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                                                       February 20, 2005

                        IP MIB for IP Fast-Reroute
                      draft-atlas-rtgwg-ipfrr-ip-mib-01

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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 [IPFRR].

Table of Contents

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 [FRAMEWORK], [IPFRR] and [IPFRR-UTURN].

   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[IPFRR], 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[RFC3036]. 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
   RFC 3410 [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,
   RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580
   [RFC2580].

2. Brief Description of MIB Objects

   This MIB module consists of five global objects, organized into the
   ipFrrProtectStats group, and two tables.

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 ipFrrAltTable

   The ipFrrAltTable extends the inetCidrRouteTable[RFC2096-update] 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.

2.3 ipFrrNoAltTable

   The ipFrrNoAltTable extends the inetCidrRouteTable[RFC2096-update] 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,
        InetAddressPrefixLength,
        InetAddress        FROM INET-ADDRESS-MIB     -- [RFC3291]

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

        ip                 FROM IP-MIB               -- [RFC2011]

        inetCidrRouteDestType,
        inetCidrRouteDest,
        inetCidrRoutePfxLen,
        inetCidrRoutePolicy,
        inetCidrRouteNextHopType,
        inetCidrRouteNextHop FROM IP-FORWARD-MIB
                             -- [draft-ietf-ipv6-rfc2096-update-07]
    ;

    ipFrrMIB MODULE-IDENTITY
        LAST-UPDATED "200502181200Z" -- February 18, 2005
        ORGANIZATION "draft-atlas-ipfrr-ip-mib-01.txt"
        CONTACT-INFO
                "       Bill Anderson
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                        Avici Systems, Inc.
                  Email: aatlas@avici.com

                        Don Fedyk
```

                         Nortel Networks
                      Email: dwfedyk@nortel.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-atlas-rtgwg-ipfrr-ip-mib-00.txt"

             REVISION   "200502181200Z" -- February 18, 2005
             DESCRIPTION
                   "Add Set operations on ipFrrAltTable"
             REVISION   "200502131200Z" -- February 13, 2005
             DESCRIPTION
                     "Initial version."
             ::= { ip 999 } -- To be assigned by IANA
      -- RFC Ed.: replace 999 with actual RFC number
      -- & remove this note

      -- 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 valid routes known by this entity."
          ::= { ipFrrProtectStats 1 }

      ipFrrUnprotectedRoutes   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."

```
            ::= { ipFrrProtectStats 2 }

    ipFrrProtectedRoutes     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."
        ::= { ipFrrProtectStats 3 }

    ipFrrLinkProtectedRoutes 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."
        ::= { ipFrrProtectStats 4 }

    ipFrrNodeProtectedRoutes 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."
        ::= { ipFrrProtectStats 5 }

    -- 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,
            ipFrrAltProtectionAvailable    BITS,
            ipFrrAltMetric1                Integer32,
            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 3291"
```

```
            ::= { 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
                     uTurn      (4)  -- u-turn alternate
                   }
         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.

                  loopFree : The shortest route to the destination
                               IP address from the alternate next-hop
                               does not traverse this system.

                  uTurn : The alternate next system, which is
                            indicated by the alternate next-hop, has
                            itself a primary path that traverses this
```

```
                          system but also has an alternate next-hop
                          for this route that does not traverse this
                          system.

                  other : The mechanism by which the alternate next-hop
                          can be used is not specified."
             ::= { ipFrrAltEntry 4 }

        ipFrrAltProtectionAvailable OBJECT-TYPE
            SYNTAX     BITS {
                          nodeProtect(0),
                          linkProtect(1),
                          unknownProtection(2)
                       }
            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 5 }

        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 6 }


        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 7 }
```

```
-- 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
                ipFrrUturnDisabled (4), -- Protection not enabled
                other             (5)  -- 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.

                     ipFrrUturnDisabled : Finding of u-turn alternate
                               next-hops is operationally disabled.  No
                               loop-free alternate could be found.

                     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 apsConfigRowStatus
          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,
             ipFrrAltIfIndex,
             ipFrrAltType,
             ipFrrAltProtectionAvailable,
             ipFrrAltMetric1,
             ipFrrAltStatus,
             ipFrrNoAltCause
    }
    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.

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