{4})|'
            + '4294[0-8][0-9]{5}|429[0-3][0-9]{6})|'
            + '42[0-8][0-9]{7}|4[01][0-9]{8})|'
            + '[1-3][0-9]{9}|[1-9][0-9]{0,8}|0))|'
            + '(1:(((0-9)|[1-9][0-9]|1[0-9]{2}|2[0-4][0-9]|'
            + '25[0-5])\.)}{3}([0-9]|[1-9][0-9]|'
            + '1[0-9]{2}|2[0-4][0-9]|25[0-5])):(6553[0-5]|'
            + '655[0-2][0-9]|'
            + '65[0-4][0-9]{2}|6[0-4][0-9]{3})|'
            + '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0))|'
            + '(2:(429496729[0-5]|42949672[0-8][0-9]|'
            + '4294967[01][0-9]{2}|'
            + '429496[0-6][0-9]{3}|42949[0-5][0-9]{4})|'
            + '4294[0-8][0-9]{5}|'
            + '429[0-3][0-9]{6}|42[0-8][0-9]{7}|4[01][0-9]{8})|'
            + '[1-3][0-9]{9}|[1-9][0-9]{0,8}|0):'
            + '(6553[0-5]|655[0-2][0-9]|65[0-4][0-9]{2})|'
            + '6[0-4][0-9]{3}|'
            + '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0))|'
            + '(6(:[a-fA-F0-9]{2}){6})|'
            + '((([3-57-9a-fA-F]|1-9a-fA-F)[0-9a-fA-F]{1,3}):'
            + '[0-9a-fA-F]{1,12}))';
    }
}

```

description

"A Route Distinguisher is an 8-octet value used to distinguish routes from different BGP VPNs (RFC 4364). A Route Distinguisher will have the same format as a Route Target as per RFC 4360 and will consist of two or three fields: a 2-octet Type field, an administrator field, and, optionally, an assigned number field.

According to the data formats for types 0, 1, 2, and 6 as defined in RFC 4360, RFC 5668, and RFC 7432, the encoding pattern is defined as:

```
0:2-octet-asn:4-octet-number
1:4-octet-ipv4addr:2-octet-number
2:4-octet-asn:2-octet-number
6:6-octet-mac-address
```

Additionally, a generic pattern is defined for future route discriminator types:

```
2-octet-other-hex-number:6-octet-hex-number
```

Some valid examples are 0:100:100, 1:1.1.1.1:100, 2:1234567890:203, and 6:26:00:08:92:78:00.";

reference

```
"RFC 4360: BGP Extended Communities Attribute.
RFC 4364: BGP/MPLS IP Virtual Private Networks (VPNs).
RFC 5668: 4-Octet AS Specific BGP Extended Community.
RFC 7432: BGP MPLS-Based Ethernet VPN.";
```

}

```

typedef route-origin {
  type string {
    pattern
      '(0:(6553[0-5]|655[0-2][0-9]|65[0-4][0-9]{2})|'
    +   '6[0-4][0-9]{3})|'
    +   '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0):(429496729[0-5]|'
    +   '42949672[0-8][0-9]|'
    +   '4294967[01][0-9]{2}|429496[0-6][0-9]{3})|'
    +   '42949[0-5][0-9]{4}|'
    +   '4294[0-8][0-9]{5}|429[0-3][0-9]{6})|'
    +   '42[0-8][0-9]{7}|4[01][0-9]{8})|'
    +   '[1-3][0-9]{9}|[1-9][0-9]{0,8}|0))|'
    + '(1:(((0-9)|[1-9][0-9]|1[0-9]{2}|2[0-4][0-9]|'
    +   '25[0-5])\.)}{3}([0-9]|1[0-9][0-9]|'
    +   '1[0-9]{2}|2[0-4][0-9]|25[0-5])):(6553[0-5]|'
    +   '655[0-2][0-9]|'
    +   '65[0-4][0-9]{2}|6[0-4][0-9]{3})|'
    +   '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0))|'
    + '(2:(429496729[0-5]|42949672[0-8][0-9]|'
    +   '4294967[01][0-9]{2}|'
    +   '429496[0-6][0-9]{3}|42949[0-5][0-9]{4}|'
    +   '4294[0-8][0-9]{5}|'
    +   '429[0-3][0-9]{6}|42[0-8][0-9]{7}|4[01][0-9]{8})|'
    +   '[1-3][0-9]{9}|[1-9][0-9]{0,8}|0):'
    +   '(6553[0-5]|655[0-2][0-9]|65[0-4][0-9]{2})|'
    +   '6[0-4][0-9]{3}|'
    +   '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0))|'
    + '(6(:[a-fA-F0-9]{2}){6})|'
    + '((([3-57-9a-fA-F]|1-9a-fA-F)[0-9a-fA-F]{1,3}):'
    +   '[0-9a-fA-F]{1,12})';
  }
  description
    "A Route Origin is an 8-octet BGP extended community
    identifying the set of sites where the BGP route
    originated (RFC 4364). A Route Origin will have the same
    format as a Route Target as per RFC 4360 and will consist
    of two or three fields: a 2-octet Type field, an
    administrator field, and, optionally, an assigned number
    field.

    According to the data formats for types 0, 1, 2, and 6 as
    defined in RFC 4360, RFC 5668, and RFC 7432, the encoding
    pattern is defined as:

    0:2-octet-asn:4-octet-number
    1:4-octet-ipv4addr:2-octet-number
    2:4-octet-asn:2-octet-number
    6:6-octet-mac-address
  
```


Additionally, a generic pattern is defined for future Route Origin types:

2-octet-other-hex-number:6-octet-hex-number

Some valid examples are 0:100:100, 1:1.1.1.1:100, 2:1234567890:203, and 6:26:00:08:92:78:00.";

reference

"RFC 4360: BGP Extended Communities Attribute.
RFC 4364: BGP/MPLS IP Virtual Private Networks (VPNs).
RFC 5668: 4-Octet AS Specific BGP Extended Community.
RFC 7432: BGP MPLS-Based Ethernet VPN.";

}

typedef ipv6-route-origin {

type string {

pattern

'((:|[0-9a-fA-F]{0,4}):)([0-9a-fA-F]{0,4}:){0,5}'
+ '((([0-9a-fA-F]{0,4}):)?(:|[0-9a-fA-F]{0,4}))|'
+ '(((25[0-5]|2[0-4][0-9]|1[0-9]{2}|[1-9]?[0-9])\.)\.)\{3}'
+ '(25[0-5]|2[0-4][0-9]|1[0-9]{2}|[1-9]?[0-9])))'
+ ':'
+ '(6553[0-5]|655[0-2][0-9]|65[0-4][0-9]{2}|'
+ '6[0-4][0-9]{3}|'
+ '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0)';
pattern '(((^[^:]+:){6}([^[^:]+:[^:]+)|(.*\.\.*)|'
+ '(((^[^:]+:)*[^[^:]+)?::([^[^:]+)*[^[^:]+)?))'
+ ':'
+ '(6553[0-5]|655[0-2][0-9]|65[0-4][0-9]{2}|'
+ '6[0-4][0-9]{3}|'
+ '[1-5][0-9]{4}|[1-9][0-9]{0,3}|0)';

}

description

"An IPv6 Route Origin is a 20-octet BGP IPv6 Address Specific Extended Community serving the same function as a standard 8-octet route, except that it only allows an IPv6 address as the global administrator. The format is <ipv6-address:2-octet-number>.

Two valid examples are 2001:db8::1:6544 and 2001:db8::5eb1:791:6b37:17958.";

reference

"RFC 5701: IPv6 Address Specific BGP Extended Community Attribute.";

}

```
/** Collection of types common to multicast */

typedef ipv4-multicast-group-address {
  type inet:ipv4-address {
    pattern '(2((2[4-9])|(3[0-9]))\.)\. *';
  }
  description
    "This type represents an IPv4 multicast group address,
    which is in the range of 224.0.0.0 to 239.255.255.255.";
  reference
    "RFC 1112: Host Extensions for IP Multicasting.";
}

typedef ipv6-multicast-group-address {
  type inet:ipv6-address {
    pattern '((([fF]{2}[0-9a-fA-F]{2}):)\. *';
  }
  description
    "This type represents an IPv6 multicast group address,
    which is in the range of ff00::/8.";
  reference
    "RFC 4291: IP Version 6 Addressing Architecture. Section 2.7.
    RFC 7346: IPv6 Multicast Address Scopes.";
}

typedef ip-multicast-group-address {
  type union {
    type ipv4-multicast-group-address;
    type ipv6-multicast-group-address;
  }
  description
    "This type represents a version-neutral IP multicast group
    address. The format of the textual representation implies
    the IP version.";
}
```

```

typedef ipv4-multicast-source-address {
  type union {
    type enumeration {
      enum * {
        description
          "Any source address.";
      }
    }
    type inet:ipv4-address;
  }
  description
    "Multicast source IPv4 address type.";
}

typedef ipv6-multicast-source-address {
  type union {
    type enumeration {
      enum * {
        description
          "Any source address.";
      }
    }
    type inet:ipv6-address;
  }
  description
    "Multicast source IPv6 address type.";
}

/**/ Collection of types common to protocols ***/

typedef bandwidth-ieee-float32 {
  type string {
    pattern
      '0[xX](0((\.\.0?)?[pP](\+)?0?|(\.\.0?))|'
      + '1(\.([0-9a-fA-F]{0,5}[02468aAcCeE]?)?)?[pP](\+)?(12[0-7]|'
      + '1[01][0-9]|0?[0-9]?[0-9])?)';
  }
  description
    "Bandwidth in IEEE 754 floating-point 32-bit binary format:
    (-1)**(S) * 2**(Exponent-127) * (1 + Fraction),
    where Exponent uses 8 bits and Fraction uses 23 bits.
    The units are octets per second.
    The encoding format is the external hexadecimal-significant
    character sequences specified in IEEE 754 and ISO/IEC C99.
    The format is restricted to be normalized, non-negative, and
    non-fraction: 0x1.hhhhhhp{+}d, 0X1.HHHHHHP{+}D, or 0x0p0,
    where 'h' and 'H' are hexadecimal digits and 'd' and 'D' are
    integers in the range of [0..127].
  "

```

When six hexadecimal digits are used for 'hhhhh' or 'HHHHH', the least significant digit must be an even number. 'x' and 'X' indicate hexadecimal; 'p' and 'P' indicate a power of two. Some examples are 0x0p0, 0x1p10, and 0x1.abcde2p+20.";

```
reference
  "IEEE Std 754-2008: IEEE Standard for Floating-Point
  Arithmetic.
  ISO/IEC C99: Information technology - Programming
  Languages - C.";
}

typedef link-access-type {
  type enumeration {
    enum broadcast {
      description
        "Specify broadcast multi-access network.";
    }
    enum non-broadcast-multiaccess {
      description
        "Specify Non-Broadcast Multi-Access (NBMA) network.";
    }
    enum point-to-multipoint {
      description
        "Specify point-to-multipoint network.";
    }
    enum point-to-point {
      description
        "Specify point-to-point network.";
    }
  }
  description
    "Link access type.";
}

typedef timer-multiplier {
  type uint8;
  description
    "The number of timer value intervals that should be
    interpreted as a failure.";
}
```

```
typedef timer-value-seconds16 {
  type union {
    type uint16 {
      range "1..65535";
    }
    type enumeration {
      enum infinity {
        description
          "The timer is set to infinity.";
      }
      enum not-set {
        description
          "The timer is not set.";
      }
    }
  }
  units "seconds";
  description
    "Timer value type, in seconds (16-bit range).";
}

typedef timer-value-seconds32 {
  type union {
    type uint32 {
      range "1..4294967295";
    }
    type enumeration {
      enum infinity {
        description
          "The timer is set to infinity.";
      }
      enum not-set {
        description
          "The timer is not set.";
      }
    }
  }
  units "seconds";
  description
    "Timer value type, in seconds (32-bit range).";
}
```

```
typedef timer-value-milliseconds {
  type union {
    type uint32 {
      range "1..4294967295";
    }
    type enumeration {
      enum infinity {
        description
          "The timer is set to infinity.";
      }
      enum not-set {
        description
          "The timer is not set.";
      }
    }
  }
  units "milliseconds";
  description
    "Timer value type, in milliseconds.";
}

typedef percentage {
  type uint8 {
    range "0..100";
  }
  description
    "Integer indicating a percentage value.";
}

typedef timeticks64 {
  type uint64;
  description
    "This type is based on the timeticks type defined in
    RFC 6991, but with 64-bit width. It represents the time,
    modulo 2^64, in hundredths of a second between two epochs.";
  reference
    "RFC 6991: Common YANG Data Types.";
}

typedef uint24 {
  type uint32 {
    range "0..16777215";
  }
  description
    "24-bit unsigned integer.";
}
```

```
/** Collection of types related to MPLS/GMPLS */

typedef generalized-label {
  type binary;
  description
    "Generalized Label. Nodes sending and receiving the
    Generalized Label are aware of the link-specific
    label context and type.";
  reference
    "RFC 3471: Generalized Multi-Protocol Label Switching (GMPLS)
    Signaling Functional Description. Section 3.2.";
}

typedef mpls-label-special-purpose {
  type identityref {
    base mpls-label-special-purpose-value;
  }
  description
    "This type represents the special-purpose MPLS label values.";
  reference
    "RFC 3032: MPLS Label Stack Encoding.
    RFC 7274: Allocating and Retiring Special-Purpose MPLS
    Labels.";
}

typedef mpls-label-general-use {
  type uint32 {
    range "16..1048575";
  }
  description
    "The 20-bit label value in an MPLS label stack as specified
    in RFC 3032. This label value does not include the
    encodings of Traffic Class and TTL (Time to Live).
    The label range specified by this type is for general use,
    with special-purpose MPLS label values excluded.";
  reference
    "RFC 3032: MPLS Label Stack Encoding.";
}
```

```
typedef mpls-label {
  type union {
    type mpls-label-special-purpose;
    type mpls-label-general-use;
  }
  description
    "The 20-bit label value in an MPLS label stack as specified
    in RFC 3032. This label value does not include the
    encodings of Traffic Class and TTL.";
  reference
    "RFC 3032: MPLS Label Stack Encoding.";
}
```

```
/** Groupings **/
```

```
grouping mpls-label-stack {
  description
    "This grouping specifies an MPLS label stack. The label
    stack is encoded as a list of label stack entries. The
    list key is an identifier that indicates the relative
    ordering of each entry, with the lowest-value identifier
    corresponding to the top of the label stack.";
  container mpls-label-stack {
    description
      "Container for a list of MPLS label stack entries.";
    list entry {
      key "id";
      description
        "List of MPLS label stack entries.";
      leaf id {
        type uint8;
        description
          "Identifies the entry in a sequence of MPLS label
          stack entries. An entry with a smaller identifier
          value precedes an entry with a larger identifier
          value in the label stack. The value of this ID has
          no semantic meaning other than relative ordering
          and referencing the entry.";
      }
      leaf label {
        type rt-types:mpls-label;
        description
          "Label value.";
      }
    }
  }
}
```



```
leaf ttl {
  type uint8;
  description
    "Time to Live (TTL).";
  reference
    "RFC 3032: MPLS Label Stack Encoding.";
}
leaf traffic-class {
  type uint8 {
    range "0..7";
  }
  description
    "Traffic Class (TC).";
  reference
    "RFC 5462: Multiprotocol Label Switching (MPLS) Label
    Stack Entry: 'EXP' Field Renamed to 'Traffic Class'
    Field.";
}
}
}
```

```
grouping vpn-route-targets {
  description
    "A grouping that specifies Route Target import-export rules
    used in BGP-enabled VPNs.";
  reference
    "RFC 4364: BGP/MPLS IP Virtual Private Networks (VPNs).
    RFC 4664: Framework for Layer 2 Virtual Private Networks
    (L2VPNs).";
  list vpn-target {
    key "route-target";
    description
      "List of Route Targets.";
    leaf route-target {
      type rt-types:route-target;
      description
        "Route Target value.";
    }
    leaf route-target-type {
      type rt-types:route-target-type;
      mandatory true;
      description
        "Import/export type of the Route Target.";
    }
  }
}
```

<CODE ENDS>

4. IANA Routing Types YANG Module

```
<CODE BEGINS> file "iana-routing-types@2017-12-04.yang"

module iana-routing-types {
  namespace "urn:ietf:params:xml:ns:yang:iana-routing-types";
  prefix iana-rt-types;

  organization
    "IANA";
  contact
    "Internet Assigned Numbers Authority

    Postal: ICANN
           12025 Waterfront Drive, Suite 300
           Los Angeles, CA 90094-2536
           United States of America
    Tel:   +1 310 301 5800
    <mailto:iana@iana.org>";

  description
    "This module contains a collection of YANG data types
    considered defined by IANA and used for routing
    protocols.

    Copyright (c) 2017 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 8294; see
    the RFC itself for full legal notices.";

  revision 2017-12-04 {
    description "Initial revision.";
    reference
      "RFC 8294: Common YANG Data Types for the Routing Area.
      Section 4.";
  }
}
```

```
/** Collection of IANA types related to routing */
/** IANA Address Family enumeration */

typedef address-family {
  type enumeration {
    enum ipv4 {
      value 1;
      description
        "IPv4 Address Family.";
    }

    enum ipv6 {
      value 2;
      description
        "IPv6 Address Family.";
    }

    enum nsap {
      value 3;
      description
        "OSI Network Service Access Point (NSAP) Address Family.";
    }

    enum hdlc {
      value 4;
      description
        "High-Level Data Link Control (HDLC) Address Family.";
    }

    enum bbn1822 {
      value 5;
      description
        "Bolt, Beranek, and Newman Report 1822 (BBN 1822)
        Address Family.";
    }

    enum ieee802 {
      value 6;
      description
        "IEEE 802 Committee Address Family
        (aka Media Access Control (MAC) address).";
    }

    enum e163 {
      value 7;
      description
        "ITU-T E.163 Address Family.";
    }
  }
}
```

```
enum e164 {
  value 8;
  description
    "ITU-T E.164 (Switched Multimegabit Data Service (SMDS),
    Frame Relay, ATM) Address Family.";
}

enum f69 {
  value 9;
  description
    "ITU-T F.69 (Telex) Address Family.";
}

enum x121 {
  value 10;
  description
    "ITU-T X.121 (X.25, Frame Relay) Address Family.";
}

enum ipx {
  value 11;
  description
    "Novell Internetwork Packet Exchange (IPX)
    Address Family.";
}

enum appletalk {
  value 12;
  description
    "Apple AppleTalk Address Family.";
}

enum decnet-iv {
  value 13;
  description
    "Digital Equipment DECnet Phase IV Address Family.";
}

enum vines {
  value 14;
  description
    "Banyan Vines Address Family.";
}
```

```
enum e164-nsap {
  value 15;
  description
    "ITU-T E.164 with NSAP sub-address Address Family.";
}

enum dns {
  value 16;
  description
    "Domain Name System (DNS) Address Family.";
}

enum distinguished-name {
  value 17;
  description
    "Distinguished Name Address Family.";
}

enum as-num {
  value 18;
  description
    "Autonomous System (AS) Number Address Family.";
}

enum xtp-v4 {
  value 19;
  description
    "Xpress Transport Protocol (XTP) over IPv4
    Address Family.";
}

enum xtp-v6 {
  value 20;
  description
    "XTP over IPv6 Address Family.";
}

enum xtp-native {
  value 21;
  description
    "XTP native mode Address Family.";
}

enum fc-port {
  value 22;
  description
    "Fibre Channel (FC) World-Wide Port Name Address Family.";
}
```

```
enum fc-node {
  value 23;
  description
    "FC World-Wide Node Name Address Family.";
}

enum gwid {
  value 24;
  description
    "ATM Gateway Identifier (GWID) Number Address Family.";
}

enum l2vpn {
  value 25;
  description
    "Layer 2 VPN (L2VPN) Address Family.";
}

enum mpls-tp-section-eid {
  value 26;
  description
    "MPLS Transport Profile (MPLS-TP) Section Endpoint
    Identifier Address Family.";
}

enum mpls-tp-lsp-eid {
  value 27;
  description
    "MPLS-TP Label Switched Path (LSP) Endpoint Identifier
    Address Family.";
}

enum mpls-tp-pwe-eid {
  value 28;
  description
    "MPLS-TP Pseudowire Endpoint Identifier Address Family.";
}

enum mt-v4 {
  value 29;
  description
    "Multi-Topology IPv4 Address Family.";
}
```

```
enum mt-v6 {
  value 30;
  description
    "Multi-Topology IPv6 Address Family.";
}

enum eigrp-common-sf {
  value 16384;
  description
    "Enhanced Interior Gateway Routing Protocol (EIGRP)
     Common Service Family Address Family.";
}

enum eigrp-v4-sf {
  value 16385;
  description
    "EIGRP IPv4 Service Family Address Family.";
}

enum eigrp-v6-sf {
  value 16386;
  description
    "EIGRP IPv6 Service Family Address Family.";
}

enum lcaf {
  value 16387;
  description
    "Locator/ID Separation Protocol (LISP)
     Canonical Address Format (LCAF) Address Family.";
}

enum bgp-ls {
  value 16388;
  description
    "Border Gateway Protocol - Link State (BGP-LS)
     Address Family.";
}

enum mac-48 {
  value 16389;
  description
    "IEEE 48-bit MAC Address Family.";
}
```



```
enum mac-64 {
  value 16390;
  description
    "IEEE 64-bit MAC Address Family.";
}

enum trill-oui {
  value 16391;
  description
    "Transparent Interconnection of Lots of Links (TRILL)
     IEEE Organizationally Unique Identifier (OUI)
     Address Family.";
}

enum trill-mac-24 {
  value 16392;
  description
    "TRILL final 3 octets of 48-bit MAC Address Family.";
}

enum trill-mac-40 {
  value 16393;
  description
    "TRILL final 5 octets of 64-bit MAC Address Family.";
}

enum ipv6-64 {
  value 16394;
  description
    "First 8 octets (64 bits) of IPv6 address
     Address Family.";
}

enum trill-rbridge-port-id {
  value 16395;
  description
    "TRILL Routing Bridge (RBridge) Port ID Address Family.";
}

enum trill-nickname {
  value 16396;
  description
    "TRILL Nickname Address Family.";
}
}
```

```
description
  "Enumeration containing all the IANA-defined
  Address Families.;"
}

/** Subsequent Address Family Identifiers (SAFIs) */
/** for multiprotocol BGP enumeration */

typedef bgp-safi {
  type enumeration {
    enum unicast-safi {
      value 1;
      description
        "Unicast SAFI.;"
    }

    enum multicast-safi {
      value 2;
      description
        "Multicast SAFI.;"
    }

    enum labeled-unicast-safi {
      value 4;
      description
        "Labeled Unicast SAFI.;"
    }

    enum multicast-vpn-safi {
      value 5;
      description
        "Multicast VPN SAFI.;"
    }

    enum pseudowire-safi {
      value 6;
      description
        "Multi-segment Pseudowire VPN SAFI.;"
    }

    enum tunnel-encap-safi {
      value 7;
      description
        "Tunnel Encap SAFI.;"
    }
  }
}
```

```
enum mcast-vpls-safi {
  value 8;
  description
    "Multicast Virtual Private LAN Service (VPLS) SAFI.";
}

enum tunnel-safi {
  value 64;
  description
    "Tunnel SAFI.";
}

enum vpls-safi {
  value 65;
  description
    "VPLS SAFI.";
}

enum mdt-safi {
  value 66;
  description
    "Multicast Distribution Tree (MDT) SAFI.";
}

enum v4-over-v6-safi {
  value 67;
  description
    "IPv4 over IPv6 SAFI.";
}

enum v6-over-v4-safi {
  value 68;
  description
    "IPv6 over IPv4 SAFI.";
}

enum l1-vpn-auto-discovery-safi {
  value 69;
  description
    "Layer 1 VPN Auto-Discovery SAFI.";
}

enum evpn-safi {
  value 70;
  description
    "Ethernet VPN (EVPN) SAFI.";
}
```

```
enum bgp-ls-safi {
  value 71;
  description
    "BGP-LS SAFI.";
}

enum bgp-ls-vpn-safi {
  value 72;
  description
    "BGP-LS VPN SAFI.";
}

enum sr-te-safi {
  value 73;
  description
    "Segment Routing - Traffic Engineering (SR-TE) SAFI.";
}

enum labeled-vpn-safi {
  value 128;
  description
    "MPLS Labeled VPN SAFI.";
}

enum multicast-mps-vpn-safi {
  value 129;
  description
    "Multicast for BGP/MPLS IP VPN SAFI.";
}

enum route-target-safi {
  value 132;
  description
    "Route Target SAFI.";
}

enum ipv4-flow-spec-safi {
  value 133;
  description
    "IPv4 Flow Specification SAFI.";
}

enum vpnv4-flow-spec-safi {
  value 134;
  description
    "IPv4 VPN Flow Specification SAFI.";
}
```

```
    enum vpn-auto-discovery-safi {
      value 140;
      description
        "VPN Auto-Discovery SAFI.";
    }
  }
  description
    "Enumeration for BGP SAFI.";
  reference
    "RFC 4760: Multiprotocol Extensions for BGP-4.";
}
}
```

<CODE ENDS>

5. IANA Considerations

This document registers the following namespace URIs in the "IETF XML Registry" [RFC3688]:

URI: urn:ietf:params:xml:ns:yang:ietf-routing-types

Registrant Contact: The IESG.

XML: N/A; the requested URI is an XML namespace.

URI: urn:ietf:params:xml:ns:yang:iana-routing-types

Registrant Contact: IANA.

XML: N/A; the requested URI is an XML namespace.

This document registers the following YANG modules in the "YANG Module Names" registry [RFC6020]:

Name: ietf-routing-types
Namespace: urn:ietf:params:xml:ns:yang:ietf-routing-types
Prefix: rt-types
Reference: RFC 8294

Name: iana-routing-types
Namespace: urn:ietf:params:xml:ns:yang:iana-routing-types
Prefix: iana-rt-types
Reference: RFC 8294

5.1. IANA-Maintained iana-routing-types Module

This document defines the initial version of the IANA-maintained iana-routing-types YANG module (Section 4).

The iana-routing-types YANG module is intended to reflect the "Address Family Numbers" registry [IANA-ADDRESS-FAMILY-REGISTRY] and the "Subsequent Address Family Identifiers (SAFI) Parameters" registry [IANA-SAFI-REGISTRY].

IANA has added this note to the "iana-routing-types YANG Module" registry:

Address Families and Subsequent Address Families must not be directly added to the iana-routing-types YANG module. They must instead be respectively added to the "Address Family Numbers" and "Subsequent Address Family Identifiers (SAFI) Parameters" registries.

When an Address Family or Subsequent Address Family is respectively added to the "Address Family Numbers" registry or the "Subsequent Address Family Identifiers (SAFI) Parameters" registry, a new "enum" statement must be added to the iana-routing-types YANG module. The name of the "enum" is the same as the corresponding Address Family or SAFI, except that it will be a valid YANG identifier in all lowercase and with hyphens separating individual words in compound identifiers. The following "enum" statement, and substatements thereof, should be defined:

"enum": Contains the YANG enum identifier for the "address-family" (for Address Families) or "bgp-safi" (for Subsequent Address Families). This may be the same as the "address-family" or "bgp-safi", or it may be a shorter version to facilitate YANG identifier usage.

"value": Contains the IANA-assigned value corresponding to the "address-family" (for Address Families) or "bgp-safi" (for Subsequent Address Families).

"status": Include only if a registration has been deprecated (use the value "deprecated") or obsoleted (use the value "obsolete").

"description": Replicate the description from the registry, if any. Insert line breaks as needed so that the line does not exceed 72 characters.

"reference": Replicate the reference from the registry, if any, and add the title of the document.

Unassigned or reserved values are not present in these modules.

When the iana-routing-types YANG module is updated, a new "revision" statement must be added in front of the existing revision statements.

IANA has added this new note to the "Address Family Numbers" and "Subsequent Address Family Identifiers (SAFI) Parameters" registries:

When this registry is modified, the YANG module iana-routing-types must be updated as defined in RFC 8294.

6. Security Considerations

This document defines common routing type definitions (i.e., typedef statements) using the YANG data modeling language. The definitions themselves have no security or privacy impact on the Internet, but the usage of these definitions in concrete YANG modules might have. The security considerations spelled out in the YANG 1.1 specification [RFC7950] apply for this document as well.

7. References

7.1. Normative References

- [RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <<https://www.rfc-editor.org/info/rfc3688>>.
- [RFC6020] Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <<https://www.rfc-editor.org/info/rfc6020>>.
- [RFC6991] Schoenwaelder, J., Ed., "Common YANG Data Types", RFC 6991, DOI 10.17487/RFC6991, July 2013, <<https://www.rfc-editor.org/info/rfc6991>>.
- [RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <<https://www.rfc-editor.org/info/rfc7950>>.

- [IANA-ADDRESS-FAMILY-REGISTRY]
"IANA Address Family Numbers Registry",
<[https://www.iana.org/assignments/
address-family-numbers/](https://www.iana.org/assignments/address-family-numbers/)>.
- [IANA-SAFI-REGISTRY]
"IANA Subsequent Address Family Identifiers (SAFI)
Parameters Registry",
<<https://www.iana.org/assignments/safi-namespace/>>.

7.2. Informative References

- [IEEE754] IEEE, "IEEE Standard for Floating-Point Arithmetic",
IEEE 754-2008, DOI 10.1109/IEEESTD.2008.4610935.
- [BGP-Model]
Shaikh, A., Ed., Shakir, R., Ed., Patel, K., Ed., Hares,
S., Ed., D'Souza, K., Bansal, D., Clemm, A., Zhdankin, A.,
Jethanandani, M., and X. Liu, "BGP Model for Service
Provider Networks", Work in Progress,
draft-ietf-idr-bgp-model-02, July 2016.
- [OSPF-YANG]
Yeung, D., Qu, Y., Zhang, J., Chen, I., and A. Lindem,
"Yang Data Model for OSPF Protocol", Work in Progress,
draft-ietf-ospf-yang-09, October 2017.
- [PIM-YANG] Liu, X., McAllister, P., Peter, A., Sivakumar, M., Liu,
Y., and F. Hu, "A YANG data model for Protocol-Independent
Multicast (PIM)", Work in Progress,
draft-ietf-pim-yang-12, December 2017.
- [TE-YANG] Saad, T., Ed., Gandhi, R., Liu, X., Beeram, V., Shah, H.,
and I. Bryskin, "A YANG Data Model for Traffic Engineering
Tunnels and Interfaces", Work in Progress,
draft-ietf-teas-yang-te-09, October 2017.
- [L2VPN-YANG]
Shah, H., Ed., Brissette, P., Ed., Chen, I., Ed., Hussain,
I., Ed., Wen, B., Ed., and K. Tiruveedhula, Ed., "YANG
Data Model for MPLS-based L2VPN", Work in Progress,
draft-ietf-bess-l2vpn-yang-07, September 2017.
- [MPLS-Base-YANG]
Saad, T., Raza, K., Gandhi, R., Liu, X., Beeram, V., Shah,
H., Bryskin, I., Chen, X., Jones, R., and B. Wen, "A YANG
Data Model for MPLS Base", Work in Progress,
draft-ietf-mppls-base-yang-05, July 2017.

- [RFC3032] Rosen, E., Tappan, D., Fedorkow, G., Rekhter, Y., Farinacci, D., Li, T., and A. Conta, "MPLS Label Stack Encoding", RFC 3032, DOI 10.17487/RFC3032, January 2001, <<https://www.rfc-editor.org/info/rfc3032>>.
- [RFC3209] Awduche, D., Berger, L., Gan, D., Li, T., Srinivasan, V., and G. Swallow, "RSVP-TE: Extensions to RSVP for LSP Tunnels", RFC 3209, DOI 10.17487/RFC3209, December 2001, <<https://www.rfc-editor.org/info/rfc3209>>.
- [RFC3471] Berger, L., Ed., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description", RFC 3471, DOI 10.17487/RFC3471, January 2003, <<https://www.rfc-editor.org/info/rfc3471>>.
- [RFC4364] Rosen, E. and Y. Rekhter, "BGP/MPLS IP Virtual Private Networks (VPNs)", RFC 4364, DOI 10.17487/RFC4364, February 2006, <<https://www.rfc-editor.org/info/rfc4364>>.
- [RFC4664] Andersson, L., Ed., and E. Rosen, Ed., "Framework for Layer 2 Virtual Private Networks (L2VPNs)", RFC 4664, DOI 10.17487/RFC4664, September 2006, <<https://www.rfc-editor.org/info/rfc4664>>.
- [RFC5701] Rekhter, Y., "IPv6 Address Specific BGP Extended Community Attribute", RFC 5701, DOI 10.17487/RFC5701, November 2009, <<https://www.rfc-editor.org/info/rfc5701>>.
- [RFC5880] Katz, D. and D. Ward, "Bidirectional Forwarding Detection (BFD)", RFC 5880, DOI 10.17487/RFC5880, June 2010, <<https://www.rfc-editor.org/info/rfc5880>>.
- [RFC7274] Kompella, K., Andersson, L., and A. Farrel, "Allocating and Retiring Special-Purpose MPLS Labels", RFC 7274, DOI 10.17487/RFC7274, June 2014, <<https://www.rfc-editor.org/info/rfc7274>>.
- [RFC7432] Sajassi, A., Ed., Aggarwal, R., Bitar, N., Isaac, A., Uttaro, J., Drake, J., and W. Henderickx, "BGP MPLS-Based Ethernet VPN", RFC 7432, DOI 10.17487/RFC7432, February 2015, <<https://www.rfc-editor.org/info/rfc7432>>.

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Authors' Addresses

Xufeng Liu
Jabil
8281 Greensboro Drive, Suite 200
McLean, VA 22102

United States of America
Email: Xufeng_Liu@jabil.com

Yingzhen Qu
Futurewei Technologies, Inc.
2330 Central Expressway
Santa Clara, CA 95050
United States of America

Email: yingzhen.qu@huawei.com

Acee Lindem
Cisco Systems
301 Midenhall Way
Cary, NC 27513
United States of America

Email: acee@cisco.com

Christian Hopps
Deutsche Telekom

Email: chopps@chopps.org

Lou Berger
LabN Consulting, L.L.C.

Email: lberger@labn.net