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IP MIB for IP Fast-Reroute
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Abstract

This draft defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects relevant for IP routes using IP Fast-Reroute [RFC5714]

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

Status of This Memo

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

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1. Introduction

This document defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it defines the managed objects used for IP routes and interfaces in relation to IP Fast-Reroute. This document uses terminology from [RFC5714] and [RFC5286].

Current work is underway to define mechanisms for determining alternate paths for traffic to use when the original path becomes unavailable due to a local failure. The alternate next-hops can be computed in the context of any IGP.

There are certain configuration attributes for IP Fast-Reroute that should be configured to enable IP Fast Reroute in the context of the IGP. These configuration attributes of IP Fast-Reroute are not covered by this MIB module. Examples include whether IP Fast-Reroute is enabled on a network region (i.e. an OSPF area or IS-IS level) and the desired local hold-down timer [RFC5286], whose proper value is dependent upon the size of the network region.

It is possible for traffic other than IP to depend upon and use the alternate next-hops computed by IP Fast-Reroute. An example would be MPLS traffic whose path is configured via LDP [RFC5036]. The additional details (for example, outgoing MPLS label) pertaining to alternate next-hops that are required by such traffic are not covered by this MIB module.

An IP route may be reachable via multiple primary next-hops which provide equal-cost paths. Where IP Fast-Reroute is enabled, each primary next-hop will be protected by one or more alternate next-hops. Such an alternate next-hop may itself be a primary next-hop.

1.1. The SNMP Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to section 7 of [RFC3410].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIv2, which is described in STD 58, [RFC2578], STD 58, [RFC2579] and STD 58, [RFC2580].

2. Brief description of MIB Objects

2.1. ipFrrProtectStats Group

The global objects in this group provide summary information related to protection for all IP routes. The information available includes counts of all routes, of all protected routes, of all unprotected routes, of all routes which are protected against a link failure, and of all routes which are protected against a node failure.

2.2. ipFrrInstanceTable

The ipFrrInstanceTable provides information about configuration of IP FRR instantiations on a node. A single node may have multiple instances of IP FRR using different algorithms or protocols.

2.3. ipFrrIfTable

The ipFrrIfTable provides information about configuration of interfaces for IPFRR.

2.4. ipFrrProtectStatsTable

The ipFrrProtectStatsTable complements the ipFrrProtectStats group by providing statistics per IP FRR instance.

2.5. ipFrrAltTable

The ipFrrAltTable extends the inetCidrRouteTable [RFC4292] to provide information about each alternate next-hop associated with a primary next-hop used by a route. Statically configured alternate next-hops associated with primary next-hops can be created.

2.6. ipFrrNoAltTable

The ipFrrNoAltTable extends the inetCidrRouteTable [RFC4292] to provide information about the routes which do not have an alternate next-hop associated with any of the route's primary next-hop. The entry provides an explanation for the lack of protection.

3. IP Fast-Reroute MIB Module Definitions

```
IPFRR-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY,
    OBJECT-TYPE,
    Gauge32,
    Integer32             FROM SNMPv2-SMI          -- [RFC2578]

    RowStatus
                          FROM SNMPv2-TC           -- [RFC2579]

    MODULE-COMPLIANCE,
    OBJECT-GROUP          FROM SNMPv2-CONF         -- [RFC2580]

    InetAddressType,
    InetAddress           FROM INET-ADDRESS-MIB    -- [RFC4001]
```

```
        ifIndex, InterfaceIndex        FROM IF-MIB              -- [RFC2863]

        ip                     FROM IP-MIB              -- [RFC4293]

        inetCidrRouteDestType,
        inetCidrRouteDest,
        inetCidrRoutePfxLen,
        inetCidrRoutePolicy,
        inetCidrRouteNextHopType,
        inetCidrRouteNextHop FROM IP-FORWARD-MIB
                             --  [RFC4292]


        IANAipRouteProtocol FROM IANA-RTPROTO-MIB



    ;

    ipFrrMIB MODULE-IDENTITY
        LAST-UPDATED "201405261200Z" -- May 26, 2014
        ORGANIZATION "draft-ietf-ipfrr-ip-mib-03.txt"
        CONTACT-INFO
                "
                        A S Kiran Koushik
                        Cisco Systems Inc.
                  EMail: kkoushik@cisco.com

                        John W Flick
                        Hewlett Packard Company
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                        Juniper Networks
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                         Stephane Litkowski
                         Orange Business Service
                  Email: stephane.litkowski@orange.com

                "
        DESCRIPTION
                "IP MIB module for management of IP Fast-Reroute.

                Copyright (C) The Internet Society (date).
                This version of this MIB module is part of
                draft-ietf-rtgwg-ipfrr-ip-mib-03.txt"
        REVISION      "201406131200Z" -- Jun 13, 2014
```

```
          DESCRIPTION
                "Add ipFrrTunnelType in ipFrrAltEntry
                Modify ipFrrAltType"
          REVISION      "201405261200Z" -- May 26, 2014
          DESCRIPTION
                 "Add ipFrrInstanceTable.
                  Add ipFrrIfTable.
                  ipFrrProtectStatsTable complements ipFrrProtectStats to have
statistics per instance.
                  Add ipFrrAltMetric2, ipFrrAltMetric3, ipFrrAltBest,
ipFrrAltNonBestReason to ipFrrAltEntry.
                  Add integer values to ipFrrAltType.
                  Add integer values to ipFrrAltProtectionAvailable.
                  Changed attachement of ipFrrAltStatus in ipFrrAltEntry.
                  Added IPv6 objects in ipFrrProtectStats."
          REVISION      "201203131200Z" -- Mar 13, 2012
          DESCRIPTION
                 "Editorial changes. Added new type to ipFrrAltType."
          REVISION      "200502181200Z"  -- February 18, 2005
          DESCRIPTION
                 "Add Set operations on ipFrrAltTable"
          REVISION     "200502131200Z" -- February 13, 2005
          DESCRIPTION
                  "Initial version."
          ::= {  ip ZZZ } -- To be assigned by IANA


      -- Top level components of this MIB module.

      ipFrrMIBObjects OBJECT IDENTIFIER ::= { ipFrrMIB 1 }

      ipFrrProtectStats OBJECT IDENTIFIER ::= { ipFrrMIBObjects 1 }

      -- the IP FRR MIB-Group

      -- A collection of objects providing summarized information
      -- about the protection availability and type of alternate paths
      -- provided by IP Fast-Reroute mechanisms.

      ipFrrTotalRoutes    OBJECT-TYPE
          SYNTAX     Gauge32
          MAX-ACCESS read-only
          STATUS     current
          DESCRIPTION
                  "The number of IPv4 valid routes known by this entity."
          ::= { ipFrrProtectStats 1 }

      ipFrrUnprotectedRoutes    OBJECT-TYPE
          SYNTAX     Gauge32
```

MAX-ACCESS read-only

```
        STATUS     current
        DESCRIPTION
               "The number of IPv4 valid routes known by this entity
                which do not have an alternate next-hop associated
                with any primary next-hop."
        ::= { ipFrrProtectStats 2 }

    ipFrrProtectedRoutes    OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
               "The number of IPv4 routes known by this entity
                which have at least one alternate next-hop."
        ::= { ipFrrProtectStats 3 }

    ipFrrLinkProtectedRoutes OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The number of IPv4 routes known by this entity
                 for which all alternate next-hops provide link
                 protection for their associated primary next-hops."
        ::= { ipFrrProtectStats 4 }

    ipFrrNodeProtectedRoutes OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
               "The number of IPv4 routes known by this entity
                for which all alternate next-hops provide node
                protection for their associated primary next-hops."
        ::= { ipFrrProtectStats 5 }

    ipv6FrrTotalRoutes    OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The number of IPv6 valid routes known by this entity."
        ::= { ipFrrProtectStats 6 }

    ipv6FrrUnprotectedRoutes    OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
```

```
        DESCRIPTION
               "The number of IPv6 valid routes known by this entity
                which do not have an alternate next-hop associated
                with any primary next-hop."
        ::= { ipFrrProtectStats 7 }

    ipv6FrrProtectedRoutes    OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
               "The number of IPv6 routes known by this entity
                which have at least one alternate next-hop."
        ::= { ipFrrProtectStats 8 }

    ipv6FrrLinkProtectedRoutes OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The number of IPv6 routes known by this entity
                 for which all alternate next-hops provide link
                 protection for their associated primary next-hops."
        ::= { ipFrrProtectStats 9 }

    ipv6FrrNodeProtectedRoutes OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
               "The number of IPv6 routes known by this entity
                for which all alternate next-hops provide node
                protection for their associated primary next-hops."
        ::= { ipFrrProtectStats 10 }

    -- the IP FRR instance MIB-group
    --
    -- The ipFrrInstanceTable provides detail on current IPFRR
    -- instances activated on the node

    ipFrrInstanceTable OBJECT-TYPE
        SYNTAX     SEQUENCE OF IpFrrInstanceEntry
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
               "This entity's IP Fast Reroute Instance table."
        ::= { ipFrrMIBObjects 4 }
```

```
      ipFrrInstanceEntry OBJECT-TYPE
          SYNTAX     IpFrrInstanceEntry
          MAX-ACCESS not-accessible
          STATUS     current
          DESCRIPTION
                "An entry containing information on a particular
                IP FRR instance on the node."

          INDEX { ipFrrInstanceId
                }
          ::= { ipFrrInstanceTable 1 }

       IpFrrInstanceEntry ::= SEQUENCE {
          ipFrrInstanceId                       INTEGER,
          ipFrrInstanceProtocol                 IANAipRouteProtocol,
          ipFrrInstanceAlgorithm                Integer32,
          ipFrrInstancePerPrefixComputation     INTEGER,
          ipFrrInstanceRowStatus                    RowStatus
      }

       ipFrrInstanceId OBJECT-TYPE
          SYNTAX     Integer32 (1..255)
          MAX-ACCESS not-accessible
          STATUS     current
          DESCRIPTION
                "This object specifies an identificator a of particular IPFRR
instance. "
          ::= { ipFrrInstanceEntry 1 }

       ipFrrInstanceProtocol OBJECT-TYPE
          SYNTAX     IANAipRouteProtocol
          MAX-ACCESS read-create
          STATUS     current
          DESCRIPTION
                "This object specifies the protocol used by the IPFRR
instance."
          ::= { ipFrrInstanceEntry 2 }

       ipFrrInstanceAlgorithm OBJECT-TYPE
          SYNTAX     INTEGER {
                        loopFree(1),
                        loopFreeRemote(2),
                        loopFreeTI(3),
                        mrt(4)
                     }
          MAX-ACCESS read-create
          STATUS     current
          DESCRIPTION
```

```
                "This object specifies the algorithm used by the IPFRR
instance."
          ::= { ipFrrInstanceEntry 3 }
```

```
       ipFrrInstancePerPrefixComputation OBJECT-TYPE
          SYNTAX     INTEGER {
                        false(0),
                        true(1)
                      }
          MAX-ACCESS read-create
          STATUS     current
          DESCRIPTION
                "This object specifies if per prefix computation is used."
          ::= { ipFrrInstanceEntry 4 }

        ipFrrInstanceRowStatus OBJECT-TYPE
          SYNTAX     RowStatus
          MAX-ACCESS read-create
          STATUS     current
          DESCRIPTION
                "."
          ::= { ipFrrInstanceEntry 5 }


      -- the IP FRR Interface MIB-Group
      --
      -- ipFrrIfTable provides information on configuration
      -- of interfaces for IPFRR


      ipFrrIfTable OBJECT-TYPE
          SYNTAX     SEQUENCE OF IpFrrIfEntry
          MAX-ACCESS not-accessible
          STATUS     current
          DESCRIPTION
                 "This entity's IP Fast Reroute Alternates Interface
configuration table."
          ::= { ipFrrMIBObjects 5 }

      ipFrrIfEntry OBJECT-TYPE
          SYNTAX    IpFrrIfEntry
          MAX-ACCESS not-accessible
          STATUS     current
          DESCRIPTION
                "An entry containing information on a particular instance of an
IPFRR interface."

          INDEX { ipFrrInstanceId,
                  ifIndex
                }
          ::= { ipFrrIfTable 1 }

      IpFrrIfEntry ::= SEQUENCE {
```

```
            ipFrrIfProtectionType           BITS,
```

```
            ipFrrIfCandidate               INTEGER,
            ipFrrIfRowStatus                   RowStatus
      }


      ipFrrIfProtectionType OBJECT-TYPE
          SYNTAX     BITS {
                        nodeProtect(0),
                        linkProtect(1),
                        nodelinkProtect(2)
                     }
          MAX-ACCESS read-create
          STATUS     current
          DESCRIPTION
                "This object specifies the scope of protection requested for
the protection of the destinations.
                 nodeProtect means node protection only compared to
nodelinkProtect which means node protection
                 if available and link protection if not available. "
          ::= { ipFrrIfEntry 1 }

       ipFrrIfCandidate OBJECT-TYPE
          SYNTAX     INTEGER {
                        false (0),
                        true (1)

                     }
          MAX-ACCESS read-create
          STATUS     current
          DESCRIPTION
                "This object specifies the scope of protection requested for
the protection of the destinations.
                 nodeProtect means node protection only compared to
nodelinkProtect which means node protection
                 if available and link protection if not available. "
          ::= { ipFrrIfEntry 2 }

       ipFrrIfRowStatus OBJECT-TYPE
          SYNTAX     RowStatus
          MAX-ACCESS read-create
          STATUS     current
          DESCRIPTION
                "."
          ::= { ipFrrIfEntry 3 }


      -- the IP FRR Stats MIB-Group
      --
```

```
    -- ipFrrProtectStatsTable provides provides
    -- protection availability and type of alternate paths
    -- provided by IP Fast-Reroute mechanisms per IPFRR instance.
```

```
      ipFrrProtectStatsTable OBJECT-TYPE
          SYNTAX     SEQUENCE OF IpFrrProtectStatsEntry
          MAX-ACCESS not-accessible
          STATUS     current
          DESCRIPTION
                 "This entity's IP Fast Reroute Alternates statistics table."
          ::= { ipFrrMIBObjects 6 }

      ipFrrProtectStatsEntry OBJECT-TYPE
          SYNTAX     IpFrrProtectStatsEntry
          MAX-ACCESS not-accessible
          STATUS     current
          DESCRIPTION
                "An entry containing information on a particular instance of
IPFRR.

                 ."

          INDEX { ipFrrInstanceId
                }
          ::= { ipFrrProtectStatsTable 1 }

      IpFrrProtectStatsEntry ::= SEQUENCE {
            ipFrrStatsTotalRoutes       Gauge32,
            ipFrrStatsUnprotectedRoutes     Gauge32,
            ipFrrStatsProtectedRoutes       Gauge32,
            ipFrrStatsLinkProtectedRoutes       Gauge32,
            ipFrrStatsNodeProtectedRoutes       Gauge32,
            ipv6FrrStatsTotalRoutes     Gauge32,
            ipv6FrrStatsUnprotectedRoutes       Gauge32,
            ipv6FrrStatsProtectedRoutes     Gauge32,
            ipv6FrrStatsLinkProtectedRoutes     Gauge32,
            ipv6FrrStatsNodeProtectedRoutes     Gauge32
      }

            ipFrrStatsTotalRoutes    OBJECT-TYPE
          SYNTAX     Gauge32
          MAX-ACCESS read-only
          STATUS     current
          DESCRIPTION
                  "The number of valid routes known by this entity."
          ::= { ipFrrProtectStatsEntry 1 }

      ipFrrStatsUnprotectedRoutes    OBJECT-TYPE
          SYNTAX     Gauge32
          MAX-ACCESS read-only
          STATUS     current
          DESCRIPTION
```

"The number of valid routes known by this entity

```
                which do not have an alternate next-hop associated
                with any primary next-hop."
        ::= { ipFrrProtectStatsEntry 2 }

    ipFrrStatsProtectedRoutes    OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
               "The number of routes known by this entity
                which have at least one alternate next-hop."
        ::= { ipFrrProtectStatsEntry 3 }

    ipFrrStatsLinkProtectedRoutes OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The number of routes known by this entity
                 for which all alternate next-hops provide link
                 protection for their associated primary next-hops."
        ::= { ipFrrProtectStatsEntry 4 }

    ipFrrStatsNodeProtectedRoutes OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
               "The number of routes known by this entity
                for which all alternate next-hops provide node
                protection for their associated primary next-hops."
        ::= { ipFrrProtectStatsEntry 5 }

     ipv6FrrStatsTotalRoutes    OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The number of valid IPv6 routes known by this entity."
        ::= { ipFrrProtectStatsEntry 6 }

    ipv6FrrStatsUnprotectedRoutes    OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
               "The number of valid IPv6 routes known by this entity
                which do not have an alternate next-hop associated
```

```
                with any primary next-hop."
        ::= { ipFrrProtectStatsEntry 7 }

    ipv6FrrStatsProtectedRoutes    OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
               "The number of IPv6 routes known by this entity
                which have at least one alternate next-hop."
        ::= { ipFrrProtectStatsEntry 8 }

    ipv6FrrStatsLinkProtectedRoutes OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The number of IPv6 routes known by this entity
                 for which all alternate next-hops provide link
                 protection for their associated primary next-hops."
        ::= { ipFrrProtectStatsEntry 9 }

    ipv6FrrStatsNodeProtectedRoutes OBJECT-TYPE
        SYNTAX     Gauge32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
               "The number of IPv6 routes known by this entity
                for which all alternate next-hops provide node
                protection for their associated primary next-hops."
        ::= { ipFrrProtectStatsEntry 10 }


    -- the IP FRR Alternate MIB-Group
    --
    -- The ipFrrAltTable extends the inetCidrRouteTable to indicate
    -- the alternate next-hop(s) associated with each primary
    -- next-hop.  The additional indices (ipFrrAltNextHopType and
    -- ipFrrAltNextHop ) allow for multiple alternate paths for a
    -- given primary next-hop.

    ipFrrAltTable OBJECT-TYPE
        SYNTAX     SEQUENCE OF IpFrrAltEntry
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
               "This entity's IP Fast Reroute Alternates table."
        ::= { ipFrrMIBObjects 2 }
```

```
      ipFrrAltEntry OBJECT-TYPE
          SYNTAX     IpFrrAltEntry
          MAX-ACCESS not-accessible
          STATUS     current
          DESCRIPTION
                "An entry containing information on a particular route,
                 one of its particular (primary) next-hops and one of
                 the associated alternate next-hops.

                 Implementers need to be aware that if the total
                 number of elements (octets or sub-identifiers) in
                 inetCidrRouteDest, inetCidrRoutePolicy,
                 inetCidrRouteNextHop, and ipFrrAltNextHop exceeds 107
                 then OIDs of column instances in this table will have
                 more than 128 sub-identifiers and cannot be accessed
                 using SNMPv1, SNMPv2c, or SNMPv3."

          INDEX { inetCidrRouteDestType,
                  inetCidrRouteDest,
                  inetCidrRoutePfxLen,
                  inetCidrRoutePolicy,
                  inetCidrRouteNextHopType,
                  inetCidrRouteNextHop,
                  ipFrrAltNextHopType,
                  ipFrrAltNextHop
                }
          ::= { ipFrrAltTable 1 }

      IpFrrAltEntry ::= SEQUENCE {
          ipFrrAltNextHopType             InetAddressType,
          ipFrrAltNextHop                 InetAddress,
          ipFrrAltIfIndex                 InterfaceIndex,
          ipFrrAltType                    INTEGER,
          ipFrrTunnelType                 INTEGER,
          ipFrrAltProtectionAvailable     BITS,
          ipFrrAltMetric1                 Integer32,
          ipFrrAltMetric2                 Integer32,
          ipFrrAltMetric3                 Integer32,
          ipFrrAltBest                    INTEGER,
          ipFrrAltNonBestReason           OCTET STRING,
          ipFrrAltStatus                  RowStatus
      }

      ipFrrAltNextHopType OBJECT-TYPE
          SYNTAX     InetAddressType
          MAX-ACCESS not-accessible
          STATUS     current
          DESCRIPTION
```

```
                "The type of the ipFrrNextHop address, as defined
                 in the InetAddress MIB.

                 Only those address types that may appear in an actual
                 routing table are allowed as values of this object."
            REFERENCE "RFC 4001"
            ::= { ipFrrAltEntry 1 }

        ipFrrAltNextHop OBJECT-TYPE
            SYNTAX     InetAddress
            MAX-ACCESS not-accessible
            STATUS     current
            DESCRIPTION
                   "The address of the next system along the alternate
                    route.

                    The type of this address is determined by the value
                    of the ipFrrAltNextHopType."
            ::= { ipFrrAltEntry 2 }

        ipFrrAltIfIndex OBJECT-TYPE
            SYNTAX     InterfaceIndex
            MAX-ACCESS read-create
            STATUS     current
            DESCRIPTION
                   "The ifIndex value which identifies the local
                    interface through which the next hop of this
                    alternate route should be reached."
            ::= { ipFrrAltEntry 3 }

        ipFrrAltType OBJECT-TYPE
            SYNTAX   INTEGER {
                        other             (1), -- type not defined
                        equalCost         (2), -- primary path
                        loopFree          (3), -- loop free alternate
                        loopFreeRemote    (4), -- remote loop free alternate
                        loopFreeNH        (5), -- loop free alternate using a
configured tunnel toward the nexthop
                        loopFreeNNH       (6), -- loop free alternate using a
configured tunnel toward the nextnexthop
                        loopFreeTI        (7), -- loop free alternate using
topology independent algorithm
                        mrt               (8)  -- Maximally Redundant Trees
                     }
            MAX-ACCESS read-create
            STATUS   current
            DESCRIPTION
                   "The type of alternate which is provided by the
```

alternate next-hop. The supported types are as follows:

```
                equalCost : The alternate next-hop is another
                            primary next-hop.

                loopFreeConnected : loop free alternate (LFA as described in
RFC5286)

                loopFreeRemote : remote LFA (as described in draft-ietf-
rtgwg-remote-lfa)

                loopFreeNH : loop free alternate using a configured tunnel
toward the nexthop (link protection only)

                loopFreeNNH : loop free alternate using a configured tunnel
toward the nextnexthop (node protection)

                loopFreeTI : loop free alternate using topology independent
algorithm

                other : The mechanism by which the alternate next-hop
                        can be used is not specified.

                MRT : Maximally Redundant Trees, where each
                      destination has two MRTs associated with it.
                      These two trees are referred as blue and red
                      MRTs.
                      See draft-ietf-rtgwg-mrt-frr-architecture-00.
                "
          ::= { ipFrrAltEntry 4 }

        ipFrrTunnelType OBJECT-TYPE
          SYNTAX   INTEGER {
                      none              (1), -- No tunnel used
                      other             (2), -- type not defined
                      LDP               (3), -- LDP tunnel
                      IP                (4), -- IP based tunnel (GRE, IPIP,
L2TP ...)
                      SPRING MPLS       (5), -- SPRING tunnel using MPLS
dataplane
                      SPRING IPv6       (6), -- SPRING tunnel using IPv6
dataplane
                      RSVP-TE           (7), -- RSVP-TE tunnel
                      MULTI-TOPOLOGY LDP(8)  -- LDP tunnel on another topology
                    }
          MAX-ACCESS read-create
          STATUS   current
          DESCRIPTION
                 "The type of tunnel used to reach the alternate.
                 The supported types are as follows:
```

none : No tunnel used

LDP : use LDP tunnel to reach the alternate (typically the case of rLFA)

IP : use IP based tunnel to reach the alternate

SPRING MPLS or SPRING IPv6 : use SPRING based tunnel (typically the case of TI-LFA)

RSVP-TE : use a RSVP-TE LSP to reach the alternate

MULTI-TOPOLOGY LDP : use an LDP tunnel based on another topology (typically the case of MRT)

```
                 "
        ::= { ipFrrAltEntry 5 }

    ipFrrAltProtectionAvailable OBJECT-TYPE
        SYNTAX     BITS {
                      nodeProtect(0),
                      linkProtect(1),
                      srlgProtect(2),
                      downstreamProtect(3),
                      unknownProtection(4)
                   }
        MAX-ACCESS read-create
        STATUS     current
        DESCRIPTION
              "This object specifies the scope of protection for
               which this alternate next-hop can provide failure
               protection.  The alternate next-hop should provide
               one or more of node-protection and link-protection.
               If the protection provided by the alternate next-hop
               is unknown, then only unknownProtection should be
               specified.  Specifying uknownProtection with any
               other type of protection is not supported. "
        ::= { ipFrrAltEntry 6 }

    ipFrrAltMetric1 OBJECT-TYPE
        SYNTAX     Integer32
        MAX-ACCESS read-create
        STATUS     current
        DESCRIPTION
                "This is the primary routing metric for this
                 alternate path to the destination IP address.
                 If the alternate path metric is unknown, the value
                 should be set to -1."
        ::= { ipFrrAltEntry 7 }

     ipFrrAltMetric2 OBJECT-TYPE
        SYNTAX     Integer32
        MAX-ACCESS read-create
        STATUS     current
        DESCRIPTION
                "This is the primary routing metric for this
                 alternate path from the PLR to the alternate.
```

If the alternate path metric is unknown, the value

```
                should be set to -1."
          ::= { ipFrrAltEntry 8 }

       ipFrrAltMetric3 OBJECT-TYPE
          SYNTAX     Integer32
          MAX-ACCESS read-create
          STATUS     current
          DESCRIPTION
                  "This is the primary routing metric for this
                   alternate path from the alternate to the destination.
                   If the alternate path metric is unknown, the value
                   should be set to -1."
          ::= { ipFrrAltEntry 9 }

       ipFrrAltBest OBJECT-TYPE
          SYNTAX     INTEGER { false(0), true(1) }
          MAX-ACCESS read-create
          STATUS     current
          DESCRIPTION
                  "This object provides information if the alternate is the
best one."
          ::= { ipFrrAltEntry 10 }

       ipFrrAltNonBestReason OBJECT-TYPE
          SYNTAX     OCTET STRING (SIZE (0..255))
          MAX-ACCESS read-create
          STATUS     current
          DESCRIPTION
                  "This object provides reason why an alternate is not the best
one."
          ::= { ipFrrAltEntry 11 }

      ipFrrAltStatus OBJECT-TYPE
       SYNTAX   RowStatus
       MAX-ACCESS read-create
       STATUS   current
       DESCRIPTION
          "The row status variable, used according to
           row installation and removal conventions."
       ::= { ipFrrAltEntry 12 }

      -- the IP FRR No Alternate MIB-Group
      --
      -- The ipFrrNoAltTable extends the inetCidrRouteTable
      -- to indicate which routes are unprotected and the reason
      -- why.  The indices do not include the primary next-hop because
      -- the lack of protection is for the route.  This allows easy
      -- access to the set of unprotected routes that would be
```

-- affected by a local failure of their primary next-hop.

```
    ipFrrNoAltTable OBJECT-TYPE
        SYNTAX     SEQUENCE OF IpFrrNoAltEntry
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
               "This entity's IP Fast Reroute Unprotected Routes
                table."
        ::= { ipFrrMIBObjects 3 }

    ipFrrNoAltEntry OBJECT-TYPE
        SYNTAX     IpFrrNoAltEntry
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
              "An entry containing the reason why a route does not
               have an alternate next-hop.  The existence of an
               entry for a route indicates that there is no
               alternate next-hop."
        INDEX { inetCidrRouteDestType,
                inetCidrRouteDest,
                inetCidrRoutePfxLen
              }
        ::= { ipFrrNoAltTable 1 }

    IpFrrNoAltEntry ::= SEQUENCE {
        ipFrrNoAltCause           INTEGER
    }

    ipFrrNoAltCause OBJECT-TYPE
        SYNTAX   INTEGER {
                   ipFrrUnavailable  (1), -- No valid alternate(s)
                   localAddress      (2), -- local/internal address
                   ipFrrDisabled     (3), -- Protection not enabled
                   other             (4)  -- unknown or other cause
                 }
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
              "For valid routes without an alternate next-hop, this
               object enumerates the reason why no protection is
               available.  The possibilities are as follows.

               ipFrrUnavailable : The supported IP Fast-Reroute
                                  mechanisms could not find a safe
                                  alternate next-hop.

               localAddress : The route represents a local address.
                         This system is the destination so no
```

```
                        alternate path is possible or necessary.

              ipFrrDisabled : Finding of alternate next-hops is
                              operationally disabled.

              other : The reason is unknown or different from those
                      specifically enumerated possible causes."
        ::= { ipFrrNoAltEntry 1 }

    -- conformance information

    ipFrrMIBConformance
                  OBJECT IDENTIFIER ::= { ipFrrMIB 2 }

    ipFrrMIBCompliances
                  OBJECT IDENTIFIER ::= { ipFrrMIBConformance 1 }

    ipFrrMIBGroups
                  OBJECT IDENTIFIER ::= { ipFrrMIBConformance 2 }

    -- compliance statements

    ipFrrMIBCompliance MODULE-COMPLIANCE
        STATUS  deprecated
        DESCRIPTION
              "Minimum requirements to state conformity
               to this MIB. Supporting only IP v4 addresses
               This is deprecated in favor of
               ipFrrMIBInetCompliance

               There are a number of INDEX objects that cannot be
               represented in the form of OBJECT clauses in SMIv2,
               but for which there are compliance requirements,
               expressed in OBJECT clause form in this description:

       OBJECT      inetCidrRouteDestType
       SYNTAX      InetAddressType { ipv4(1), ipv4z(3) }
       MIN-ACCESS  read-only
       DESCRIPTION
              A (deprecated) complying implementation at this
              level is required to support IPv4 addresses only.
              This compliance level is defined so an
              implementation only needs to support the addresses
              it actually supports on the device.

        OBJECT      inetCidrRouteNextHopType
        SYNTAX      InetAddressType { ipv4(1), ipv4z(3) }
          MIN-ACCESS  read-only
```

```
        DESCRIPTION
               A (deprecated) complying implementation at this
               level is required to support IPv4 addresses only.
               This compliance level is defined so an
               implementation only needs to support the addresses
               it actually supports on the device.

        OBJECT      ipFrrAltNextHopType
        SYNTAX      InetAddressType { ipv4(1), ipv4z(3) }
          MIN-ACCESS  read-only
        DESCRIPTION
               A (deprecated) complying implementation at this
               level is required to support IPv4 addresses only.
               This compliance level is defined so an
               implementation only needs to support the
               addresses it actually supports on the device.
        "
        MODULE  -- this module
        MANDATORY-GROUPS { ipFrrBasicGroup }

       ::= { ipFrrMIBCompliances 1 }


    ipFrrMIBInetCompliance MODULE-COMPLIANCE
        STATUS  current
        DESCRIPTION
                "Full conformity to this MIB."
        MODULE  -- this module
        MANDATORY-GROUPS { ipFrrBasicGroup }

        OBJECT  ipFrrAltStatus
        SYNTAX INTEGER { active(1) }
        WRITE-SYNTAX INTEGER { createAndGo(4), destroy(6) }
        DESCRIPTION
            "Support for createAndWait and notInService is not
             required."

       ::= { ipFrrMIBCompliances 2 }

     ipFrrReadOnlyCompliance MODULE-COMPLIANCE
         STATUS  current
         DESCRIPTION

             "When this MIB is implemented without support for
              read-create (i.e. in read-only mode), then that
              implementation can claim read-only compliance. In that
              case, ipFrrAlt group can be monitored but cannot be
              configured with this MIB."
```

```
            MODULE
            MANDATORY-GROUPS { ipFrrBasicGroup }

            OBJECT  ipFrrAltIfIndex
            MIN-ACCESS  read-only
            DESCRIPTION
                "Write access is not required."

            OBJECT  ipFrrAltType
            MIN-ACCESS  read-only
            DESCRIPTION
                "Write access is not required."

            OBJECT  ipFrrAltProtectionAvailable
            MIN-ACCESS  read-only
            DESCRIPTION
                "Write access is not required."

            OBJECT  ipFrrAltMetric1
            MIN-ACCESS  read-only
            DESCRIPTION
                "Write access is not required."

            OBJECT  ipFrrAltStatus
            MIN-ACCESS  read-only
            DESCRIPTION
                "Write access is not required."

          ::= { ipFrrMIBCompliances 3 }

      -- units of conformance
      ipFrrBasicGroup OBJECT-GROUP
          OBJECTS {ipFrrTotalRoutes,
                   ipFrrUnprotectedRoutes,
                   ipFrrProtectedRoutes,
                   ipFrrLinkProtectedRoutes,
                   ipFrrNodeProtectedRoutes,
                   ipv6FrrTotalRoutes,
                   ipv6FrrUnprotectedRoutes,
                   ipv6FrrProtectedRoutes,
                   ipv6FrrLinkProtectedRoutes,
                   ipv6FrrNodeProtectedRoutes,
                   ipFrrAltIfIndex,
                   ipFrrAltType,
                   ipFrrAltProtectionAvailable,
                   ipFrrAltMetric1,
                   ipFrrAltMetric2,
                   ipFrrAltMetric3,
```

```
                ipFrrAltNonBestReason,
                ipFrrAltBest,
                ipFrrAltStatus,
                ipFrrNoAltCause,
                ipFrrInstanceAlgorithm,
                ipFrrInstanceProtocol,
                ipFrrInstancePerPrefixComputation,
                ipFrrInstanceRowStatus,
                ipFrrIfCandidate,
                ipFrrIfProtectionType,
                ipFrrIfRowStatus,
                ipFrrStatsTotalRoutes,
                ipFrrStatsUnprotectedRoutes,
                ipFrrStatsProtectedRoutes,
                ipFrrStatsLinkProtectedRoutes,
                ipFrrStatsNodeProtectedRoutes,
                ipv6FrrStatsTotalRoutes,
                ipv6FrrStatsUnprotectedRoutes,
                ipv6FrrStatsProtectedRoutes,
                ipv6FrrStatsLinkProtectedRoutes,
                ipv6FrrStatsNodeProtectedRoutes

        }
        STATUS  current
        DESCRIPTION
                "The entire collection of objects defined in
                 this MIB for management of IP Fast Reroute ."
        ::= { ipFrrMIBGroups 1 }

    END
```

4. Security Considerations

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write and/or read-create. Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations. The ipFrrAltTable contains routing and forwarding information that is critical to the operation of the network in the event of a local failure. Allowing unauthenticated write access to this table can compromise the validity of the alternate forwarding information.

Some of the readable objects in this MIB module (i.e. objects with a MAX-ACCESS other than not-accessible) may be considered sensitive or vulnerable in some network environments. It is thus important to

control even GET access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPSec), even then, there is no control as to who on the secure network is allowed to access and GET the objects in this MIB module.

It is RECOMMENDED that implementers consider the security features as provided by the SNMPv3 framework (see [RFC3410], section 8), including full support for the SNMPv3 cryptographic mechanisms (for authentication and privacy).

Further, deployment of SNMP versions prior to SNMPv3 is NOT RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of this MIB module is properly configured to give access to the objects only to those principals (users) that have legitimate rights to indeed GET them.

5. Acknowledgements

The authors would like to acknowledge contributions made by Bill Anderson, Don Fedyk and Bruno Decraene.

6. IANA Considerations

The MIB module in this document uses the following IANA-assigned OBJECT IDENTIFIER value recorded in the SMI Numbers registry.

The IANA is requested to assign { ip ZZZ } to the IPFRR-MIB MIB module specified in this document.

Editor's Note (to be removed prior to publication): the IANA is requested to assign a value for "ZZZ" under the ip subtree and to record the assignments in the SMI Numbers registry. When the assignments have been made, the RFC Editor is asked to replace "ZZZ" (here and in the MIB modules) with the assigned value and to remove this note.

7. References

7.1. Normative References

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7.2. Informative References

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