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Multiprotocol Label Switching (MPLS) Traffic Engineering Management Information Base for Fast Reroute

Abstract

This memo defines a portion of the Management Information Base for use with network management protocols in the Internet community. In particular, it describes managed objects used to support two fast reroute (FRR) methods for Multiprotocol Label Switching (MPLS)-based traffic engineering (TE). The two methods are the one-to-one backup method and the facility backup method.

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 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc6445.

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1. Introduction

This memo defines a portion of the Management Information Base (MIB) containing objects used to manage Multiprotocol Label Switching (MPLS)-based fast rerouting features on MPLS Label Switching Routers (LSRs) as defined in [RFC4090]. The MIB modules defined in this document should be used in conjunction with [RFC3811], [RFC3812], and [RFC3813].

1.1. Conventions Used in This Document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

2. Terminology

This document uses terminology from "Multiprotocol Label Switching Architecture" [RFC3031] and from "Fast Reroute Extensions to RSVP-TE for LSP Tunnels" [RFC4090].

3. The Internet-Standard 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 module 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 MIB modules that are compliant to the SMIv2, which is described in STD 58, RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [RFC2580].

4. Overview of the MIB Modules

[RFC4090] stipulates two different approaches to implementing MPLS TE fast reroute: one-to-one backup and facility backup.

We define three MIB modules to represent the respective components: general, one-to-one backup, and facility backup.

They are:

- MPLS-FRR-GENERAL-STD-MIB: Contains objects that apply to any MPLS LSR implementing MPLS TE fast-reroute functionality.

- MPLS-FRR-ONE2ONE-STD-MIB: Contains objects that apply to the one-to-one backup method.

- MPLS-FRR-FACILITY-STD-MIB: Contains objects that apply to the facility backup method.

Although [RFC4090] specifies that a node is able to support both fast-reroute methods simultaneously, common practice has shown that operators choose to configure either the one-to-one backup method or the facility backup method at any given time. So, by dividing the MIB modules into three, we allow the developers to choose the MIB modules they want to implement, depending on the method supported on that node.

4.1. MPLS-FRR-GENERAL-STD-MIB

This MIB module MUST be implemented if either of the fast-reroute methods is implemented.

4.1.1. mplsFrrConstraintsTable

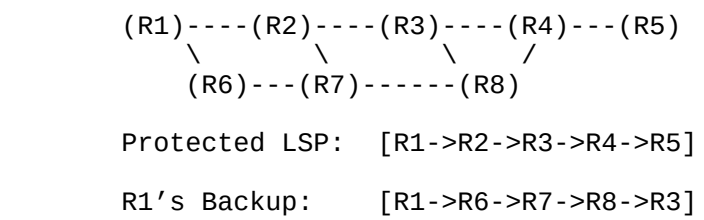
This table contains objects that apply to all LSRs implementing MPLS TE fast-reroute functions. In particular, this table defines fast-reroute constraints, such as bandwidth, for a tunnel instance to be protected by using backup Label Switched Paths (LSPs) (detour LSPs or bypass tunnels).

This table MUST be implemented at the ingress node of the protected TE tunnel instance to configure backup LSP setup constraints.

4.1.2. mplsFrrTunnelARHopTable

This table extends mplsTunnelARHopTable (defined in the MPLS-TE-STD-MIB [RFC3812]) with fast-reroute objects that specify the local protection type or types of availability, as well as what type or types are actually in use for each tunnel hop traversed by a protected TE tunnel.

4.1.3. Example of Relationship between Various Tables of MPLS-FRR-GENERAL-STD-MIB



In the above topology, the various tables on R1 will be populated as indicated below.

```
mplsFrrGeneralConstraintsTable
{
 mplsFrrGeneralConstraintsIfIndexOrZero  = 10,-- interface to protect
 mplsFrrGeneralConstraintsTunnelIndex    = 1, -- protecting tunnel
 mplsFrrGeneralConstraintsTunnelInstance = 0, -- use any instance
 mplsFrrGeneralConstraintsProtectionType = 1, -- linkProtection
 mplsFrrGeneralConstraintsSetupPrio      = 0,
 mplsFrrGeneralConstraintsHoldingPrio     = 0,
 mplsFrrGeneralConstraintsInclAnyAffinity = 0,
 mplsFrrGeneralConstraintsInclAllAffinity = 0,
 mplsFrrGeneralConstraintsExclAnyAffinity = 0,
 mplsFrrGeneralConstraintsHopLimit        = 0,
 mplsFrrGeneralConstraintsBandwidth       = 0, -- best effort
 mplsFrrGeneralConstraintsStorageType     = 2, -- volatile
 mplsFrrGeneralConstraintsRowStatus       = 1, -- active
 };

mplsFrrGeneralTunnelARHopEntry
{
 mplsFrrGeneralTunnelARHopSessionAttributeFlags = 5,
                          -- sestyleDesired | localProtectionDesired
 mplsFrrGeneralTunnelARHopRROSubObjectFlags = 2
                          -- localProtectionInUse
 };
```

4.2. MPLS-FRR-ONE2ONE-STD-MIB

This MIB module MUST be implemented if the one-to-one backup fast-reroute method is implemented.

4.2.1. mplsFrrOne2OnePlrTable

The mplsFrrOne2OnePlrTable contains information about Points of Local Repair (PLRs) that initiated detour LSPs to protect tunnel instances. This table MUST be supported for LSRs implementing the one-to-one backup method. In these cases, the detour LSPs are reflected in the mplsFrrOne2OneDetourTable.

4.2.2. mplsFrrOne2OneDetourTable

The mplsFrrOne2OneDetourTable shows the detour LSPs in each node (ingress, transit, and egress nodes). An entry in this table represents a detour LSP.

Each detour is identified by the following indexes:

- mplsTunnelIndex [RFC3812]: set to the Tunnel ID of an LSP protected by a detour.

- mplsTunnelInstance [RFC3812]: consists of two parts:

    1) the higher 16 bits:
        - protected TE tunnel instance
        - uniquely identifies a protected LSP within a tunnel.

    2) the lower 16 bits:
        - detour instance
        - uniquely identifies a detour LSP of a protected TE tunnel instance. Multiple detours of the same protected LSP may go through the same node. In this case, the higher 16 bits of the tunnel instance object is used as a detour instance.

- ingress node’s LSR ID (mplsFrrOne2OnePlrTunnelIngressLSRId): set to the ingress node of an LSP protected by a detour.

- egress node’s LSR ID (mplsFrrOne2OnePlrTunnelEgressLSRId): set to the egress node of an LSP protected by a detour.

A detour LSP is also considered as an instance of a protected TE tunnel. Therefore, each detour LSP SHOULD have an entry in the mplsTunnelTable (defined in the MPLS-TE-STD-MIB [RFC3812]).

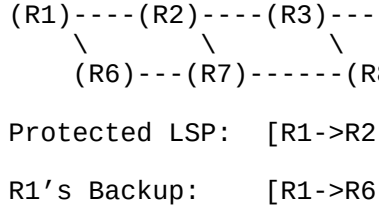
The mplsTunnelTable entries are indexed using mplsTunnelIndex, mplsTunnelInstance, mplsTunnelIngressLSRId, and mplsTunnelEgressLSRId.

Entries where the higher 16 bits of mplsTunnelInstance are set to zero represent detour TE tunnel instances. All other values of the higher 16 bits represent protected tunnel instances.

This table MUST be supported if the one-to-one backup method is used.

4.2.3. Example of Relationship between mplsFrrOne2OnePlrTable, mplsFrrOne2OneDetourTable, and mplsTunnelTable

This section contains an example depicting the interrelationship between mplsFrrOne2OnePlrTable, mplsFrrOne2OneDetourTable, and mplsTunnelTable.



In the above topology, the various tables will be populated as indicated below.

In mplsFrrOne2OnePlrTable:

```
  {
    mplsFrrOne2OnePlrTunnelIndex           = 1,
    mplsFrrOne2OnePlrTunnelDetourInstance  = 6553601,
    --
    -- (100 << 16 | 1) = 6553601
    -- 100 is the tunnel instance of the protected tunnel.
    --
    mplsFrrOne2OnePlrTunnelIngressLSRId    = 192.0.2.1, -- R1
    mplsFrrOne2OnePlrTunnelEgressLSRId     = 192.0.2.5, -- R5
    mplsFrrOne2OnePlrId                    = 192.0.2.1,
                                                    -- R1 is PLR

    mplsFrrOne2OnePlrSenderAddrType        = ipv4(1),
    mplsFrrOne2OnePlrSenderAddr            = "192.0.2.1", -- R1
    mplsFrrOne2OnePlrAvoidNodeAddrType     = ipv4(1),
    mplsFrrOne2OnePlrAvoidNodeAddr         = "192.0.2.2",
                                                    -- R1-R2 (Avoid)
  }
```

```
In mplsFrrOne2OneDetourTable:

{
  mplsFrrOne2OnePlrTunnelIndex           = 1,
  mplsFrrOne2OnePlrTunnelDetourInstance  = 6553601,
  --
  -- (100 << 16 | 1) == 6553601
  --
  -- 1 is mplsTunnelInstance for the detour LSP
  -- from mplsTunnelTable.  Marked by AAA below.
  -- Shift 16 to put this into the high-order bits
  --
  -- 100 is mplsTunnelInstance for the protected tunnel
  -- from the mplsTunnelTable.  Marked by BBB below.
  -- Need to OR the index value into low-order bits)

  -- To get all detour LSPs of a protected tunnel (of instance 100)
  -- we could do an snmpwalk of the mplsFrrOne2OneDetourEntry
  -- where mplsFrrOne2OnePlrTunnelIndex == 1
  -- mplsFrrOne2OnePlrTunnelDetourInstance == 6553600

  -- The first value would be:
  --                 mplsFrrOne2OneDetourActive.1.6553601

  mplsFrrOne2OnePlrTunnelIngressLSRId    = 192.0.2.1, -- R1
  mplsFrrOne2OnePlrTunnelEgressLSRId     = 192.0.2.3, -- R3
  mplsFrrOne2OneDetourActive             = false(2),
  mplsFrrOne2OneDetourMergedStatus       = notMerged(1),
  mplsFrrOne2OneDetourMergedDetourInst   = 0,
}
```

```
In mplsTunnelTable(protected tunnel entry):

{
 mplsTunnelIndex              = 1,
 mplsTunnelInstance           = 100,-- Indicating protected tunnel
                                    -- AAA

 mplsTunnelIngressLSRId       = 192.0.2.1,
 mplsTunnelEgressLSRId        = 192.0.2.5,
 mplsTunnelName               = "R1-R5",
 mplsTunnelDescr              = "R1-R5",
 mplsTunnelIsIf               = true(1),
 mplsTunnelXCPointer          = 0.0,
 mplsTunnelSignallingProto    = none(1),
 mplsTunnelSetupPrio          = 0,
 mplsTunnelHoldingPrio        = 0,
 mplsTunnelSessionAttributes  = 0,
 mplsTunnelLocalProtectInUse  = true(1),
 mplsTunnelResourcePointer    = mplsTunnelResourceMaxRate.5,
 mplsTunnelInstancePriority   = 1,
 mplsTunnelHopTableIndex      = 1,
 mplsTunnelIncludeAnyAffinity = 0,
 mplsTunnelIncludeAllAffinity = 0,
 mplsTunnelExcludeAnyAffinity = 0,
 mplsTunnelPathInUse          = 1,
 mplsTunnelRole               = head(1),
}
```

```
     In mplsTunnelTable (detour LSP entry):

     {
      mplsTunnelIndex             = 1,
      mplsTunnelInstance          = 1,
                             -- Indicating detour LSP (higher 16 bits)
                             -- BBB

      mplsTunnelIngressLSRId      = 192.0.2.1,
      mplsTunnelEgressLSRId       = 192.0.2.3,
      mplsTunnelName              = "R1-R3",
      mplsTunnelDescr             = "R1-R3",
      mplsTunnelIsIf              = true(1),
      mplsTunnelXCPointer         = 0.0,
      mplsTunnelSignallingProto   = none(1),
      mplsTunnelSetupPrio         = 0,
      mplsTunnelHoldingPrio       = 0,
      mplsTunnelSessionAttributes = 0,
      mplsTunnelLocalProtectInUse = false(0),
      mplsTunnelResourcePointer   = mplsTunnelResourceMaxRate.6,
      mplsTunnelInstancePriority  = 1,
      mplsTunnelHopTableIndex     = 1,
      mplsTunnelIncludeAnyAffinity = 0,
      mplsTunnelIncludeAllAffinity = 0,
      mplsTunnelExcludeAnyAffinity = 0,
      mplsTunnelPathInUse         = 1,
      mplsTunnelRole              = head(1),
     }
```

4.3. MPLS-FRR-FACILITY-STD-MIB

This MIB module MUST be implemented if the facility backup fast-reroute method is implemented.

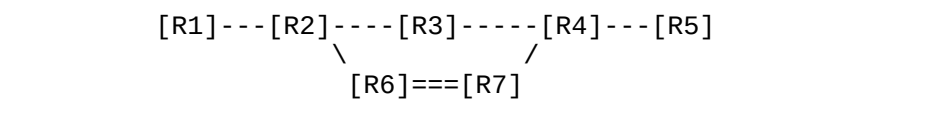
4.3.1. mplsFrrFacilityDBTable

The mplsFrrFacilityDBTable provides information about the fast-reroute database for facility-based fast reroute.

An entry is created in this table for each tunnel being protected by a backup tunnel. Backup tunnels are defined to protect the tunnels traversing an interface.

The protecting tunnel will exist on the PLR as per [RFC4090]. Protected tunnels are the LSPs that traverse the protected link.

4.3.2. Example of Relationship between Various Tables of MPLS-FRR-FACILITY-STD-MIB



Protected LSP 1 : [R1->R2->R3->R4->R5]
Protecting Tunnel 999: [R2->R6->R7->R4]

Facility Backup Technique

In the above topology, the following tables are populated at R2:

```
mplsFrrFacilityDBEntry
    {
       mplsFrrFacilityProtectedIfIndex          = 10,
       mplsFrrFacilityProtectingTunnelIndex     = 999,
       mplsFrrFacilityBackupTunnelIndex         = 1,
       mplsFrrFacilityBackupTunnelInstance      = 0,
       mplsFrrFacilityBackupTunnelIngressLSRId  = 192.0.2.1
                                               -- 192.0.2.1/24
       mplsFrrFacilityBackupTunnelEgressLSRId   = 192.0.2.2
                                               -- 192.0.2.2/24
       mplsFrrFacilityDBNumProtectingTunnelOnIf = 1,
       mplsFrrFacilityDBNumProtectedLspOnIf     = 1,
       mplsFrrFacilityDBNumProtectedTunnels     = 1,
       mplsFrrFacilityDBProtectingTunnelStatus  = 1, -- active
       mplsFrrFacilityDBProtectingTunnelResvBw  = 0,
    };
```

In mplsTunnelTable (protecting tunnel entry):

```
{
 mplsTunnelIndex              = 999, -- protecting tunnel index
 mplsTunnelInstance           = 0,   -- head
 mplsTunnelIngressLSRId       = 192.0.2.2,
 mplsTunnelEgressLSRId        = 192.0.2.4,
 mplsTunnelName               = "R2-R4",
 mplsTunnelDescr              = "R2-R4",
 mplsTunnelIsIf               = true(1),
 mplsTunnelXCPointer          = 0.0,
 mplsTunnelSignallingProto    = none(1),
 mplsTunnelSetupPrio          = 0,
 mplsTunnelHoldingPrio        = 0,
 mplsTunnelSessionAttributes  = 0,
 mplsTunnelLocalProtectInUse  = false(1),
 mplsTunnelResourcePointer    = mplsTunnelResourceMaxRate.5,
 mplsTunnelInstancePriority   = 1,
 mplsTunnelHopTableIndex      = 1,
 mplsTunnelIncludeAnyAffinity = 0,
 mplsTunnelIncludeAllAffinity = 0,
 mplsTunnelExcludeAnyAffinity = 0,
 mplsTunnelPathInUse          = 1,
 mplsTunnelRole               = head(1),
}
```

```
In mplsTunnelTable (protected LSP):

{
 mplsTunnelIndex              = 1,
                         -- protected LSP tunnel index
 mplsTunnelInstance           = 100,
                         -- specific instance protected
 mplsTunnelIngressLSRId       = 192.0.2.1,
 mplsTunnelEgressLSRId        = 192.0.2.5,
 mplsTunnelName               = "R1-R5",
 mplsTunnelDescr              = "R1-R5",
 mplsTunnelIsIf               = false(2),
 mplsTunnelXCPointer          = 0.0,
 mplsTunnelSignallingProto    = none(1),
 mplsTunnelSetupPrio          = 0,
 mplsTunnelHoldingPrio        = 0,
 mplsTunnelSessionAttributes  = 0,
 mplsTunnelLocalProtectInUse  = true(1),
 mplsTunnelResourcePointer    = mplsTunnelResourceMaxRate.6,
 mplsTunnelInstancePriority   = 1,
 mplsTunnelHopTableIndex      = 1,
 mplsTunnelIncludeAnyAffinity = 0,
 mplsTunnelIncludeAllAffinity = 0,
 mplsTunnelExcludeAnyAffinity = 0,
 mplsTunnelPathInUse          = 1,
 mplsTunnelRole               = transit(2),
}
```

5. Handling IPv6 Tunnels

As described in [RFC4990], in order to support IPv6 MPLS tunnels in the mplsTunnelTable [RFC3812], all LSRs in the network MUST have a 32-bit LSR ID that can be used to identify the LSR with the existing mplsTunnelIngressLSRId and mplsTunnelEgressLSRId objects, which are 32 bits long.

In this MIB, the following objects, which refer to ingress/egress LSRs, will therefore have the 32-bit LSR ID to support IPv6 tunnels:

- mplsFrrOne2OnePlrTunnelIngressLSRId and mplsFrrOne2OnePlrTunnelEgressLSRId objects of the mplsFrrOne2OnePlrTable

- mplsFrrOne2OnePlrTunnelIngressLSRId and mplsFrrOne2OnePlrTunnelEgressLSRId objects of the mplsFrrOne2OneDetourTable

- mplsFrrFacilityBackupTunnelIngressLSRId and mplsFrrFacilityBackupTunnelEgressLSRId objects of the mplsFrrFacilityDBTable

6. MIB Module Definitions

6.1. MPLS-FRR-GENERAL-STD-MIB Module Definitions

```
   -- Start of MPLS-FRR-GENERAL-STD-MIB

   MPLS-FRR-GENERAL-STD-MIB DEFINITIONS ::= BEGIN

    IMPORTS
       MODULE-IDENTITY, OBJECT-TYPE, mib-2,
       Unsigned32,
       Counter32
          FROM SNMPv2-SMI                              -- [RFC2578]
       MODULE-COMPLIANCE, OBJECT-GROUP
          FROM SNMPv2-CONF                             -- [RFC2580]
       RowStatus, StorageType
          FROM SNMPv2-TC                               -- [RFC2579]
       InterfaceIndexOrZero,
       ifGeneralInformationGroup,
       ifCounterDiscontinuityGroup

          FROM IF-MIB                                  -- [RFC2863]
       MplsTunnelIndex, MplsTunnelInstanceIndex,
       MplsBitRate,
       MplsTunnelAffinity
          FROM MPLS-TC-STD-MIB                         -- [RFC3811]
       mplsTunnelGroup, mplsTunnelScalarGroup,
       mplsTunnelARHopListIndex, mplsTunnelARHopIndex
          FROM MPLS-TE-STD-MIB                         -- [RFC3812]
       ;

    mplsFrrGeneralMIB MODULE-IDENTITY
       LAST-UPDATED
          "201111030000Z" -- 03 Nov 2011 00:00:00 GMT
       ORGANIZATION
          "Multiprotocol Label Switching (MPLS) Working Group"
       CONTACT-INFO
            "
                    Riza Cetin
              Email: riza.cetin@alcatel.be

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```

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                A S Kiran Koushik
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          "

      DESCRIPTION
        "Copyright (c) 2011 IETF Trust and the persons
         identified as authors of the code.  All rights
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         IETF Documents
         (http://trustee.ietf.org/license-info).

         This MIB module contains generic object definitions for
         MPLS Traffic Engineering Fast Reroute as defined in
         RFC 4090."

   -- Revision history.
      REVISION
        "201111030000Z" -- 03 Nov 2011 00:00:00 GMT
      DESCRIPTION
        "Initial version.  Published as RFC 6445."
      ::= { mib-2 202 }

   -- Top-level components of this MIB module

   mplsFrrGeneralObjects
               OBJECT IDENTIFIER ::= { mplsFrrGeneralMIB 1 }

   mplsFrrGeneralConformance
               OBJECT IDENTIFIER ::= { mplsFrrGeneralMIB 2 }

   -- MPLS Fast-Reroute generic scalars

   mplsFrrGeneralProtectionMethod OBJECT-TYPE
      SYNTAX        INTEGER {
                              unknown(1),
                              oneToOneBackup(2),
```

```
                              facilityBackup(3)
                            }
      MAX-ACCESS    read-write
      STATUS        current
      DESCRIPTION
        "Indicates which protection method is to be used for fast
         reroute on this device.  Some devices may require a reboot
         if this variable is to take effect after being modified."
      ::= { mplsFrrGeneralObjects 1 }

   mplsFrrGeneralIngressTunnelInstances OBJECT-TYPE
      SYNTAX        Counter32
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
        "The number of tunnel instances for either detour LSPs or
         bypass tunnels for which this LSR is the ingress."
      ::= { mplsFrrGeneralObjects 2 }

   --
   -- General FRR Table section
   --
   -- These tables apply to both types of FRR
   -- and should be implemented by all LSRs supporting
   -- FRR.
   --
   -- MPLS Fast-Reroute Constraints table

   mplsFrrGeneralConstraintsTable OBJECT-TYPE
      SYNTAX        SEQUENCE OF MplsFrrGeneralConstraintsEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
        "This table shows detour LSP or bypass tunnel setup
         constraints."
      ::= {  mplsFrrGeneralObjects 3 }

   mplsFrrGeneralConstraintsEntry OBJECT-TYPE
      SYNTAX        MplsFrrGeneralConstraintsEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
        "An entry in this table represents detour LSP or bypass
         tunnel setup constraints for an interface or link to be
         protected by detour LSPs or a bypass tunnel.

         Once the LSP or tunnel instance to be protected is identified
         in the mplsTunnelTable, the corresponding mplsTunnelIfIndex
```

value of that tunnel can be used to get the ifIndex of
the underlying physical interface using the ifStackTable.
That ifIndex of the underlying physical interface will
be used as mplsFrrGeneralConstraintsIfIndexOrZero in this
table to protect the LSPs or tunnel instances determined
earlier.

It is recommended that ifIndex persistence be enabled
across re-initializations. If persistence is not
implemented, then the value of
mplsFrrGeneralConstraintsIfIndexOrZero in this
table cannot be guaranteed across restarts and all entries
in this table MUST NOT be persistent, or the values of
mplsFrrGeneralConstraintsIfIndexOrZero MUST be reconstructed
on restart.

SNMP engines must only allow entries in this table
to be created for tunnel instances that require fast reroute
as indicated by the presence of the FAST_REROUTE object
in the signaling for the LSP in question.

An entry in this table can be created only if a
corresponding entry in mplsTunnelTable exists with the
same mplsTunnelIndex as mplsFrrGeneralConstraintsTunnelIndex.

Entries in this table are deleted when the corresponding
entries in mplsTunnelTable are deleted.

It is recommended that entries in this table be persistent
across reboots.

Entries indexed with mplsFrrGeneralConstraintsIfIndexOrZero
and set to 0 apply to all interfaces on this device for
which the FRR feature can operate.

If the mplsTunnelInstance object is set to a value of 0,
it indicates that the mplsTunnelEntry contains a tunnel
ingress. This is typically how configuration of this
feature is performed on devices where the actual
protection LSP used is left up to the protecting tunnel.
However, in cases where static configuration is
possible, any valid tunnel instance is possible;
however, it is strongly RECOMMENDED that the instance
index SHOULD use the following convention to identify
backup LSPs:

- lower 16 bits : protected tunnel instance
- higher 16 bits: must be all zeros"

```
      REFERENCE
        "Section 4.1 of RFC 4090 and Section 6.1 of RFC 3812."
      INDEX { mplsFrrGeneralConstraintsIfIndexOrZero,
              mplsFrrGeneralConstraintsTunnelIndex,
              mplsFrrGeneralConstraintsTunnelInstance
            }
      ::= { mplsFrrGeneralConstraintsTable 1 }

   MplsFrrGeneralConstraintsEntry ::= SEQUENCE {
      mplsFrrGeneralConstraintsIfIndexOrZero   InterfaceIndexOrZero,
      mplsFrrGeneralConstraintsTunnelIndex     MplsTunnelIndex,
      mplsFrrGeneralConstraintsTunnelInstance  MplsTunnelInstanceIndex,
      mplsFrrGeneralConstraintsProtectionType  INTEGER,
      mplsFrrGeneralConstraintsSetupPrio       Unsigned32,
      mplsFrrGeneralConstraintsHoldingPrio     Unsigned32,
      mplsFrrGeneralConstraintsInclAnyAffinity MplsTunnelAffinity,
      mplsFrrGeneralConstraintsInclAllAffinity MplsTunnelAffinity,
      mplsFrrGeneralConstraintsExclAnyAffinity MplsTunnelAffinity,
      mplsFrrGeneralConstraintsHopLimit        Unsigned32,
      mplsFrrGeneralConstraintsBandwidth       MplsBitRate,
      mplsFrrGeneralConstraintsStorageType     StorageType,
      mplsFrrGeneralConstraintsRowStatus       RowStatus
   }

   mplsFrrGeneralConstraintsIfIndexOrZero  OBJECT-TYPE
      SYNTAX        InterfaceIndexOrZero
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
        "Uniquely identifies an interface that a fast-reroute
         protection tunnel is configured to potentially protect
         in the event of a fault.  Entries with this index set to
         0 indicate that the configured protection tunnel protects
         all interfaces on this device (i.e., node protection)."
      ::= { mplsFrrGeneralConstraintsEntry 1 }

   mplsFrrGeneralConstraintsTunnelIndex OBJECT-TYPE
      SYNTAX        MplsTunnelIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
        "Uniquely identifies a tunnel in the mplsTunnelTable that
         is configured to possibly protect the interface(s) specified
         by mplsFrrGeneralConstraintsIfIndexOrZero in the event of a
         fault."
      REFERENCE
        "mplsTunnelTable from RFC 3812."
      ::= { mplsFrrGeneralConstraintsEntry 2 }
```

```
    mplsFrrGeneralConstraintsTunnelInstance OBJECT-TYPE
       SYNTAX        MplsTunnelInstanceIndex
       MAX-ACCESS    not-accessible
       STATUS        current
       DESCRIPTION
         "Uniquely identifies an existing instance of this tunnel
          for which fast reroute is requested.  Note that a value of
          0 indicates that the configuration points at a tunnel
          head (as specified in RFC 3812).  This is typically how
          configuration of this feature is performed on devices
          where the actual protection LSP used is left up to the
          protecting tunnel.  However, in cases where static
          configuration is possible, any valid tunnel instance is
          permissible.  In these cases, it is recommended that the
          instance index follow the following convention so as
          to make identification of backup LSPs easier:

          - lower 16 bits : protected tunnel instance
          - higher 16 bits: must be all zeros"
       ::= { mplsFrrGeneralConstraintsEntry 3 }

    mplsFrrGeneralConstraintsProtectionType OBJECT-TYPE
       SYNTAX        INTEGER { linkProtection(1),
                               nodeProtection(2)
                             }
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
         "Indicates type of the resource protection:

          linkProtection(1) indicates that this tunnel is
          set up to protect a particular link's resources.

          nodeProtection(2) indicates that this tunnel is
          set up to protect an entire node from failure."
       REFERENCE
         "Section 3 of RFC 4090."
       DEFVAL { nodeProtection }
       ::= { mplsFrrGeneralConstraintsEntry 4 }

    mplsFrrGeneralConstraintsSetupPrio OBJECT-TYPE
       SYNTAX        Unsigned32 (0..7)
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
         "Indicates the setup priority of the detour LSP
          or bypass tunnel."
```

```
      REFERENCE
        "Section 4.7 of RFC 3209."
      DEFVAL { 7 }
      ::= { mplsFrrGeneralConstraintsEntry 5 }

   mplsFrrGeneralConstraintsHoldingPrio OBJECT-TYPE
      SYNTAX        Unsigned32 (0..7)
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
        "Indicates the holding priority for the detour LSP
         or bypass tunnel."
      REFERENCE
        "Section 4.7 of RFC 3209."
      DEFVAL { 0 }
      ::= { mplsFrrGeneralConstraintsEntry 6 }

   mplsFrrGeneralConstraintsInclAnyAffinity OBJECT-TYPE
      SYNTAX        MplsTunnelAffinity
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
        "Indicates the include-any link constraint for the
         detour LSP or bypass tunnel.  A link satisfies the
         include-any constraint if and only if the constraint
         is zero, or the link and the constraint have a
         resource class in common."
      REFERENCE
        "Section 4.7 of RFC 3209."
      DEFVAL { 0 }
      ::= { mplsFrrGeneralConstraintsEntry 7 }

   mplsFrrGeneralConstraintsInclAllAffinity OBJECT-TYPE
      SYNTAX        MplsTunnelAffinity
      MAX-ACCESS    read-create
      STATUS        current
      DESCRIPTION
        "Indicates the include-all link constraint for the
         detour LSP or bypass tunnel.  A link satisfies the
         include-all constraint if and only if the link contains
         all of the administrative groups specified in the
         constraint."
      REFERENCE
        "Section 4.7 of RFC 3209."
      DEFVAL { 0 }
      ::= { mplsFrrGeneralConstraintsEntry 8 }
```

```
    mplsFrrGeneralConstraintsExclAnyAffinity OBJECT-TYPE
       SYNTAX        MplsTunnelAffinity
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
         "Indicates the exclude-any link constraint for the
          detour LSP or bypass tunnel.  A link satisfies the
          exclude-any constraint if and only if the link contains
          none of the administrative groups specified in the
          constraint."
       REFERENCE
         "Section 4.7 of RFC 3209."
       DEFVAL { 0 }
       ::= { mplsFrrGeneralConstraintsEntry 9 }

    mplsFrrGeneralConstraintsHopLimit OBJECT-TYPE
       SYNTAX        Unsigned32(0..255)
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
         "The maximum number of hops that the detour LSP or
          bypass tunnel may traverse."
       REFERENCE
         "Section 4.1 of RFC 4090."
       DEFVAL { 32 }
       ::= { mplsFrrGeneralConstraintsEntry 10 }

    mplsFrrGeneralConstraintsBandwidth OBJECT-TYPE
       SYNTAX        MplsBitRate
       UNITS         "kilobits per second"
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
         "The maximum bandwidth specifically reserved for a detour
          LSP or bypass tunnel, in units of thousands of bits
          per second (kbps).  Note that setting this value to 0
          indicates best-effort treatment."
       DEFVAL { 0 }
       ::= { mplsFrrGeneralConstraintsEntry 11 }

    mplsFrrGeneralConstraintsStorageType OBJECT-TYPE
       SYNTAX        StorageType
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
         "The storage type for this configuration entry.
          Conceptual rows having the value 'permanent'
          need not allow write access to any columnar
```

```
          objects in the row."
       DEFVAL { volatile }
       ::= { mplsFrrGeneralConstraintsEntry 12 }

    mplsFrrGeneralConstraintsRowStatus OBJECT-TYPE
       SYNTAX        RowStatus
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION
         "This object is used to create, modify, and/or delete a row
          in this table.  When a row in this table is in active(1)
          state, no objects in that row can be modified
          except mplsFrrGeneralConstraintsRowStatus and
          mplsFrrGeneralConstraintsStorageType."
       ::= { mplsFrrGeneralConstraintsEntry 13 }

    -- MPLS Fast-Reroute Tunnel Actual Route Hop table

    mplsFrrGeneralTunnelARHopTable OBJECT-TYPE
       SYNTAX             SEQUENCE OF MplsFrrGeneralTunnelARHopEntry
       MAX-ACCESS         not-accessible
       STATUS             current
       DESCRIPTION
         "This table sparsely extends mplsTunnelARHopTable defined
          in the MPLS-TE-STD-MIB module with fast-reroute objects.
          These objects specify the status of local protection,
          including availability and active use, on a per-hop basis,
          of hops traversed by a protected tunnel."
       ::= {  mplsFrrGeneralObjects 4 }

    mplsFrrGeneralTunnelARHopEntry  OBJECT-TYPE
       SYNTAX             MplsFrrGeneralTunnelARHopEntry
       MAX-ACCESS         not-accessible
       STATUS             current
       DESCRIPTION
         "This entry contains fast-reroute protection status of a
          single protected tunnel hop."
       INDEX {
         mplsTunnelARHopListIndex,
         mplsTunnelARHopIndex
       }
       ::= { mplsFrrGeneralTunnelARHopTable 1 }

    MplsFrrGeneralTunnelARHopEntry    ::= SEQUENCE {
        mplsFrrGeneralTunnelARHopSessionAttributeFlags   BITS,
        mplsFrrGeneralTunnelARHopRROSubObjectFlags       BITS
    }
```

```
    mplsFrrGeneralTunnelARHopSessionAttributeFlags  OBJECT-TYPE
       SYNTAX            BITS { arHopSessionAttrFlagsUnsupported(0),
                                localProtectionDesired(1),
                                labelRecordingDesired(2),
                                sestyleDesired(3),
                                bandwidthProtectionDesired(4),
                                nodeProtectionDesired(5)
                              }
       MAX-ACCESS                  read-only
       STATUS                      current
       DESCRIPTION
         "This object indicates the desired values for the
          associated SESSION_ATTRIBUTE flags.  Note that since
          this object is a BITS type, the bits may be set to
          indicate various desired combinations of the
          SESSION_ATTRIBUTE flags.

          If SESSION_ATTRIBUTE flags are not supported, then this
          object contains the value of
          arHopSessionAttrFlagsUnsupported(0)."
       REFERENCE
         "See Section 4.3 of RFC 4090 for SESSION_ATTRIBUTE flags."
       ::= { mplsFrrGeneralTunnelARHopEntry 1 }

    mplsFrrGeneralTunnelARHopRROSubObjectFlags OBJECT-TYPE
       SYNTAX             BITS { arHopRROSubObjectFlagsUnsupported(0),
                                 localProtectionAvailable(1),
                                 localProtectionInUse(2),
                                 bandwidthProtection(3),
                                 nodeProtection(4)
                               }
       MAX-ACCESS                  read-only
       STATUS                      current
       DESCRIPTION
         "This object indicates the flags that are currently
          in use by the associated Record Route Object (RRO)
          sub-object.

          Note that since this object is a BITS type,
          the bits may be set to indicate various combinations of
          the flags.

          If the RRO sub-object is not supported, then this object
          contains the value of arHopRROSubObjectFlagsUnsupported(0)."
       REFERENCE
          "Section 4.4 of RFC 4090."
       ::= { mplsFrrGeneralTunnelARHopEntry 2 }
```

```
    -- Notifications

    -- Module Conformance Statement

    mplsFrrGeneralCompliances
       OBJECT IDENTIFIER ::= {mplsFrrGeneralConformance 1 }

    mplsFrrGeneralGroups
       OBJECT IDENTIFIER ::= {mplsFrrGeneralConformance 2 }

    mplsFrrGeneralModuleFullCompliance MODULE-COMPLIANCE
       STATUS current
       DESCRIPTION
         "Compliance statements for SNMP engines that support the
          MPLS-FRR-GENERAL-STD-MIB module."

      MODULE IF-MIB -- The Interfaces Group MIB module, RFC 2863.
         MANDATORY-GROUPS {
            ifGeneralInformationGroup,
            ifCounterDiscontinuityGroup
         }

      MODULE MPLS-TE-STD-MIB  -- The MPLS Traffic Engineering
                              -- MIB module, RFC 3812
         MANDATORY-GROUPS {
            mplsTunnelGroup,
            mplsTunnelScalarGroup
         }

       MODULE -- this module
           MANDATORY-GROUPS {
                             mplsFrrGeneralScalarGroup,
                             mplsFrrGeneralTunnelARHopGroup,
                             mplsFrrGeneralConstraintsGroup
                            }

       OBJECT       mplsFrrGeneralConstraintsRowStatus
       SYNTAX       RowStatus { active(1), notInService(2) }
       WRITE-SYNTAX RowStatus { active(1), notInService(2),
                                createAndGo(4), destroy(6)
                              }
       DESCRIPTION
         "Support for createAndWait and notReady is not required."

       ::= { mplsFrrGeneralCompliances 1 }

    mplsFrrGeneralModuleReadOnlyCompliance MODULE-COMPLIANCE
       STATUS current
```

```
        DESCRIPTION
          "Compliance statements for SNMP engines that support the
           MPLS-FRR-GENERAL-STD-MIB module."
        MODULE

            MANDATORY-GROUPS {
                              mplsFrrGeneralScalarGroup,
                              mplsFrrGeneralTunnelARHopGroup,
                              mplsFrrGeneralConstraintsGroup
                             }

        -- Scalars

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

        -- mplsFrrGeneralConstraintsTable

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

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

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

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

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

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

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

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

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

        OBJECT        mplsFrrGeneralConstraintsRowStatus
        SYNTAX        RowStatus { active(1) }
        MIN-ACCESS    read-only
        DESCRIPTION
          "Write access is not required."

        ::= { mplsFrrGeneralCompliances 2 }

    -- Units of conformance

    mplsFrrGeneralScalarGroup OBJECT-GROUP
        OBJECTS {
                  mplsFrrGeneralIngressTunnelInstances,
                  mplsFrrGeneralProtectionMethod
                 }
        STATUS        current
        DESCRIPTION
          "Objects that are required to display general fast-reroute
           information."
        ::= { mplsFrrGeneralGroups 1 }

    mplsFrrGeneralConstraintsGroup OBJECT-GROUP
        OBJECTS {
           mplsFrrGeneralConstraintsProtectionType,
           mplsFrrGeneralConstraintsSetupPrio,
           mplsFrrGeneralConstraintsHoldingPrio,
           mplsFrrGeneralConstraintsInclAnyAffinity,
           mplsFrrGeneralConstraintsInclAllAffinity,
```

```
          mplsFrrGeneralConstraintsExclAnyAffinity,
          mplsFrrGeneralConstraintsHopLimit,
          mplsFrrGeneralConstraintsBandwidth,
          mplsFrrGeneralConstraintsStorageType,
          mplsFrrGeneralConstraintsRowStatus
       }

       STATUS        current
       DESCRIPTION
         "Objects that are required to configure fast-reroute
          constraints at the ingress LSR of the tunnel that
          requires fast-reroute service."
       ::= { mplsFrrGeneralGroups 2 }

    mplsFrrGeneralTunnelARHopGroup         OBJECT-GROUP
       OBJECTS {
                 mplsFrrGeneralTunnelARHopSessionAttributeFlags,
                 mplsFrrGeneralTunnelARHopRROSubObjectFlags
               }
       STATUS        current
       DESCRIPTION
         "Objects that are required to present per-hop fast-reroute
          protection status."
       ::= { mplsFrrGeneralGroups 3}

   END

   -- End of MPLS-FRR-GENERAL-STD-MIB
```

6.2. MPLS-FRR-ONE2ONE-STD-MIB Module Definitions

```
   -- Start of MPLS-FRR-ONE2ONE-STD-MIB

   MPLS-FRR-ONE2ONE-STD-MIB DEFINITIONS ::= BEGIN

    IMPORTS
       MODULE-IDENTITY, OBJECT-TYPE, mib-2,
       Integer32, Gauge32
          FROM SNMPv2-SMI                              -- [RFC2578]
       MODULE-COMPLIANCE, OBJECT-GROUP
          FROM SNMPv2-CONF                             -- [RFC2580]
       TruthValue
          FROM SNMPv2-TC                               -- [RFC2579]
       MplsTunnelIndex, MplsTunnelInstanceIndex,
       MplsLsrIdentifier
          FROM MPLS-TC-STD-MIB                         -- [RFC3811]
       InetAddressType, InetAddress
```

```
          FROM INET-ADDRESS-MIB                        -- [RFC4001]
       mplsFrrGeneralScalarGroup, mplsFrrGeneralTunnelARHopGroup,
       mplsFrrGeneralConstraintsGroup
          FROM MPLS-FRR-GENERAL-STD-MIB
       ;

    mplsFrrOne2OneMIB MODULE-IDENTITY
       LAST-UPDATED
          "201111030000Z" -- 03 Nov 2011 00:00:00 GMT
       ORGANIZATION
          "Multiprotocol Label Switching (MPLS) Working Group"
       CONTACT-INFO
            "
                    Riza Cetin
              Email: riza.cetin@alcatel.be

                    Thomas D. Nadeau
              Email: thomas.nadeau@ca.com

                    A S Kiran Koushik
              Email: kkoushik@cisco.com

                    Stefaan De Cnodder
              Email: Stefaan.de_cnodder@alcatel.be

                    Der-Hwa Gan
              Email: dhg@juniper.net
            "
       DESCRIPTION
         "Copyright (c) 2011 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
          (http://trustee.ietf.org/license-info).

          This MIB module contains object definitions for the
          MPLS Traffic Engineering one-to-one backup method for
          Fast Reroute as defined in RFC 4090."

    -- Revision history.
       REVISION
         "201111030000Z" -- 03 Nov 2011 00:00:00 GMT
```

```
      DESCRIPTION
        "Initial version.  Published as RFC 6445."
      ::= { mib-2 203 }

   -- Top-level components of this MIB module

   mplsFrrOne2OneObjects OBJECT IDENTIFIER
                         ::= { mplsFrrOne2OneMIB 1 }
   mplsFrrOne2OneConformance   OBJECT IDENTIFIER
                         ::= { mplsFrrOne2OneMIB 2 }

   -- Scalar objects defined for the one-to-one style of FRR

   mplsFrrIncomingDetourLSPs OBJECT-TYPE
      SYNTAX        Integer32 (0..2147483647)
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
        "The number of detour LSPs entering the device."
      ::= { mplsFrrOne2OneObjects 1 }

   mplsFrrOutgoingDetourLSPs OBJECT-TYPE
      SYNTAX        Integer32 (0..2147483647)
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
        "The number of detour LSPs leaving the device."
      ::= { mplsFrrOne2OneObjects 2 }

   mplsFrrOne2OneDetourOriginating OBJECT-TYPE
      SYNTAX        Integer32(0..2147483647)
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
        "The number of detour LSPs originating at this PLR."
      ::= { mplsFrrOne2OneObjects 3 }

   mplsFrrActiveProtectedLSPs OBJECT-TYPE
      SYNTAX        Gauge32
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
        "Indicates the number of LSPs currently protected by
         the FRR feature where this device acts as the PLR
         for those LSPs."
      ::= { mplsFrrOne2OneObjects 4 }

   --
```

```
    -- One-to-One specific tables
    --
    -- Tables in this section pertain only to the one-to-one
    -- style of FRR.
    --

    -- MPLS Fast-Reroute Point of Local Repair table

    mplsFrrOne2OnePlrTable  OBJECT-TYPE
       SYNTAX        SEQUENCE OF MplsFrrOne2OnePlrEntry
       MAX-ACCESS    not-accessible
       STATUS        current
       DESCRIPTION
         "This table shows a list of protected TE tunnels with
          the corresponding protecting tunnel, as well as the PLR
          where the protecting tunnel that initiated the detour
          LSPs traverses this node."
       ::= { mplsFrrOne2OneObjects 5 }

    mplsFrrOne2OnePlrEntry  OBJECT-TYPE
       SYNTAX        MplsFrrOne2OnePlrEntry
       MAX-ACCESS    not-accessible
       STATUS        current
       DESCRIPTION
         "An entry in this table represents a protected tunnel LSP
          together with its detour tunnel instance.  An entry in
          this table is only created by an SNMP engine as instructed
          by an MPLS signaling protocol.

          The entries of this table are present in all LSRs on the
          path of the detour LSP.

          The objects mplsFrrOne2OnePlrSenderAddrType and
          mplsFrrOne2OnePlrSenderAddr can be modified after the row
          is created.

          The objects mplsFrrOne2OnePlrTunnelIndex,
          mplsFrrOne2OnePlrTunnelDetourInstance,
          mplsFrrOne2OnePlrTunnelIngressLSRId,
          and mplsFrrOne2OnePlrTunnelEgressLSRId have the same
          values as the objects mplsTunnelIndex, mplsTunnelInstance,
          mplsTunnelIngressLSRId, and mplsTunnelEgressLSRId of the
          detour tunnel instance created in the mplsTunnelTable
          (MPLS-TE-STD-MIB).

          The entries in this table will be deleted when the
          corresponding entries in the mplsTunnelTable are deleted."
       INDEX { mplsFrrOne2OnePlrTunnelIndex,     -- from MPLS-TE-STD-MIB
```

```
              mplsFrrOne2OnePlrTunnelDetourInstance,-- mplsTunnelTable
              mplsFrrOne2OnePlrTunnelIngressLSRId,-- Tunnels must exist
              mplsFrrOne2OnePlrTunnelEgressLSRId,  -- a priori
              mplsFrrOne2OnePlrId    }
       ::= { mplsFrrOne2OnePlrTable 1 }

    MplsFrrOne2OnePlrEntry ::= SEQUENCE {
        mplsFrrOne2OnePlrTunnelIndex           MplsTunnelIndex,
        mplsFrrOne2OnePlrTunnelDetourInstance  MplsTunnelInstanceIndex,
        mplsFrrOne2OnePlrTunnelIngressLSRId    MplsLsrIdentifier,
        mplsFrrOne2OnePlrTunnelEgressLSRId     MplsLsrIdentifier,
        mplsFrrOne2OnePlrId                    MplsLsrIdentifier,
        mplsFrrOne2OnePlrSenderAddrType        InetAddressType,
        mplsFrrOne2OnePlrSenderAddr            InetAddress,
        mplsFrrOne2OnePlrAvoidNodeAddrType     InetAddressType,
        mplsFrrOne2OnePlrAvoidNodeAddr         InetAddress
    }

    mplsFrrOne2OnePlrTunnelIndex OBJECT-TYPE
       SYNTAX        MplsTunnelIndex
       MAX-ACCESS    not-accessible
       STATUS        current
       DESCRIPTION
         "Uniquely identifies a tunnel between a pair of LSRs
          from the mplsTunnelEntry."
       ::= { mplsFrrOne2OnePlrEntry 1 }

    mplsFrrOne2OnePlrTunnelDetourInstance OBJECT-TYPE
       SYNTAX        MplsTunnelInstanceIndex
       MAX-ACCESS    not-accessible
       STATUS        current
       DESCRIPTION
         "Uniquely identifies a detour instance of a tunnel from
          the mplsTunnelEntry.

         - lower 16 bits : protected tunnel instance
         - higher 16 bits: detour instance"
       ::= { mplsFrrOne2OnePlrEntry 2 }

    mplsFrrOne2OnePlrTunnelIngressLSRId OBJECT-TYPE
       SYNTAX        MplsLsrIdentifier
       MAX-ACCESS    not-accessible
       STATUS        current
       DESCRIPTION
         "The purpose of this object is to uniquely identify a
          tunnel within a network.  When the MPLS signaling
          protocol is rsvp(2), this object SHOULD contain the
          same value as the Extended Tunnel ID field in the
```

```
          SESSION object.  When the MPLS signaling protocol
          is crldp(3), this object SHOULD contain the same
          value as the Ingress LSR Router ID field in the
          LSPID TLV object.

          This value represents the head-end of the protected
          tunnel instance."
       REFERENCE
         "Section 4.7 of RFC 3209."
       ::= { mplsFrrOne2OnePlrEntry 3 }

    mplsFrrOne2OnePlrTunnelEgressLSRId OBJECT-TYPE
       SYNTAX        MplsLsrIdentifier
       MAX-ACCESS    not-accessible
       STATUS        current
       DESCRIPTION
         "Specifies the egress LSR ID of the protected tunnel instance."
       ::= { mplsFrrOne2OnePlrEntry 4 }

    mplsFrrOne2OnePlrId OBJECT-TYPE
       SYNTAX        MplsLsrIdentifier
       MAX-ACCESS    not-accessible
       STATUS        current
       DESCRIPTION
         "This value represents the PLR that has initiated a detour LSP
          to protect a tunnel instance.

          This value is signaled via the DETOUR object defined in
          MPLS RSVP."
       REFERENCE
         "Section 4.2 of RFC 4090."
       ::= { mplsFrrOne2OnePlrEntry 5 }

    mplsFrrOne2OnePlrSenderAddrType OBJECT-TYPE
       SYNTAX        InetAddressType
       MAX-ACCESS    read-write
       STATUS        current
       DESCRIPTION
         "Denotes the address type of this detour instance's sender
          address."
       DEFVAL        { ipv4 }
       ::= { mplsFrrOne2OnePlrEntry 6 }

    mplsFrrOne2OnePlrSenderAddr OBJECT-TYPE
       SYNTAX        InetAddress
       MAX-ACCESS    read-write
       STATUS        current
```

```
      DESCRIPTION
        "The IP address of the PLR that has initiated the detour LSP.
         The type of this address is determined by the value of the
         mplsFrrOne2OnePlrSenderAddrType object."
      ::= { mplsFrrOne2OnePlrEntry 7 }

   mplsFrrOne2OnePlrAvoidNodeAddrType OBJECT-TYPE
      SYNTAX        InetAddressType
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
        "Denotes the address type of the node that this PLR tries to
         avoid."
      DEFVAL        { ipv4 }
      ::= { mplsFrrOne2OnePlrEntry 8 }

   mplsFrrOne2OnePlrAvoidNodeAddr OBJECT-TYPE
      SYNTAX        InetAddress
      MAX-ACCESS    read-only
      STATUS        current
      DESCRIPTION
        "The IP address of the node that this PLR tries to avoid.
         The type of this address is determined by the value of the
         mplsFrrOne2OnePlrAvoidNodeAddrType object.

         This value is signaled via the DETOUR object defined in
         MPLS RSVP."
      REFERENCE
        "Section 4.2 of RFC 4090."
      ::= { mplsFrrOne2OnePlrEntry 9 }

   -- MPLS One-to-One Fast-Reroute Detour table

   mplsFrrOne2OneDetourTable OBJECT-TYPE
      SYNTAX        SEQUENCE OF MplsFrrOne2OneDetourEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
        "This table shows detour LSPs."
      ::= { mplsFrrOne2OneObjects 6 }

   mplsFrrOne2OneDetourEntry OBJECT-TYPE
      SYNTAX        MplsFrrOne2OneDetourEntry
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
        "An entry in this table represents a detour.  An entry in this
         table is only created by an SNMP engine as instructed by an
```

```
          MPLS signaling protocol."
       INDEX {
               mplsFrrOne2OnePlrTunnelIndex,     -- from MPLS-TE-STD-MIB
               mplsFrrOne2OnePlrTunnelDetourInstance, -- mplsTunnelTable
               mplsFrrOne2OnePlrTunnelIngressLSRId,-- Tunnels must exist
               mplsFrrOne2OnePlrTunnelEgressLSRId    -- a priori
          }
       ::= { mplsFrrOne2OneDetourTable 1 }

    MplsFrrOne2OneDetourEntry ::= SEQUENCE {
          mplsFrrOne2OneDetourActive             TruthValue,
          mplsFrrOne2OneDetourMergedStatus       INTEGER,
          mplsFrrOne2OneDetourMergedDetourInst   MplsTunnelInstanceIndex
    }

    mplsFrrOne2OneDetourActive OBJECT-TYPE
       SYNTAX        TruthValue
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
         "Indicates whether or not the main LSP has switched over to
          this detour LSP.

          If the value of this object is 'true', then it means that
          the main LSP has switched over to this detour LSP.  Otherwise,
          it contains a value of 'false'.
          This is only relevant for detours originated by this node."
       ::= { mplsFrrOne2OneDetourEntry 1 }

    mplsFrrOne2OneDetourMergedStatus OBJECT-TYPE
       SYNTAX        INTEGER { notMerged(1),
                               mergedWithProtectedTunnel(2),
                               mergedWithDetour(3)
                             }
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
         "This value represents whether or not this detour is merged.
          This value is set to notMerged(1) if this detour is not
          merged.

          This value is set to mergedWithProtectedTunnel(2) if
          this detour is merged with the protected tunnel.  This value
          is mergedWithDetour(3) if this detour is merged
          with another detour protecting the same tunnel."
       ::= { mplsFrrOne2OneDetourEntry 2 }
```

```
    mplsFrrOne2OneDetourMergedDetourInst OBJECT-TYPE
       SYNTAX        MplsTunnelInstanceIndex
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
         "This value represents the mplsTunnelInstance of the detour
          with which this detour is merged.  This object is only valid
          when mplsFrrOne2OneDetourMergedStatus is set to
          mergedWithDetour(3).

          - lower 16 bits : protected tunnel instance
          - higher 16 bits: detour instance"
       ::= { mplsFrrOne2OneDetourEntry 3 }

    -- Module Conformance Statement

    mplsFrrOne2OneCompliances
       OBJECT IDENTIFIER ::= {mplsFrrOne2OneConformance 1 }

    mplsFrrOne2OneGroups
       OBJECT IDENTIFIER ::= {mplsFrrOne2OneConformance 2 }

    mplsFrrOne2OneModuleFullCompliance MODULE-COMPLIANCE
       STATUS current
       DESCRIPTION
         "Compliance statements for SNMP engines that support the
          MPLS-FRR-ONE2ONE-STD-MIB module."

      MODULE MPLS-FRR-GENERAL-STD-MIB -- MPLS FRR Generic MIB
         MANDATORY-GROUPS {
                           mplsFrrGeneralScalarGroup,
                           mplsFrrGeneralTunnelARHopGroup,
                           mplsFrrGeneralConstraintsGroup
         }

       MODULE -- this module
           MANDATORY-GROUPS {
                           mplsFrrOne2OneScalarsGroup,
                           mplsFrrOne2OnePLRDetourGroup,
                           mplsFrrOne2OnePlrGroup
                          }

       ::= { mplsFrrOne2OneCompliances 1 }

    mplsFrrOne2OneModuleReadOnlyCompliance MODULE-COMPLIANCE
       STATUS current
       DESCRIPTION
         "Compliance statements for SNMP engines that support the
```

```
          MPLS-FRR-ONE2ONE-STD-MIB module."
       MODULE
           MANDATORY-GROUPS {
                             mplsFrrOne2OneScalarsGroup,
                             mplsFrrOne2OnePLRDetourGroup,
                             mplsFrrOne2OnePlrGroup
                            }
       -- mplsFrrOne2OnePlrTable

       OBJECT        mplsFrrOne2OnePlrSenderAddrType
       MIN-ACCESS    read-only
       DESCRIPTION
         "Write access is not required."

       OBJECT        mplsFrrOne2OnePlrSenderAddr
       MIN-ACCESS    read-only
       DESCRIPTION
         "Write access is not required."

       ::= { mplsFrrOne2OneCompliances 2 }

    -- Units of conformance

    mplsFrrOne2OneScalarsGroup OBJECT-GROUP
       OBJECTS {
                mplsFrrIncomingDetourLSPs,
                mplsFrrOutgoingDetourLSPs,
                mplsFrrOne2OneDetourOriginating,
                mplsFrrActiveProtectedLSPs
               }
       STATUS        current
       DESCRIPTION
         "Objects that are required for general One-to-One PLR
          information."
       ::= { mplsFrrOne2OneGroups 1 }

    mplsFrrOne2OnePLRDetourGroup OBJECT-GROUP
       OBJECTS {
                mplsFrrOne2OneDetourActive,
                mplsFrrOne2OneDetourMergedStatus,
                mplsFrrOne2OneDetourMergedDetourInst
               }
       STATUS        current
       DESCRIPTION
         "Objects that are required to present the detour LSP
          information at the detour ingress, transit, and egress
          LSRs."
       ::= { mplsFrrOne2OneGroups 2 }
```

```
    mplsFrrOne2OnePlrGroup OBJECT-GROUP
       OBJECTS {
           mplsFrrOne2OnePlrSenderAddrType,
           mplsFrrOne2OnePlrSenderAddr,
           mplsFrrOne2OnePlrAvoidNodeAddrType,
           mplsFrrOne2OnePlrAvoidNodeAddr
          }
       STATUS        current
       DESCRIPTION
         "Objects that are required to represent the FRR
          One-to-One PLR information."
       ::= { mplsFrrOne2OneGroups 3 }

   END

   -- End of MPLS-FRR-ONE2ONE-STD-MIB
```

6.3. MPLS-FRR-FACILITY-STD-MIB Module Definitions

```
   -- Start of MPLS-FRR-FACILITY-STD-MIB

   MPLS-FRR-FACILITY-STD-MIB DEFINITIONS ::= BEGIN

    IMPORTS
       MODULE-IDENTITY, OBJECT-TYPE, mib-2,
       Integer32,
       NOTIFICATION-TYPE, Gauge32
          FROM SNMPv2-SMI                              -- [RFC2578]
       MODULE-COMPLIANCE, OBJECT-GROUP,
       NOTIFICATION-GROUP
          FROM SNMPv2-CONF                             -- [RFC2580]
       TruthValue
          FROM SNMPv2-TC                               -- [RFC2579]
       InterfaceIndex
          FROM IF-MIB                                  -- [RFC2863]
       MplsTunnelIndex, MplsTunnelInstanceIndex,
       MplsLsrIdentifier, MplsBitRate
          FROM MPLS-TC-STD-MIB                         -- [RFC3811]
       mplsFrrGeneralScalarGroup, mplsFrrGeneralTunnelARHopGroup,
       mplsFrrGeneralConstraintsGroup
          FROM MPLS-FRR-GENERAL-STD-MIB
       ;

    mplsFrrFacilityMIB MODULE-IDENTITY
       LAST-UPDATED
          "201111030000Z" -- 03 Nov 2011 00:00:00 GMT
       ORGANIZATION
          "Multiprotocol Label Switching (MPLS) Working Group"
```

```
       CONTACT-INFO
            "
                    Riza Cetin
              Email: riza.cetin@alcatel.be

                    Thomas D. Nadeau
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                    Der-Hwa Gan
              Email: dhg@juniper.net
            "
       DESCRIPTION
         "Copyright (c) 2011 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
          (http://trustee.ietf.org/license-info).

          This MIB module contains object definitions for the
          MPLS Traffic Engineering facility backup method for
          Fast Reroute as defined in RFC 4090."

    -- Revision history.
       REVISION
         "201111030000Z" -- 03 Nov 2011 00:00:00 GMT
       DESCRIPTION
         "Initial version.  Published as RFC 6445."
       ::= { mib-2 204 }

    -- Top-level components of this MIB module

    mplsFrrFacilityNotifications         OBJECT IDENTIFIER
                                      ::= { mplsFrrFacilityMIB 0 }

    mplsFrrFacilityObjects               OBJECT IDENTIFIER
                                      ::= { mplsFrrFacilityMIB 1 }
```

```
    mplsFrrFacilityConformance           OBJECT IDENTIFIER
                                    ::= { mplsFrrFacilityMIB 2 }

    -- Scalar objects defined for the facility backup style of FRR

    mplsFrrConfiguredInterfaces OBJECT-TYPE
       SYNTAX        Integer32(0..2147483647)
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
         "Indicates the number of MPLS interfaces configured for
          protection."
       DEFVAL { 0 }
       ::= { mplsFrrFacilityObjects 1 }

    mplsFrrActiveInterfaces OBJECT-TYPE
       SYNTAX        Gauge32
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
         "Indicates the number of interfaces currently being
          protected.  This value MUST be less than or equal
          to mplsFrrConfiguredInterfaces."
       DEFVAL { 0 }
       ::= { mplsFrrFacilityObjects 2 }

    mplsFrrConfiguredBypassTunnels OBJECT-TYPE
       SYNTAX        Gauge32
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
         "Indicates the number of bypass tunnels configured to
          protect TE tunnels on this LSR."
       DEFVAL { 0 }
       ::= { mplsFrrFacilityObjects 3 }

    mplsFrrActiveBypassTunnels OBJECT-TYPE
       SYNTAX        Gauge32

       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION
         "Indicates the number of bypass tunnels indicated in
          mplsFrrConfiguredBypassTunnels whose operStatus
          is up(1), indicating that they are currently protecting
          TE tunnels on this LSR."
       DEFVAL { 0 }
       ::= { mplsFrrFacilityObjects 4 }
```

```
    mplsFrrFacilityNotificationsEnabled OBJECT-TYPE
       SYNTAX            TruthValue
       MAX-ACCESS        read-write
       STATUS            current
       DESCRIPTION
         "Enables or disables FRR notifications defined in this
          MIB module.  Notifications are disabled by default.

          This object is needed to control the notifications
          emitted by this implementation."
       DEFVAL { false }
       ::= { mplsFrrFacilityObjects 5 }

    mplsFrrFacilityNotificationsMaxRate OBJECT-TYPE
       SYNTAX       Gauge32
       UNITS        "Notifications per Second"
       MAX-ACCESS   read-write
       STATUS       current
       DESCRIPTION
         "This variable indicates the maximum number of
          notifications issued per second.  If events occur
          more rapidly, the implementation may simply fail to
          emit these notifications during that period, or may
          queue them until an appropriate time.  In case the
          implementation chooses to drop the events during
          throttling instead of queuing them to be sent at a later
          time, it is assumed that there will be no indication
          that events are being thrown away.

          A value of 0 means no throttling is applied and
          events may be generated at the rate at which they occur."
       DEFVAL       { 0 }
       ::= { mplsFrrFacilityObjects 6 }

    --
    -- Facility-based FRR-specific tables
    --
    -- Tables in this section pertain only to the facility-based
    -- style of FRR.
    --

     mplsFrrFacilityDBTable OBJECT-TYPE
        SYNTAX            SEQUENCE OF MplsFrrFacilityDBEntry
        MAX-ACCESS        not-accessible
        STATUS            current
        DESCRIPTION
          "The mplsFrrFacilityDBTable provides information about the
           fast-reroute database.  Each entry belongs to a protected
```

```
            interface, protecting backup tunnel, and protected tunnel.
            MPLS interfaces defined on this node are protected by
            backup tunnels and are indicated by the index
            mplsFrrFacilityProtectedIfIndex.  If the interface index is
            set to 0, this indicates that the remaining indexes apply
            to all configured protected interfaces.

            Note that all objects in this table are read-only, and
            if new objects are added to this table, they should also
            be read-only.

            It is recommended that ifIndex persistence be enabled
            across re-initializations.
            If persistence is not implemented, then the value of
            mplsFrrFacilityProtectedIfIndex in this
            table cannot be guaranteed across restarts and all entries
            in this table MUST NOT be persistent, or the values of
            mplsFrrFacilityProtectedIfIndex MUST be reconstructed
            on restart.

            It is recommended that entries in this table be persistent
            across reboots.

            The protecting tunnel is indicated by the
            index mplsFrrFacilityProtectingTunnelIndex and
            represents a valid mplsTunnelEntry.  Note that the tunnel
            instance index of the protecting tunnel may be set to 0,
            which indicates the tunnel head interface for the
            protecting tunnel, as per RFC 3812, but it may also be
            defined using the following semantics:

            - lower 16 bits : protected tunnel instance
            - higher 16 bits: must be all zeros"
        ::= { mplsFrrFacilityObjects 7 }

    mplsFrrFacilityDBEntry OBJECT-TYPE
        SYNTAX        MplsFrrFacilityDBEntry
        MAX-ACCESS    not-accessible
        STATUS        current
        DESCRIPTION
          "An entry in the mplsFrrFacilityDBTable represents a single
           protected LSP, protected by a backup tunnel on a
           specific protected interface, or if the interface
           index is set to 0, on all interfaces.  Note that for
           brevity, managers should consult the mplsTunnelTable
           present in the MPLS-TE-STD-MIB module for
           additional information about the protecting and protected
           tunnels, and the ifEntry in the IF-MIB module
```

```
          for the protected interface."
       INDEX {
              mplsFrrFacilityProtectedIfIndex,   -- protected ifIndex
              mplsFrrFacilityProtectingTunnelIndex,-- protecting TE tun
              mplsFrrFacilityBackupTunnelIndex,    -- protected TE tun
              mplsFrrFacilityBackupTunnelInstance, -- LSP
              mplsFrrFacilityBackupTunnelIngressLSRId,
              mplsFrrFacilityBackupTunnelEgressLSRId }
       ::= { mplsFrrFacilityDBTable 1 }

    MplsFrrFacilityDBEntry ::= SEQUENCE {
       mplsFrrFacilityProtectedIfIndex          InterfaceIndex,
       mplsFrrFacilityProtectingTunnelIndex     MplsTunnelIndex,
       mplsFrrFacilityBackupTunnelIndex         MplsTunnelIndex,
       mplsFrrFacilityBackupTunnelInstance      MplsTunnelInstanceIndex,
       mplsFrrFacilityBackupTunnelIngressLSRId  MplsLsrIdentifier,
       mplsFrrFacilityBackupTunnelEgressLSRId   MplsLsrIdentifier,
       mplsFrrFacilityDBNumProtectingTunnelOnIf Gauge32,
       mplsFrrFacilityDBNumProtectedLspOnIf     Gauge32,
       mplsFrrFacilityDBNumProtectedTunnels     Gauge32,
       mplsFrrFacilityDBProtectingTunnelStatus  INTEGER,
       mplsFrrFacilityDBProtectingTunnelResvBw  MplsBitRate
    }

    mplsFrrFacilityProtectedIfIndex OBJECT-TYPE
       SYNTAX        InterfaceIndex
       MAX-ACCESS    not-accessible
       STATUS        current
       DESCRIPTION
         "Uniquely identifies the interface configured for FRR
          protection.  If this object is set to 0, this indicates
          that the remaining indexing combinations for this row
          apply to all interfaces on this device for which
          the FRR feature can operate."
       ::= { mplsFrrFacilityDBEntry 1 }

    mplsFrrFacilityProtectingTunnelIndex OBJECT-TYPE
       SYNTAX        MplsTunnelIndex
       MAX-ACCESS    not-accessible
       STATUS        current
       DESCRIPTION
         "Uniquely identifies the mplsTunnelEntry primary index for
          the tunnel head interface designated to protect the
          interface as specified in the mplsFrrFacilityProtectedIfIndex
          (and all of the tunnels using this interface).  Note
          that the corresponding mplsTunnelInstance MUST BE
          0 as per the indexing convention stipulated."
```

```
      REFERENCE
        "Section 6.1 of RFC 3812."
      ::= { mplsFrrFacilityDBEntry 2 }

   mplsFrrFacilityBackupTunnelIndex OBJECT-TYPE
      SYNTAX        MplsTunnelIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
        "Uniquely identifies the mplsTunnelEntry primary index for
         the TE tunnel LSP being protected on the
         interface as specified by mplsFrrFacilityProtectedIfIndex."
      ::= { mplsFrrFacilityDBEntry 3 }

   mplsFrrFacilityBackupTunnelInstance OBJECT-TYPE
      SYNTAX        MplsTunnelInstanceIndex
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
        "Uniquely identifies the mplsTunnelEntry secondary index
         for the TE tunnel LSP being protected on the
         interface as specified by mplsFrrFacilityProtectedIfIndex."
      ::= { mplsFrrFacilityDBEntry 4 }

   mplsFrrFacilityBackupTunnelIngressLSRId OBJECT-TYPE
      SYNTAX        MplsLsrIdentifier
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
        "Uniquely identifies the mplsTunnelEntry third index
         for the TE tunnel LSP being protected on the
         interface as specified by mplsFrrFacilityProtectedIfIndex."
      REFERENCE
        "Section 6.1 of RFC 3812."
      ::= { mplsFrrFacilityDBEntry 5 }

   mplsFrrFacilityBackupTunnelEgressLSRId  OBJECT-TYPE
      SYNTAX        MplsLsrIdentifier
      MAX-ACCESS    not-accessible
      STATUS        current
      DESCRIPTION
        "Uniquely identifies the mplsTunnelEntry fourth index
         for the TE tunnel LSP being protected on the
         interface as specified by mplsFrrFacilityProtectedIfIndex."
      ::= { mplsFrrFacilityDBEntry 6 }
```

```
    mplsFrrFacilityDBNumProtectingTunnelOnIf OBJECT-TYPE
       SYNTAX            Gauge32
       MAX-ACCESS        read-only
       STATUS            current
       DESCRIPTION
         "The number of backup tunnels protecting the
          interface specified by mplsFrrFacilityProtectedIfIndex."
       ::= { mplsFrrFacilityDBEntry 7 }

    mplsFrrFacilityDBNumProtectedLspOnIf OBJECT-TYPE
       SYNTAX            Gauge32
       MAX-ACCESS        read-only
       STATUS            current
       DESCRIPTION
         "The number of LSPs currently being protected on
          the interface specified by
          mplsFrrFacilityProtectedIfIndex."
       ::= { mplsFrrFacilityDBEntry 8 }

    mplsFrrFacilityDBNumProtectedTunnels OBJECT-TYPE
       SYNTAX            Gauge32
       MAX-ACCESS        read-only
       STATUS            current
       DESCRIPTION
         "The number of tunnels protected on the interface
          specified by mplsFrrFacilityProtectedIfIndex."
       ::= { mplsFrrFacilityDBEntry 9 }

    mplsFrrFacilityDBProtectingTunnelStatus OBJECT-TYPE
       SYNTAX            INTEGER {
                             active(1),
                             ready(2),
                             partial(3)
                         }
       MAX-ACCESS        read-only
       STATUS            current
       DESCRIPTION
         "Specifies the state of the protecting tunnel as
          specified by mplsFrrFacilityProtectingTunnelIndex.

          active  - This tunnel's label has been placed in the
                    LFIB and is ready to be applied to incoming
                    packets.
          ready   - This tunnel's label entry has been created but
                    is not yet in the LFIB.
          partial - This tunnel's label entry has not been fully
                    created."
       ::= { mplsFrrFacilityDBEntry 10 }
```

```
    mplsFrrFacilityDBProtectingTunnelResvBw  OBJECT-TYPE
       SYNTAX            MplsBitRate
       UNITS             "kilobits per second"
       MAX-ACCESS        read-only
       STATUS            current
       DESCRIPTION
         "Specifies the amount of bandwidth in units
          of '1,000 bits per second', actually reserved by
          the protecting tunnel for facility backup purposes.
          This value is repeated here from the MPLS-TE-STD-MIB
          module because the tunnel entry will reveal the
          bandwidth reserved by the signaling protocol, which is
          typically 0 for backup tunnels so as to not over-book
          bandwidth.  However, internal reservations are
          typically made on the PLR; thus, this value should be
          revealed here, as it is often different from
          mplsTunnelResourceMeanRate found in the MPLS-TE-STD-MIB
          module."
       ::= { mplsFrrFacilityDBEntry 11 }

    -- Notifications
    mplsFrrFacilityInitialBackupTunnelInvoked  NOTIFICATION-TYPE
       OBJECTS { mplsFrrFacilityDBNumProtectingTunnelOnIf,
                 mplsFrrFacilityDBNumProtectedLspOnIf,
                 mplsFrrFacilityDBNumProtectedTunnels,
                 mplsFrrFacilityDBProtectingTunnelStatus,
                 mplsFrrFacilityDBProtectingTunnelResvBw
               }
       STATUS      current
       DESCRIPTION
         "This notification is generated when a tunnel running over an
          interface as specified in the mplsFrrConstraintsTable is
          initially protected by the backup tunnel also specified in the
          mplsFrrConstraintsTable.  In some implementations, there may
          be a difference between when the control plane triggers
          this notification and when the hardware is programmed to
          utilize the protection path.  Due to the urgency of this
          operation, it is acceptable for the control plane to
          issue this notification either before or after it programs
          the hardware.  In cases where it is the latter approach,
          the notification MUST be sent immediately after the
          data plane has been altered.

          This notification should not be generated for each subsequent
          tunnel that is backed up by the FRR feature on this LSR, as
          this may result in potential scaling issues with regard to
          LSR performance and network load.  Note also that
          notifications MUST be generated in accordance with the
```

```
          mplsFrrNotificationsMaxRate."

       ::= { mplsFrrFacilityNotifications 1 }

    mplsFrrFacilityFinalTunnelRestored NOTIFICATION-TYPE
       OBJECTS { mplsFrrFacilityDBNumProtectingTunnelOnIf,
                 mplsFrrFacilityDBNumProtectedLspOnIf,
                 mplsFrrFacilityDBNumProtectedTunnels,
                 mplsFrrFacilityDBProtectingTunnelStatus,
                 mplsFrrFacilityDBProtectingTunnelResvBw
               }
       STATUS      current
       DESCRIPTION
         "This notification is generated when the final tunnel that is
          being protected by a backup tunnel as specified in the
          mplsFrrConstraintsTable is restored to normal operation.  This
          notification should not be generated for each restored tunnel,
          as this may result in potential scaling issues with regard to
          LSR performance and network load.  Note also that
          notifications MUST be generated in accordance with the
          mplsFrrNotificationsMaxRate."
       ::= { mplsFrrFacilityNotifications 2 }

    -- Module Conformance Statement

    mplsFrrFacilityCompliances
       OBJECT IDENTIFIER ::= {mplsFrrFacilityConformance 1 }

    mplsFrrFacilityGroups
       OBJECT IDENTIFIER ::= {mplsFrrFacilityConformance 2 }

    mplsFrrFacilityModuleFullCompliance MODULE-COMPLIANCE
       STATUS current
       DESCRIPTION
         "Compliance statements for SNMP engines that support the
          MPLS-FRR-FACILITY-STD-MIB module."

      MODULE MPLS-FRR-GENERAL-STD-MIB  -- MPLS FRR Generic MIB
         MANDATORY-GROUPS {
                             mplsFrrGeneralScalarGroup,
                             mplsFrrGeneralTunnelARHopGroup,
                             mplsFrrGeneralConstraintsGroup
         }

       MODULE -- this module
           MANDATORY-GROUPS {
                             mplsFrrFacilityScalarGroup,
                             mplsFrrFacilityDBGroup,
```

```
                            mplsFrrFacilityNotificationsGroup
                           }

       ::= { mplsFrrFacilityCompliances 1 }

    mplsFrrFacilityModuleReadOnlyCompliance MODULE-COMPLIANCE
       STATUS current
       DESCRIPTION
         "Compliance statements for SNMP engines that support the
          MPLS-FRR-FACILITY-STD-MIB module."

      MODULE MPLS-FRR-GENERAL-STD-MIB -- MPLS FRR Generic MIB
         MANDATORY-GROUPS {
                            mplsFrrGeneralScalarGroup,
                            mplsFrrGeneralTunnelARHopGroup,
                            mplsFrrGeneralConstraintsGroup
         }

       MODULE -- this module
           MANDATORY-GROUPS {
                            mplsFrrFacilityScalarGroup,
                            mplsFrrFacilityDBGroup,
                            mplsFrrFacilityNotificationsGroup
                           }

       ::= { mplsFrrFacilityCompliances 2 }

    -- Units of conformance

    mplsFrrFacilityScalarGroup OBJECT-GROUP
       OBJECTS { mplsFrrConfiguredInterfaces,
                 mplsFrrActiveInterfaces,
                 mplsFrrConfiguredBypassTunnels,
                 mplsFrrActiveBypassTunnels,
                 mplsFrrFacilityNotificationsEnabled,
                 mplsFrrFacilityNotificationsMaxRate
         }
       STATUS        current
       DESCRIPTION
         "Objects that are required to represent the FRR
          Facility Route Database information."
       ::= { mplsFrrFacilityGroups 1 }

    mplsFrrFacilityDBGroup OBJECT-GROUP
       OBJECTS { mplsFrrFacilityDBNumProtectingTunnelOnIf,
                 mplsFrrFacilityDBNumProtectedLspOnIf,
                 mplsFrrFacilityDBNumProtectedTunnels,
                 mplsFrrFacilityDBProtectingTunnelStatus,
```

```
                mplsFrrFacilityDBProtectingTunnelResvBw
        }
      STATUS        current
      DESCRIPTION
        "Objects that are required to represent the FRR
         Facility Route Database information."
      ::= { mplsFrrFacilityGroups 2 }

   mplsFrrFacilityNotificationsGroup NOTIFICATION-GROUP
      NOTIFICATIONS { mplsFrrFacilityInitialBackupTunnelInvoked,
                      mplsFrrFacilityFinalTunnelRestored
                    }
      STATUS        current
      DESCRIPTION
        "Objects that are required to represent FRR notifications."
      ::= { mplsFrrFacilityGroups 3 }

END

-- End of MPLS-FRR-FACILITY-STD-MIB
```

7. Security Considerations

It is clear that these MIB modules are potentially useful for the monitoring of MPLS LSRs supporting fast reroute. These MIB modules can also be used for configuration of certain objects; note that anything that can be configured can be incorrectly configured, with potentially disastrous results.

There are a number of management objects defined in these MIB modules 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. These are the tables and objects and their sensitivity/vulnerability:

- The mplsFrrGeneralConstraintsTable (mplsFrrGeneralConstraintsProtectionType, mplsFrrGeneralConstraintsSetupPrio, etc.), and some objects in the mplsFrrScalarGroup (mplsFrrGeneralProtectionMethod, mplsFrrFacilityNotificationsEnabled, etc.) contain objects that may be used to provision MPLS fast-reroute features. Unauthorized access to these objects could result in disruption of traffic on the network.

Some of the readable objects in these MIB modules (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 and/or NOTIFY access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP. These are the tables and objects and their sensitivity/vulnerability:

- The mplsFrrOne2OnePlrTable (mplsFrrOne2OnePlrSenderAddr, mplsFrrOne2OnePlrAvoidNodeAddr, etc.), mplsFrrOne2OneDetourTable (mplsFrrOne2OneDetourActive, mplsFrrOne2OneDetourMergedDetourInst, etc.), and mplsFrrGeneralTunnelARHopTable (mplsFrrGeneralTunnelARHopSessionAttributeFlags, mplsFrrGeneralTunnelARHopRROSubObjectFlags, etc.), and some objects contained in the mplsFrrScalarGroup (mplsFrrGeneralProtectionMethod, mplsFrrActiveInterfaces, etc.), collectively show the MPLS fast-reroute interfaces, tunnels, and other associated fast-reroute feature configurations as well as their linkages to other MPLS-related configuration and/or performance statistics. Administrators not wishing to reveal this information should consider these objects sensitive/vulnerable and take precautions so they are not revealed.

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/SET (read/change/create/delete) the objects in these MIB modules.

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 these MIB modules is properly configured to give access to the objects only to those principals (users) that have legitimate rights to indeed GET or SET (change/create/delete) them.

8. IANA Considerations

The MIB modules in this document use the IANA-assigned OBJECT IDENTIFIER values recorded in the SMI Numbers registry.

8.1. IANA Considerations for MPLS-FRR-GENERAL-STD-MIB

IANA has assigned { mib-2 202 } to the MPLS-FRR-GENERAL-STD-MIB module specified in this document.

8.2. IANA Considerations for MPLS-FRR-ONE2ONE-STD-MIB

IANA has assigned { mib-2 203 } to the MPLS-FRR-ONE2ONE-STD-MIB module specified in this document.

8.3. IANA Considerations for MPLS-FRR-FACILITY-STD-MIB

IANA has assigned { mib-2 204 } to the MPLS-FRR-FACILITY-STD-MIB module specified in this document.

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