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                    A Traffic Engineering (TE) MIB

Status of This Memo

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Abstract

   This memo defines a portion of the Management Information Base (MIB)
   for use with network management protocols in the Internet community.
   In particular, it describes managed objects for Traffic Engineered
   (TE) Tunnels; for example, Multi-Protocol Label Switched Paths.

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1. Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects for Traffic Engineered (TE) Tunnels; for example, Multi-Protocol Label Switched Paths ([7], [8]). The MIB module defined by this memo allows one to configure TE Tunnels, to assign one or more paths to a Tunnel, and to monitor operational aspects of the Tunnel, such as the number of octets and packets that have passed through the Tunnel.

As it stands, this MIB module can only be used to configure or monitor a TE Tunnel at its ingress. The ingress is then expected to use some protocol (such as RSVP-TE) to signal the other routers in the path the information they need to set up the tunnel. The extension of this module for use at other points of a Tunnel is for further study.

1.1. Specification of Requirements

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [1].

2. 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 RFC 3410 [8].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIv2, which is described in STD 58, RFC 2578 [2], STD 58, RFC 2579 [3] and STD 58, RFC 2580 [4].

3. Overview of the MIB Module

The Traffic Engineering MIB module consists of four parts:

    1) Traffic Engineering information,
    2) a table of Traffic Engineering Tunnels,
    3) a table of Paths that tunnels take, and
    4) a table of Hops that make up a tunnel path.

The MIB module also has statements for minimal and full compliance.

The following subsections give an overview of each part. All objects
are mandatory. For minimal compliance, all objects MAY be
implemented read-only; for full compliance, all objects must be
implemented to their stated MAX-ACCESS capabilities. Notifications
are optional.

3.1. Traffic Engineering Information

This part contains information about the Link State Protocols used to
carry TE information, the signaling protocols used to set up Traffic
Tunnels, the number of Traffic Tunnels that have been configured and
that are operational, and a mapping of Administrative Group (called
Resource Classes in [7]) numbers to names.

3.2. Traffic Tunnel Information

This part contains a table of Traffic Tunnels and information about
each one. This information includes the Tunnel name, its
configuration information, its operational information, and the
active path(s) that the Tunnel takes.

Configuration information includes the end points of the Traffic
Tunnel, and the number of configured paths for the Traffic Tunnel.

Operational information includes the current state (up/down), the
count of octets and packets sent on the Traffic Tunnel, how long it
has been up, and how many state transitions the Traffic Tunnel has
had.

Operational path information includes the number of operational
paths, the number of path changes, and when the last path change was.

3.3. Path Information

A Tunnel is a logical entity. An instantiation of a Tunnel is one or
more Paths; each Path has a route (also called Explicit Route) or
sequence of hops. A Path is indexed by a dual index: The primary
index is that of the Tunnel to which the Path belongs; the secondary
index is that of the Path itself.

The configured information for a Path consists of the constraints for
the Path and a configured route.

The operational information consists of the Path status, the computed
route (i.e., the route that was computed to satisfy the constraints),
and the actual path as recorded by the signaling protocol.

3.4. Hop Information

A path consists of a sequence of hops. A hop can be loose (meaning
that the path eventually traverses the specified node) or strict
(meaning that the specified node and possibly the link must be the
next node in the path). A hop can be specified as an IPv4 address,
an IPv6 address, an Autonomous System number or an unnumbered
interface index [5].

The Hop Table contains all hops for all paths on a given router. It
is organized as follows. There is a primary index that identifies a
list of hops and a secondary index that identifies individual hops.
Thus, to get the sequence of recorded hops for a path, one looks up
the path's tePathRecordedRoute, which is a primary index into the Hop
Table. Then to get the list of actual hops in order for the recorded
path, one uses a secondary index of 1, 2, ...

3.5. Relationship with Other MIB Modules

A TE Tunnel can extend objects from two other MIB modules; one is the
Interfaces MIB [10], and the other is the IP Tunnel MIB [11]. The
mechanism for doing so is to assign the TE Tunnel index
(teTunnelIndex) with a valid ifIndex value in ifTable.

If a TE Tunnel is deemed an interface, a new interface object is
created and assigned an ifIndex value in ifTable. Then a TE Tunnel
object is created, setting teTunnelIndex to the same value as the
interface index.

If (and only if) a TE Tunnel is considered an interface, it may also
be considered an IP tunnel (if the encapsulation of the TE Tunnel is
IP). In that case, the interface associated with the TE Tunnel
should have its ifType set to tunnel(131).

If a TE Tunnel is not considered an interface, then the TE Tunnel
index (teTunnelIndex) SHOULD be set to a value at least 2^24, so that
it is distinct from normal interfaces.

4. Creating, Modifying, and Deleting a TE Tunnel

To create a TE Tunnel, one first obtains a free Tunnel index by using
the object teNextTunnelIndex. One then creates the Tunnel, including
all parameters, either as createAndGo or createAndWait. Then, TE
Paths for this Tunnel can be created by using the
teTunnelNextPathIndex object, again as createAndGo or createAndWait.
A particular Path is computed and signaled when both the Path and the
enclosing Tunnel have RowStatus 'active'.

To build a Path's configured route, one first gets a free PathHop
index by using teNextPathHopIndex, and then builds the route hop-by-
hop using the secondary index, setting the AddrType, Address, and
HopType for each Hop. Finally, one sets the tePathConfiguredRoute in
the Path to the PathHop index obtained.

Modifying certain properties of a TE Tunnel or a TE Path may require
setting the RowStatus of the Tunnel (or Path) to 'notInService'
before making the changes and then setting the RowStatus of the
Tunnel (or Path) back to 'active' to re-signal all Paths of the
Tunnel (or the modified Path).

A TE Tunnel and all its Paths can be deleted by setting the Tunnel's
RowStatus to 'destroy'. A specific Path within a Tunnel can be
destroyed by setting that Path's RowStatus to 'destroy'.

5. MIB Specification

This MIB module IMPORTs objects from RFCs 2578 [2], 2579 [3], 2580
[3], 3411 [6], and 3811 [5] and it also has REFERENCE clauses to RFCs
3209 [8] and 3212 [12].

TE-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY, OBJECT-TYPE,
    NOTIFICATION-TYPE, mib-2,
    Integer32, Gauge32, Counter32,
    Counter64, Unsigned32, TimeTicks   FROM SNMPv2-SMI

    RowStatus, StorageType, TimeStamp,
    TruthValue   FROM SNMPv2-TC

    SnmpAdminString   FROM SNMP-FRAMEWORK-MIB

    MODULE-COMPLIANCE, OBJECT-GROUP,
    NOTIFICATION-GROUP   FROM SNMPv2-CONF

    TeHopAddress, TeHopAddressType,
    MplsBitRate   FROM MPLS-TC-STD-MIB;

teMIB MODULE-IDENTITY
    LAST-UPDATED "200501040000Z"   -- 01 January 2005
    ORGANIZATION "IETF Traffic Engineering Working Group"
    CONTACT-INFO "
                    Editor: Kireeti Kompella
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                    The IETF Traffic Engineering Working Group is
                    chaired by Jim Boyle and Ed Kern.

                    WG Mailing List information:

                       General Discussion: te-wg@ops.ietf.org
                        To Subscribe: te-wg-request@ops.ietf.org
                          In Body: subscribe
                         Archive: ftp://ops.ietf.org/pub/lists

                    Comments on the MIB module should be sent to the
                    mailing list. The archives for this mailing list
                    should be consulted for previous discussion on
                    this MIB.
                   "
      DESCRIPTION   "The Traffic Engineering MIB module.

                    Copyright (C) The Internet Society (2005). This
                    version of this MIB module is part of RFC 3970;
                    see the RFC itself for full legal notices.
                   "

       -- revision history

       REVISION   "200501040000Z"   -- 01 January 2005
       DESCRIPTION   "Initial version, published as RFC 3970."
       ::= { mib-2 122 }

   -- Top level objects

   teMIBNotifications OBJECT IDENTIFIER ::= { teMIB 0 }
   teMIBObjects   OBJECT IDENTIFIER ::= { teMIB 1 }
   teMIBConformance   OBJECT IDENTIFIER ::= { teMIB 2 }

   -- **
   --
   -- TE MIB Objects
   --

   -- TE Info

   teInfo OBJECT IDENTIFIER ::= { teMIBObjects 1 }

   teDistProtocol   OBJECT-TYPE

```
        SYNTAX         BITS {
                          other(0),
                          isis(1),
                          ospf(2)
                       }
        MAX-ACCESS     read-only
        STATUS         current
        DESCRIPTION "IGP used to distribute Traffic Engineering
                     information and topology to each device for the
                     purpose of automatic path computation.  More than
                     one IGP may be used to distribute TE information.
                    "
        ::= { teInfo 1 }

    teSignalingProto OBJECT-TYPE
        SYNTAX         BITS {
                          other(0),
                          rsvpte(1),
                          crldp(2),
                          static(3)    -- static configuration
                       }
        MAX-ACCESS     read-only
        STATUS         current
        DESCRIPTION "Traffic Engineering signaling protocols supported
                     by this device.  More than one protocol may be
                     supported.
                    "
        REFERENCE   "For a description of RSVP-TE, see RFC 3209;
                     for CR-LDP, see RFC 3212.
                    "
        ::= { teInfo 2 }

    teNotificationEnable OBJECT-TYPE
        SYNTAX         TruthValue
        MAX-ACCESS     read-write
        STATUS         current
        DESCRIPTION "If this object is true, then it enables the
                     generation of notifications from this MIB module.
                     Otherwise notifications are not generated.
                    "
        DEFVAL { false }
        ::= { teInfo 3 }

    teNextTunnelIndex OBJECT-TYPE
        SYNTAX         Unsigned32
        MAX-ACCESS     read-only
        STATUS         current
        DESCRIPTION "An integer that may be used as a new Index in the
```

teTunnelTable.

The special value of 0 indicates that no more new
entries can be created in that table.

When this MIB module is used for configuration, this
object always contains a legal value (if non-zero)
for an index that is not currently used in that
table. The Command Generator (Network Management
Application) reads this variable and uses the
(non-zero) value read when creating a new row with
an SNMP SET. When the SET is performed, the Command
Responder (agent) must determine whether the value
is indeed still unused; Two Network Management
Applications may attempt to create a row
(configuration entry) simultaneously and use the
same value. If it is currently unused, the SET
succeeds, and the Command Responder (agent) changes
the value of this object according to an
implementation-specific algorithm. If the value is
in use, however, the SET fails. The Network
Management Application must then re-read this
variable to obtain a new usable value.
                  "
        ::= { teInfo 4 }

    teNextPathHopIndex OBJECT-TYPE
        SYNTAX   Unsigned32
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION "An integer that may be used as a new Index in the
                      tePathHopTable.

                      The special value of 0 indicates that no more new
                      entries can be created in that table.

                      When this MIB module is used for configuration, this
                      object always contains a legal value (if non-zero)
                      for an index that is not currently used in that
                      table. The Command Generator (Network Management
                      Application) reads this variable and uses the
                      (non-zero) value read when creating a new row with
                      an SNMP SET. When the SET is performed, the Command
                      Responder (agent) must determine whether the value
                      is indeed still unused; Two Network Management
                      Applications may attempt to create a row
                      (configuration entry) simultaneously and use the
                      same value. If it is currently unused, the SET

```
                        succeeds, and the Command Responder (agent) changes
                        the value of this object according to an
                        implementation-specific algorithm.  If the value is
                        in use, however, the SET fails.  The Network
                        Management Application must then re-read this
                        variable to obtain a new usable value.
                        "
        ::= { teInfo 5 }

    teConfiguredTunnels OBJECT-TYPE
        SYNTAX        Gauge32
        MAX-ACCESS    read-only
        STATUS        current
        DESCRIPTION "Number of currently configured Tunnels."
        ::= { teInfo 6 }

    teActiveTunnels  OBJECT-TYPE
        SYNTAX        Gauge32
        MAX-ACCESS    read-only
        STATUS        current
        DESCRIPTION "Number of currently active Tunnels."
        ::= { teInfo 7 }

    tePrimaryTunnels OBJECT-TYPE
        SYNTAX        Gauge32
        MAX-ACCESS    read-only
        STATUS        current
        DESCRIPTION "Number of currently active Tunnels running on
                        their primary paths.
                        "
        ::= { teInfo 8 }

    teAdminGroupTable OBJECT-TYPE
        SYNTAX          SEQUENCE OF TeAdminGroupEntry
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION "A mapping of configured administrative groups.  Each
                        entry represents an Administrative Group and
                        provides a name and index for the group.
                        Administrative groups are used to label links in the
                        Traffic Engineering topology in order to place
                        constraints (include and exclude) on Tunnel paths.

                        A groupName can only be linked to one group number.
                        The groupNumber is the number assigned to the
                        administrative group used in constraints,
                        such as tePathIncludeAny or tePathIncludeAll.
                        "
```

```
        ::= { teInfo 9 }

    teAdminGroupEntry OBJECT-TYPE
        SYNTAX         TeAdminGroupEntry
        MAX-ACCESS     not-accessible
        STATUS         current
        DESCRIPTION "A mapping between a configured group number and
                     its human-readable name.  The group number should
                     be between 1 and 32, inclusive.  Group number n
                     represents bit number (n-1) in the bit vector for
                     Include/Exclude constraints.

                     All entries in this table MUST be kept in stable
                     storage so that they will re-appear in case of a
                     restart/reboot.
                    "
        INDEX          { teAdminGroupNumber }
        ::= { teAdminGroupTable 1 }

    TeAdminGroupEntry ::=
        SEQUENCE {
            teAdminGroupNumber     Integer32,
            teAdminGroupName       SnmpAdminString,
            teAdminGroupRowStatus RowStatus
        }

    teAdminGroupNumber OBJECT-TYPE
        SYNTAX         Integer32 (1..32)
        MAX-ACCESS     not-accessible
        STATUS         current
        DESCRIPTION "Index of the administrative group."
        ::= { teAdminGroupEntry 1 }

    teAdminGroupName OBJECT-TYPE
        SYNTAX         SnmpAdminString (SIZE (1..32))
        MAX-ACCESS     read-create
        STATUS         current
        DESCRIPTION "Name of the administrative group."
        ::= { teAdminGroupEntry 2 }

    teAdminGroupRowStatus OBJECT-TYPE
        SYNTAX         RowStatus
        MAX-ACCESS     read-create
        STATUS         current
        DESCRIPTION "The status of this conceptual row.

                     The value of this object has no effect on whether
                     other objects in this conceptual row can be
```

```
                    modified.
                  "
       ::= { teAdminGroupEntry 3 }

    -- Tunnel Table

    teTunnelTable    OBJECT-TYPE
        SYNTAX       SEQUENCE OF TeTunnelEntry
        MAX-ACCESS   not-accessible
        STATUS       current
        DESCRIPTION "Table of Configured Traffic Tunnels."
        ::= { teMIBObjects 2 }

    teTunnelEntry    OBJECT-TYPE
        SYNTAX       TeTunnelEntry
        MAX-ACCESS   not-accessible
        STATUS       current
        DESCRIPTION "Entry containing information about a particular
                     Traffic Tunnel.
                  "
        INDEX        { teTunnelIndex }
        ::= { teTunnelTable 1 }

    TeTunnelEntry ::=
        SEQUENCE {
            teTunnelIndex                 Unsigned32,
            teTunnelName                  SnmpAdminString,
            teTunnelNextPathIndex         Unsigned32,
         -- Conceptual row information:
            teTunnelRowStatus             RowStatus,
            teTunnelStorageType           StorageType,
         -- Address information:
            teTunnelSourceAddressType     TeHopAddressType,
            teTunnelSourceAddress         TeHopAddress,
            teTunnelDestinationAddressType TeHopAddressType,
            teTunnelDestinationAddress    TeHopAddress,
         -- State/performance information:
            teTunnelState                 INTEGER,
            teTunnelDiscontinuityTimer    TimeStamp,
            teTunnelOctets                Counter64,
            teTunnelPackets               Counter64,
            teTunnelLPOctets              Counter32,
            teTunnelLPPackets             Counter32,
            teTunnelAge                   TimeTicks,
            teTunnelTimeUp                TimeTicks,
            teTunnelPrimaryTimeUp         TimeTicks,
            teTunnelTransitions           Counter32,
            teTunnelLastTransition        TimeTicks,
```

```
            teTunnelPathChanges                 Counter32,
            teTunnelLastPathChange              TimeTicks,
            teTunnelConfiguredPaths             Gauge32,
            teTunnelStandbyPaths                Gauge32,
            teTunnelOperationalPaths            Gauge32
        }

    teTunnelIndex       OBJECT-TYPE
        SYNTAX          Unsigned32 (1..4294967295)
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION "A unique index that identifies a Tunnel.  If the TE
                     Tunnel is considered an interface, then this index
                     must match the interface index of the corresponding
                     interface.  Otherwise, this index must be at least
                     2^24, so that it does not overlap with any existing
                     interface index.
                    "
        ::= { teTunnelEntry 1 }

    teTunnelName        OBJECT-TYPE
        SYNTAX          SnmpAdminString (SIZE (1..32))
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION "Name of the Traffic Tunnel.

                     Note that the name of a Tunnel MUST be unique.
                     When a SET request contains a name that is already
                     in use for another entry, then the implementation
                     must return an inconsistentValue error.

                     The value of this object cannot be changed if the
                     if the value of the corresponding teTunnelRowStatus
                     object is 'active'.
                    "
        ::= { teTunnelEntry 2 }

    teTunnelNextPathIndex   OBJECT-TYPE
        SYNTAX          Unsigned32
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION "An integer that may be used as a new Index for the
                     next Path in this Tunnel.

                     The special value of 0 indicates that no more Paths
                     can be created for this Tunnel, or that no more new
                     entries can be created in tePathTable.
```

                         When this MIB module is used for configuration, this
                         object always contains a legal value (if non-zero)
                         for an index that is not currently used in that
                         table. The Command Generator (Network Management
                         Application) reads this variable and uses the
                         (non-zero) value read when creating a new row with
                         an SNMP SET. When the SET is performed, the Command
                         Responder (agent) must determine whether the value
                         is indeed still unused; Two Network Management
                         Applications may attempt to create a row
                         (configuration entry) simultaneously and use the
                         same value. If it is currently unused, the SET
                         succeeds, and the Command Responder (agent) changes
                         the value of this object according to an
                         implementation-specific algorithm. If the value is
                         in use, however, the SET fails. The Network
                         Management Application must then re-read this
                         variable to obtain a new usable value.
                         "
         ::= { teTunnelEntry 3 }

    teTunnelRowStatus OBJECT-TYPE
         SYNTAX   RowStatus
         MAX-ACCESS   read-create
         STATUS   current
         DESCRIPTION "The status of this conceptual row.

                         When the value of this object is 'active', then
                         the values for the corresponding objects
                         teTunnelName, teTunnelSourceAddressType,
                         teTunnelSourceAddress,
                         teTunnelDestinationAddressType, and
                         teTunnelDestinationAddress cannot be changed.
                         "
         ::= { teTunnelEntry 4 }

    teTunnelStorageType OBJECT-TYPE
         SYNTAX   StorageType
         MAX-ACCESS   read-create
         STATUS   current
         DESCRIPTION "The storage type for this conceptual row.

                         Conceptual rows having the value 'permanent' need
                         not allow write-access to any columnar objects
                         in the row.
                         "
         ::= { teTunnelEntry 5 }

```
    teTunnelSourceAddressType OBJECT-TYPE
        SYNTAX        TeHopAddressType
        MAX-ACCESS    read-create
        STATUS        current
        DESCRIPTION "The type of Traffic Engineered Tunnel hop address
                     for the source of this Tunnel.  Typically, this
                     address type is IPv4 or IPv6, with a prefix length
                     of 32 or 128, respectively.  If the TE Tunnel path
                     is being computed by a path computation server,
                     however, it is possible to use more flexible source
                     address types, such as AS numbers or prefix lengths
                     less than host address lengths.

                     The value of this object cannot be changed
                     if the value of the corresponding teTunnelRowStatus
                     object is 'active'.
                    "
        ::= { teTunnelEntry 6 }

    teTunnelSourceAddress OBJECT-TYPE
        SYNTAX        TeHopAddress
        MAX-ACCESS    read-create
        STATUS        current
        DESCRIPTION "The Source Traffic Engineered Tunnel hop address of
                     this Tunnel.

                     The type of this address is determined by the value
                     of the corresponding teTunnelSourceAddressType.

                     Note that the source and destination addresses of a
                     Tunnel can be different address types.

                     The value of this object cannot be changed
                     if the value of the corresponding teTunnelRowStatus
                     object is 'active'.
                    "
        ::= { teTunnelEntry 7 }

    teTunnelDestinationAddressType OBJECT-TYPE
        SYNTAX        TeHopAddressType
        MAX-ACCESS    read-create
        STATUS        current
        DESCRIPTION "The type of Traffic Engineered Tunnel hop address
                     for the destination of this Tunnel.

                     The value of this object cannot be changed
                     if the value of the corresponding teTunnelRowStatus
                     object is 'active'.
```

```
                          "
          ::= { teTunnelEntry 8 }

   teTunnelDestinationAddress OBJECT-TYPE
       SYNTAX        TeHopAddress
       MAX-ACCESS    read-create
       STATUS        current
       DESCRIPTION "The Destination Traffic Engineered Tunnel hop
                    address of this Tunnel.

                    The type of this address is determined by the value
                    of the corresponding teTunnelDestinationAddressType.

                    Note that source and destination addresses of a
                    Tunnel can be different address types.

                    The value of this object cannot be changed
                    if the value of the corresponding teTunnelRowStatus
                    object is 'active'.
                          "
          ::= { teTunnelEntry 9 }

   teTunnelState      OBJECT-TYPE
       SYNTAX         INTEGER {
                        unknown(1),
                        up(2),
                        down(3),
                        testing(4)
                      }
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION "The operational state of the Tunnel."
       ::= { teTunnelEntry 10 }

   teTunnelDiscontinuityTimer OBJECT-TYPE
       SYNTAX        TimeStamp
       MAX-ACCESS    read-only
       STATUS        current
       DESCRIPTION "The value of sysUpTime on the most recent occasion
                    at which any one or more of this tunnel's counters
                    suffered a discontinuity.  The relevant counters
                    are teTunnelOctets, teTunnelPackets,
                    teTunnelLPOctets, and teTunnelLPPackets.  If no such
                    discontinuities have occurred since the last
                    re-initialization of the local management subsystem
                    then this object contains a zero value.
                          "
          ::= { teTunnelEntry 11 }
```

```
teTunnelOctets    OBJECT-TYPE
    SYNTAX        Counter64
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION "The number of octets that have been forwarded over
                 the Tunnel.

                 Discontinuities in the value of this counter can
                 occur at re-initialization of the management system,
                 and at other times, as indicated by the value of
                 teTunnelDiscontinuityTimer.
                "
    ::= { teTunnelEntry 12 }

teTunnelPackets   OBJECT-TYPE
    SYNTAX        Counter64
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION "The number of packets that have been forwarded over
                 the Tunnel.

                 Discontinuities in the value of this counter can
                 occur at re-initialization of the management system
                 and at other times, as indicated by the value of
                 teTunnelDiscontinuityTimer.
                "
    ::= { teTunnelEntry 13 }

teTunnelLPOctets OBJECT-TYPE
    SYNTAX        Counter32
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION "The number of octets that have been forwarded over
                 the Tunnel.

                 Discontinuities in the value of this counter can
                 occur at re-initialization of the management system
                 and at other times, as indicated by the value of
                 teTunnelDiscontinuityTimer.
                "
    ::= { teTunnelEntry 14 }

teTunnelLPPackets OBJECT-TYPE
    SYNTAX        Counter32
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION "The number of packets that have been forwarded over
                 the Tunnel.
```

                        Discontinuities in the value of this counter can
                        occur at re-initialization of the management system
                        and at other times, as indicated by the value of
                        teTunnelDiscontinuityTimer.
                     "
        ::= { teTunnelEntry 15 }

     teTunnelAge   OBJECT-TYPE
        SYNTAX   TimeTicks
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION "The age (i.e., time from creation of this conceptual
                        row till now) of this Tunnel in hundredths of a
                        second. Note that because TimeTicks wrap in about
                        16 months, this value is best used in interval
                        measurements.
                     "
        ::= { teTunnelEntry 16 }

     teTunnelTimeUp   OBJECT-TYPE
        SYNTAX   TimeTicks
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION "The total time in hundredths of a second that this
                        Tunnel has been operational. Note that because
                        TimeTicks wrap in about 16 months, this value is
                        best used in interval measurements.

                        An example of usage of this object would be to
                        compute the percentage up time over a period of time
                        by obtaining values of teTunnelAge and
                        teTunnelTimeUp at two points in time and computing
                        the following ratio:
                        ((teTunnelTimeUp2 - teTunnelTimeUp1)/
                        (teTunnelAge2 - teTunnelAge1)) * 100 %. In doing
                        so, the management station must account for
                        wrapping of the values of teTunnelAge and
                        teTunnelTimeUp between the two measurements.
                     "
        ::= { teTunnelEntry 17 }

     teTunnelPrimaryTimeUp OBJECT-TYPE
        SYNTAX   TimeTicks
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION "The total time in hundredths of a second that this
                        Tunnel's primary path has been operational. Note
                        that because TimeTicks wrap in about 16 months, this

value is best used in interval measurements.

An example of usage of this field would be to
compute what percentage of time that a TE Tunnel was
on the primary path over a period of time by
computing
((teTunnelPrimaryTimeUp2 - teTunnelPrimaryTimeUp1)/
(teTunnelTimeUp2 - teTunnelTimeUp1))*100 %. In
doing so, the management station must account for
wrapping of the values of teTunnelPrimaryTimeUp and
teTunnelTimeUp between the two measurements.
                "
    ::= { teTunnelEntry 18 }

teTunnelTransitions OBJECT-TYPE
    SYNTAX   Counter32
    MAX-ACCESS   read-only
    STATUS   current
    DESCRIPTION "The number of operational state transitions
                (up -> down and down -> up) this Tunnel has
                undergone.
                "
    ::= { teTunnelEntry 19 }

teTunnelLastTransition OBJECT-TYPE
    SYNTAX   TimeTicks
    MAX-ACCESS   read-only
    STATUS   current
    DESCRIPTION "The time in hundredths of a second since the last
                operational state transition occurred on this
                Tunnel.

                Note that if the last transition was over 16
                months ago, this value will be inaccurate.
                "
    ::= { teTunnelEntry 20 }

teTunnelPathChanges OBJECT-TYPE
    SYNTAX   Counter32
    MAX-ACCESS   read-only
    STATUS   current
    DESCRIPTION "The number of path changes this Tunnel has had."
    ::= { teTunnelEntry 21 }

teTunnelLastPathChange OBJECT-TYPE
    SYNTAX   TimeTicks
    MAX-ACCESS   read-only
    STATUS   current

```
        DESCRIPTION "The time in hundredths of a second since the last
                     path change occurred on this Tunnel.

                     Note that if the last transition was over 16
                     months ago, this value will be inaccurate.

                     Path changes may be caused by network events or by
                     reconfiguration that affects the path.
                     "
        ::= { teTunnelEntry 22 }

    teTunnelConfiguredPaths OBJECT-TYPE
        SYNTAX        Gauge32
        MAX-ACCESS    read-only
        STATUS        current
        DESCRIPTION "The number of paths configured for this Tunnel."
        ::= { teTunnelEntry 23 }

    teTunnelStandbyPaths OBJECT-TYPE
        SYNTAX        Gauge32
        MAX-ACCESS    read-only
        STATUS        current
        DESCRIPTION "The number of standby paths configured for this
                     Tunnel.
                     "
        ::= { teTunnelEntry 24 }

    teTunnelOperationalPaths OBJECT-TYPE
        SYNTAX        Gauge32
        MAX-ACCESS    read-only
        STATUS        current
        DESCRIPTION "The number of operational paths for this Tunnel.
                     This includes the path currently active, as
                     well as operational standby paths.
                     "
        ::= { teTunnelEntry 25 }

    -- ****************************************************************
    --
    -- Tunnel Path Table
    --

    tePathTable       OBJECT-TYPE
        SYNTAX        SEQUENCE OF TePathEntry
        MAX-ACCESS    not-accessible
        STATUS        current
        DESCRIPTION "Table of Configured Traffic Tunnels."
        ::= { teMIBObjects 3 }
```

```
    tePathEntry        OBJECT-TYPE
        SYNTAX         TePathEntry
        MAX-ACCESS     not-accessible
        STATUS         current
        DESCRIPTION "Entry containing information about a particular
                     Traffic Tunnel.  Each Traffic Tunnel can have zero
                     or more Traffic Paths.

                     As a Traffic Path can only exist over an existing
                     Traffic Tunnel, all tePathEntries with
                     a value of n for teTunnelIndex MUST be removed by
                     the implementation when the corresponding
                     teTunnelEntry with a value of n for teTunnelIndex
                     is removed.
                     "
        INDEX          { teTunnelIndex, tePathIndex }
        ::= { tePathTable 1 }

    TePathEntry ::=
        SEQUENCE {
            tePathIndex                 Unsigned32,
            tePathName                  SnmpAdminString,
         -- Conceptual row information
            tePathRowStatus             RowStatus,
            tePathStorageType           StorageType,
         -- Path properties
            tePathType                  INTEGER,
            tePathConfiguredRoute       Unsigned32,
            tePathBandwidth             MplsBitRate,
            tePathIncludeAny            Unsigned32,
            tePathIncludeAll            Unsigned32,
            tePathExclude               Unsigned32,
            tePathSetupPriority         Integer32,
            tePathHoldPriority          Integer32,
            tePathProperties            BITS,
         -- Path status
            tePathOperStatus            INTEGER,
            tePathAdminStatus           INTEGER,
            tePathComputedRoute         Unsigned32,
            tePathRecordedRoute         Unsigned32
        }

    tePathIndex        OBJECT-TYPE
        SYNTAX         Unsigned32 (1..4294967295)
        MAX-ACCESS     not-accessible
        STATUS         current
        DESCRIPTION "An index that uniquely identifies a path within
                     a Tunnel.
```

                      The combination of <teTunnelIndex, tePathIndex> thus
                      uniquely identifies a path among all paths on this
                      router.
                      "
        ::= { tePathEntry 1 }

    tePathName   OBJECT-TYPE
        SYNTAX   SnmpAdminString (SIZE(0..32))
        MAX-ACCESS   read-create
        STATUS   current
        DESCRIPTION "The name of this path.

                      A pathName must be unique within the set of paths
                      over a single tunnel. If a SET request is received
                      with a duplicate name, then the implementation MUST
                      return an inconsistentValue error.

                      The value of this object cannot be changed
                      if the value of the corresponding teTunnelRowStatus
                      object is 'active'.
                      "
        ::= { tePathEntry 2 }

    tePathRowStatus   OBJECT-TYPE
        SYNTAX   RowStatus
        MAX-ACCESS   read-create
        STATUS   current
        DESCRIPTION "The status of this conceptual row.

                      When the value of this object is 'active', then
                      the value of tePathName cannot be changed. All
                      other writable objects may be changed; however,
                      these changes may affect traffic going over the TE
                      tunnel or require the path to be computed and/or
                      re-signaled.
                      "
        ::= { tePathEntry 3 }

    tePathStorageType OBJECT-TYPE
        SYNTAX   StorageType
        MAX-ACCESS   read-create
        STATUS   current
        DESCRIPTION "The storage type for this conceptual row.

                      Conceptual rows having the value 'permanent' need
                      not allow write-access to any columnar objects
                      in the row.
                      "

```
        ::= { tePathEntry 4 }

    tePathType OBJECT-TYPE
        SYNTAX          INTEGER {
                            other(1),
                            primary(2),
                            standby(3),
                            secondary(4)
                        }
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION "The type for this PathEntry; i.e., whether this path
                    is a primary path, a standby path, or a secondary
                    path.
                    "
        ::= { tePathEntry 5 }

    tePathConfiguredRoute OBJECT-TYPE
        SYNTAX          Unsigned32
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION "The route that this TE path is configured to follow;
                    i.e., an ordered list of hops.  The value of this
                    object gives the primary index into the Hop Table.
                    The secondary index is the hop count in the path, so
                    to get the route, one could get the first hop with
                    index <tePathConfiguredRoute, 1> in the Hop Table
                    and do a getnext to get subsequent hops.
                    "
        ::= { tePathEntry 6 }

    tePathBandwidth  OBJECT-TYPE
        SYNTAX          MplsBitRate
        UNITS           "Kilobits per second"
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION "The configured bandwidth for this Tunnel,
                    in units of thousands of bits per second (Kbps).
                    "
        DEFVAL          { 0 }
        ::= { tePathEntry 7 }

    tePathIncludeAny OBJECT-TYPE
        SYNTAX          Unsigned32
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION "This is a configured set of administrative groups
                    specified as a bit vector (i.e., bit n is 1 if group
```

                         n is in the set, where n = 0 is the LSB). For each
                         link that this path goes through, the link must have
                         at least one of the groups specified in IncludeAny
                         to be acceptable. If IncludeAny is zero, all links
                         are acceptable.
                         "
         DEFVAL   { 0 }
         ::= { tePathEntry 8 }

    tePathIncludeAll OBJECT-TYPE

         SYNTAX   Unsigned32
         MAX-ACCESS   read-create
         STATUS   current
         DESCRIPTION "This is a configured set of administrative groups
                         specified as a bit vector (i.e., bit n is 1 if group
                         n is in the set, where n = 0 is the LSB). For each
                         link that this path goes through, the link must have
                         all of the groups specified in IncludeAll to be
                         acceptable. If IncludeAll is zero, all links are
                         acceptable.
                         "
         DEFVAL   { 0 }
         ::= { tePathEntry 9 }

    tePathExclude   OBJECT-TYPE
         SYNTAX   Unsigned32
         MAX-ACCESS   read-create
         STATUS   current
         DESCRIPTION "This is a configured set of administrative groups
                         specified as a bit vector (i.e., bit n is 1 if group
                         n is in the set, where n = 0 is the LSB). For each
                         link that this path goes through, the link MUST have
                         groups associated with it, and the intersection of
                         the link's groups and the 'exclude' set MUST be
                         null.
                         "
         DEFVAL   { 0 }
         ::= { tePathEntry 10 }

    tePathSetupPriority OBJECT-TYPE
         SYNTAX   Integer32 (0..7)
         MAX-ACCESS   read-create
         STATUS   current
         DESCRIPTION "The setup priority configured for this path, with 0
                         as the highest priority and 7 as the lowest.
                         "
         DEFVAL   { 7 }

```
        ::= { tePathEntry 11 }

    tePathHoldPriority OBJECT-TYPE
        SYNTAX      Integer32 (0..7)
        MAX-ACCESS  read-create
        STATUS      current
        DESCRIPTION "The hold priority configured for this path, with 0
                     as the highest priority and 7 as the lowest.
                    "
        DEFVAL      { 0 }
        ::= { tePathEntry 12 }

    tePathProperties OBJECT-TYPE
        SYNTAX      BITS {
                        recordRoute(0),
                        cspf(1),
                        makeBeforeBreak(2),
                        mergeable(3),
                        fastReroute(4),
                        protected(5)
                    }
        MAX-ACCESS  read-create
        STATUS      current
        DESCRIPTION "The set of configured properties for this path,
                     expressed as a bit map.  For example, if the path
                     supports 'make before break', then bit 2 is set.
                    "
        ::= { tePathEntry 13 }

    tePathOperStatus OBJECT-TYPE
        SYNTAX      INTEGER {
                        unknown(0),
                        down(1),
                        testing(2),
                        dormant(3),
                        ready(4),
                        operational(5)
                    }
        MAX-ACCESS  read-only
        STATUS      current
        DESCRIPTION "The operational status of the path:
                     unknown:
                     down:       Signaling failed.
                     testing:    Administratively set aside for testing.
                     dormant:    Not signaled (for a backup tunnel).
                     ready:      Signaled but not yet carrying traffic.
                     operational: Signaled and carrying traffic.
                    "
```

```
        ::= { tePathEntry 14 }

   tePathAdminStatus OBJECT-TYPE
       SYNTAX          INTEGER {
                           normal(1),
                           testing(2)
                       }
       MAX-ACCESS   read-create
       STATUS       current
       DESCRIPTION "The operational status of the path:
                    normal:     Used normally for forwarding.
                    testing:    Administratively set aside for testing.
                   "
        ::= { tePathEntry 15 }

   tePathComputedRoute OBJECT-TYPE
       SYNTAX          Unsigned32
       MAX-ACCESS   read-only
       STATUS       current
       DESCRIPTION "The route computed for this path, perhaps using
                    some form of Constraint-based Routing.  The
                    algorithm is implementation dependent.

                    This object returns the computed route as an ordered
                    list of hops.  The value of this object gives the
                    primary index into the Hop Table.  The secondary
                    index is the hop count in the path, so to get the
                    route, one could get the first hop with index
                    <tePathComputedRoute, 1> in the Hop Table and do a
                    getnext to get subsequent hops.

                    A value of zero (0) means there is no computedRoute.
                   "
        ::= { tePathEntry 16 }

   tePathRecordedRoute OBJECT-TYPE
       SYNTAX          Unsigned32
       MAX-ACCESS   read-only
       STATUS       current
       DESCRIPTION "The route actually used for this path, as recorded
                    by the signaling protocol.  This is again an ordered
                    list of hops; each hop is expected to be strict.

                    The value of this object gives the primary index
                    into the Hop Table.  The secondary index is the hop
                    count in the path, so to get the route, one can get
                    the first hop with index <tePathRecordedRoute, 1>
                    in the Hop Table and do a getnext to get subsequent
```

                  hops.

                  A value of zero (0) means there is no recordedRoute.
                  "
     ::= { tePathEntry 17 }

    -- ***
    --
    -- Tunnel Path Hop Table
    --

    tePathHopTable   OBJECT-TYPE
        SYNTAX   SEQUENCE OF TePathHopEntry
        MAX-ACCESS   not-accessible
        STATUS   current
        DESCRIPTION "Table of Tunnel Path Hops."
        ::= { teMIBObjects 4 }

    tePathHopEntry   OBJECT-TYPE
        SYNTAX   TePathHopEntry
        MAX-ACCESS   not-accessible
        STATUS   current
        DESCRIPTION "Entry containing information about a particular
                     hop.
                     "
        INDEX   { teHopListIndex, tePathHopIndex }
        ::= { tePathHopTable 1 }

    TePathHopEntry ::=
        SEQUENCE {
            teHopListIndex   Unsigned32,
            tePathHopIndex   Unsigned32,
          -- Conceptual row information
            tePathHopRowStatus   RowStatus,
            tePathHopStorageType   StorageType,
            tePathHopAddrType   TeHopAddressType,
            tePathHopAddress   TeHopAddress,
            tePathHopType   INTEGER
        }

    teHopListIndex   OBJECT-TYPE
        SYNTAX   Unsigned32 (1..4294967295)
        MAX-ACCESS   not-accessible
        STATUS   current
        DESCRIPTION "An index that identifies a list of hops. This is
                     the primary index to access hops.
                     "
        ::= { tePathHopEntry 1 }

```
    tePathHopIndex    OBJECT-TYPE
        SYNTAX        Unsigned32 (1..4294967295)
        MAX-ACCESS    not-accessible
        STATUS        current
        DESCRIPTION "An index that identifies a particular hop among the
                     list of hops for a path.  An index of i identifies
                     the ith hop.  This is the secondary index for a hop
                     entry.
                    "
        ::= { tePathHopEntry 2 }

    tePathHopRowStatus OBJECT-TYPE
        SYNTAX        RowStatus
        MAX-ACCESS    read-create
        STATUS        current
        DESCRIPTION "The status of this conceptual row.

                     Any field in this table can be changed, even if the
                     value of this object is 'active'.  However, such a
                     change may cause traffic to be rerouted or even
                     disrupted.
                    "
        ::= { tePathHopEntry 3 }

    tePathHopStorageType OBJECT-TYPE
        SYNTAX        StorageType
        MAX-ACCESS    read-create
        STATUS        current
        DESCRIPTION "The storage type for this conceptual row.

                     Conceptual rows having the value 'permanent' need
                     not allow write-access to any columnar objects
                     in the row.
                    "
        ::= { tePathHopEntry 4 }

    tePathHopAddrType OBJECT-TYPE
        SYNTAX        TeHopAddressType
        MAX-ACCESS    read-create
        STATUS        current
        DESCRIPTION "The type of Traffic Engineered Tunnel hop Address
                     of this hop.

                     The value of this object cannot be changed
                     if the value of the corresponding tePathRowStatus
                     object is 'active'.
                    "
        ::= { tePathHopEntry 5 }
```

```
   tePathHopAddress OBJECT-TYPE
       SYNTAX       TeHopAddress
       MAX-ACCESS   read-create
       STATUS       current
       DESCRIPTION "The Traffic Engineered Tunnel hop Address of this
                    hop.

                    The type of this address is determined by the value
                    of the corresponding tePathHopAddressType.

                    The value of this object cannot be changed
                    if the value of the corresponding teTunnelRowStatus
                    object is 'active'.
                   "
       ::= { tePathHopEntry 6 }

   tePathHopType    OBJECT-TYPE
       SYNTAX       INTEGER {
                        unknown(0),
                        loose(1),
                        strict(2)
                    }
       MAX-ACCESS   read-only
       STATUS       current
       DESCRIPTION "The type of hop:
                    unknown:
                    loose:    This hop is a LOOSE hop.
                    strict:   This hop is a STRICT hop.
                   "
       ::= { tePathHopEntry 7 }

   -- ****************************************************************
   --
   -- TE Notifications
   --

   teTunnelUp       NOTIFICATION-TYPE
       OBJECTS      { teTunnelName,
                      tePathName }  -- TunnelPath
       STATUS       current
       DESCRIPTION "A teTunnelUp notification is generated when the
                    Tunnel indexed by teTunnelName transitions to the
                    'up' state.

                    A tunnel is up when at least one of its paths is up.
                    The tePathName is the name of the path whose
                    transition to up made the tunnel go up.
```

```
                      This notification MUST be limited to at most one
                      every minute, in case the tunnel flaps up and down.
                     "
         ::= { teMIBNotifications 1 }

     teTunnelDown       NOTIFICATION-TYPE
         OBJECTS        { teTunnelName,
                          tePathName }  -- TunnelPath
         STATUS         current
         DESCRIPTION "A teTunnelDown notification is generated when the
                      Tunnel indexed by teTunnelName transitions to the
                      'down' state.

                      A tunnel is up when at least one of its paths is up.
                      The tePathName is the name of the path whose
                      transition to down made the tunnel go down.

                      This notification MUST be limited to at most one
                      every minute, in case the tunnel flaps up and down.
                     "
         ::= { teMIBNotifications 2 }

     teTunnelChanged  NOTIFICATION-TYPE
         OBJECTS        { teTunnelName,
                          tePathName }  -- toTunnelPath
         STATUS         current
         DESCRIPTION "A teTunnelChanged notification is generated when an
                      active path on the Tunnel indexed by teTunnelName
                      changes or a new path becomes active.  The value
                      of tePathName is the new active path.

                      This notification MUST be limited to at most one
                      every minute, in case the tunnel changes quickly.
                     "
         ::= { teMIBNotifications 3 }

     teTunnelRerouted NOTIFICATION-TYPE
         OBJECTS        { teTunnelName,
                          tePathName }  -- toTunnelPath
         STATUS         current
         DESCRIPTION "A teTunnelRerouted notification is generated when
                      an active path for the Tunnel indexed by
                      teTunnelName stays the same, but its route changes.

                      This notification MUST be limited to at most one
                      every minute, in case the tunnel reroutes quickly.
                     "
         ::= { teMIBNotifications 4 }
```

```
    -- End of TE-MIB objects

    -- ************************************************************
    --
    -- TE Compliance Statements
    --

    teGroups
        OBJECT IDENTIFIER ::= { teMIBConformance 1 }

    teModuleCompliance
        OBJECT IDENTIFIER ::= { teMIBConformance 2 }

    -- ************************************************************
    --
    -- TE object groups
    --

    teTrafficEngineeringGroup OBJECT-GROUP
        OBJECTS {
            teTunnelName,
            teTunnelNextPathIndex,
            teTunnelRowStatus,
            teTunnelStorageType,
            teTunnelSourceAddressType,
            teTunnelSourceAddress,
            teTunnelDestinationAddressType,
            teTunnelDestinationAddress,
            teTunnelState,
            teTunnelDiscontinuityTimer,
            teTunnelOctets,
            teTunnelPackets,
            teTunnelLPOctets,
            teTunnelLPPackets,
            teTunnelAge,
            teTunnelTimeUp,
            teTunnelPrimaryTimeUp,
            teTunnelTransitions,
            teTunnelLastTransition,
            teTunnelPathChanges,
            teTunnelLastPathChange,
            teTunnelConfiguredPaths,
            teTunnelStandbyPaths,
            teTunnelOperationalPaths,
            tePathBandwidth,
            tePathIncludeAny,
            tePathIncludeAll,
            tePathExclude,
```

```
               tePathSetupPriority,
               tePathHoldPriority,
               tePathProperties,
               tePathOperStatus,
               tePathAdminStatus,
               tePathComputedRoute,
               tePathRecordedRoute,
               teDistProtocol,
               teSignalingProto,
               teNotificationEnable,
               teNextTunnelIndex,
               teNextPathHopIndex,
               teAdminGroupName,
               teAdminGroupRowStatus,
               teConfiguredTunnels,
               teActiveTunnels,
               tePrimaryTunnels,
               tePathName,
               tePathType,
               tePathRowStatus,
               tePathStorageType,
               tePathConfiguredRoute,
               tePathHopRowStatus,
               tePathHopStorageType,
               tePathHopAddrType,
               tePathHopAddress,
               tePathHopType
           }
        STATUS        current
        DESCRIPTION "Objects for Traffic Engineering in this MIB module."
        ::= { teGroups 1 }

    teNotificationGroup NOTIFICATION-GROUP
        NOTIFICATIONS {
            teTunnelUp,
            teTunnelDown,
            teTunnelChanged,
            teTunnelRerouted
        }
        STATUS        current
        DESCRIPTION "Notifications specified in this MIB module."
        ::= { teGroups 2 }

    -- ************************************************************
    --
    -- TE compliance statements
    --
    --     There are four compliance statements: read-only and full
```

```
--       compliance for regular TE devices, and read-only and full
--       compliance for path computation servers.
--

teModuleReadOnlyCompliance MODULE-COMPLIANCE
    STATUS        current
    DESCRIPTION "When this MIB module is implemented without support
                 for read-create (i.e., in read-only mode), then such
                 an implementation can claim read-only compliance.
                 Such a device can be monitored but cannot be
                 configured with this MIB module.
                "

    MODULE          -- enclosing module, i.e., TE-MIB

        MANDATORY-GROUPS {
            teTrafficEngineeringGroup
        }

        GROUP         teNotificationGroup
        DESCRIPTION "Implementation of this group is optional."

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

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

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

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

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

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

```
            OBJECT          teTunnelSourceAddressType
            SYNTAX          TeHopAddressType { ipv4(1), ipv6(2) }
            MIN-ACCESS      read-only
            DESCRIPTION "Write access is not required.  An
                         implementation is only required to support
                         IPv4 and IPv6 host addresses."

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

    ::= { teModuleCompliance 1 }

  teModuleFullCompliance MODULE-COMPLIANCE
      STATUS          current
      DESCRIPTION "When this MIB module is implemented with support for
                   read-create, then the implementation can claim
                   full compliance.  Such devices can be both
```

                    monitored and configured with this MIB module.
              "

       MODULE   -- enclosing module, i.e., TE-MIB

           MANDATORY-GROUPS {
               teTrafficEngineeringGroup
           }

           GROUP   teNotificationGroup
           DESCRIPTION "Implementation of this group is optional."

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

           OBJECT   teTunnelRowStatus
           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.
                      "

           OBJECT   teTunnelSourceAddressType
           SYNTAX   TeHopAddressType { ipv4(1), ipv6(2) }
           DESCRIPTION "Write access is required. An implementation is
                        only required to support IPv4 and IPv6 host
                        addresses.
                      "

           OBJECT   tePathRowStatus
           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.
                      "

           OBJECT   tePathHopRowStatus
           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.
                      "
        ::= { teModuleCompliance 2 }

    teModuleServerReadOnlyCompliance MODULE-COMPLIANCE
        STATUS        current
        DESCRIPTION "When this MIB module is implemented by a path
                      computation server without support for read-create
                      (i.e., in read-only mode), then the implementation
                      can claim read-only compliance.  Such
                      a device can be monitored but cannot be
                      configured with this MIB module.
                    "

        MODULE         -- enclosing module, i.e., TE-MIB

          MANDATORY-GROUPS {
              teTrafficEngineeringGroup
          }

          GROUP         teNotificationGroup
          DESCRIPTION "Implementation of this group is optional."

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

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

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

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

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

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

            OBJECT          teTunnelSourceAddressType
            MIN-ACCESS      read-only
            DESCRIPTION "Write access is not required.  A path
                         computation server SHOULD implement all types
                         of tunnel source address types.
                        "

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

        ::= { teModuleCompliance 3 }

     teModuleServerFullCompliance MODULE-COMPLIANCE
```

```
         STATUS         current
         DESCRIPTION "When this MIB module is implemented by a path
                      computation server with support for read-create,
                      then the implementation can claim full
                      compliance.
                     "

         MODULE         -- enclosing module, i.e., TE-MIB
            MANDATORY-GROUPS {
               teTrafficEngineeringGroup
            }

            GROUP          teNotificationGroup
            DESCRIPTION "Implementation of this group is optional."


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

            OBJECT          teTunnelRowStatus
            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.
                        "

            OBJECT          teTunnelSourceAddressType
            DESCRIPTION "Write access is required.  An implementation
                         of a path computation server SHOULD support all
                         types of tunnel source address types.
                        "

            OBJECT          tePathRowStatus
            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.
                        "

            OBJECT          tePathHopRowStatus
```

```
        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.
                    "
    ::= { teModuleCompliance 4 }

  END
```

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7. Security Considerations

   This MIB module relates to the configuration and management of
   Traffic Engineering tunnels. The unauthorized manipulation of fields
   in the tables teAdminGroupTable, teTunnelTable, tePathTable, and
   tePathHopTable may lead to tunnel flapping, tunnel paths being
   changed, or traffic being disrupted. In addition, if these tables
   are read by unauthorized parties, the information can be used to
   trace traffic patterns, traffic volumes, and tunnel paths. This may
   be considered proprietary and confidential information by some
   providers.

   There are a number of management objects defined in this MIB module
   with a MAX-ACCESS clause of read-write and/or read-create. Such
   objects may be considered sensitive or vulnerable in some network
   environments. The support for SET operations in a non-secure
   environment without proper protection can have a negative effect on
   network operations. These are the tables and objects and their
   sensitivity/vulnerability:

   teAdminGroupTable: Changing this will affect the semantics of include
   and exclude constraints, and thus traffic takes unintended routes.

   teTunnelTable: Changing this affects many properties of traffic
   tunnels.

   tePathTable: Changing this affects the constraints (including
   bandwidth) of tunnel paths, as well as the status of the path.

   tePathHopTable: Changing this affects the route followed by a traffic
   tunnel path.

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

         teTunnelTable: Describes tunnel endpoints and traffic volumes.
         tePathTable: Describes path properties.
         tePathHopTable: Describes path routes.

      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 this MIB module.

      It is RECOMMENDED that implementers consider the security features as
      provided by the SNMPv3 framework (see [9], section 8), including full
      support for the SNMPv3 cryptographic mechanisms (for authentication
      and privacy).

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

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