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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

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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

```

(R1)----(R2)----(R3)----(R4)---(R5)
  \      \      \      /
  (R6)---(R7)----- (R8)

```

Protected LSP: [R1->R2->R3->R4->R5]

R1's Backup: [R1->R6->R7->R8->R3]

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
  mplsFrrGeneralTunnelARHopRRROSubObjectFlags = 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`.

```
(R1)----(R2)----(R3)----(R4)---(R5)
      \      \      \      /
      (R6)---(R7)----- (R8)
```

Protected LSP: [R1->R2->R3->R4->R5]

R1's Backup: [R1->R6->R7->R8->R3]

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

```

[R1]---[R2]----[R3]-----[R4]---[R5]
      \          /
      [R6]==[R7]

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"

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DESCRIPTION

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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-TYPESYNTAX 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,
    mplsFrrGeneralTunnelARHopRRROSubObjectFlags     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,
        mplsFrrGeneralTunnelARHopRRSubObjectFlags
    }

```

```

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

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        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

```
"
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    Email: riza.cetin@alcatel.be

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    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
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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,
            mplsFrrFacilityDBGGroup,

```

```

        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,
        mplsFrrFacilityDBGGroup,
        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 }

mplsFrrFacilityDBGGroup 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:

- o 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:

- o The `mplsFrrOne2OnePlrTable` (`mplsFrrOne2OnePlrSenderAddr`, `mplsFrrOne2OnePlrAvoidNodeAddr`, etc.), `mplsFrrOne2OneDetourTable` (`mplsFrrOne2OneDetourActive`, `mplsFrrOne2OneDetourMergedDetourInst`, etc.), and `mplsFrrGeneralTunnelARHopTable` (`mplsFrrGeneralTunnelARHopSessionAttributeFlags`, `mplsFrrGeneralTunnelARHopRRSubObjectFlags`, 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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