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Link Bundling Management Information Base

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[1.](#) 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 modeling link bundling as described in the Link Bundling in MPLS Traffic Engineering Internet Draft.

[2.](#) Introduction

OSPF [[OSPF](#)], Generalized MPLS (GMPLS) [[GMPLS](#)] and the Link Management Protocol (LMP) [[LMP](#)] use the concept of traffic engineering (TE) links to abstract link properties. The effect of this approach is the reduction of the amount of routing information exchanged in the network, which improves routing scalability. In addition, the use of TE link allows the implementation of new capabilities such as link protection.

We present in this document a MIB that can be used to manage TE links and their extension, the bundled link. This MIB enable both the configuration and the performance monitoring of TE links and bundled link.

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](#), reference [\[RFC2119\]](#).

3. Terminology

This document uses terminology from the documents describing link bundling [\[BUNDLING\]](#) and G-MPLS [\[GMPLS-ARCH\]](#).

The link bundling feature is designed to aggregate one or more similar entities between a node pair into a bundled link [\[BUNDLING\]](#). In the document, those entities are referred to as TE links. A TE link is a subinterface capable of carrying MPLS traffic engineered traffic. A TE Link may be comprised of only one underlying component links. In cases where more than one component link is to be combined, multiple component links should be created with differing priorities to indicate hot-standby or parallel utilization.

A bundled link is just another kind of Traffic Engineering (TE) link (see [\[GMPLS-OSPF\]](#)). A link bundle is a subinterface which bonds the traffic of a group of one or more TE links. There should be more than one TE Link in a link bundle, but this is not a requirement. Furthermore, if there are more than one TE link in a link bundle at some time, and at some point later, all but one of the links are deleted, the agent may choose to either delete the link bundle, or it may choose to leave it intact. Traffic counters on a link bundle are cumulative for all subinterfaces which it binds together.

4. The SNMP Management Framework

The SNMP Management Framework presently consists of five major components:

- An overall architecture, described in [RFC 2571](#) [\[RFC2571\]](#).

Mechanisms for describing and naming objects and events for the purpose of management. The first version of this Structure of Management Information (SMI) is called SMIV1 and described in STD 16, [RFC 1155](#) [\[RFC1155\]](#), STD 16, [RFC 1212](#) [\[RFC1212\]](#) and [RFC 1215](#) [\[RFC1215\]](#). The second version, called SMIV2, is described in STD 58, [RFC 2578](#) [\[RFC2578\]](#), STD 58, [RFC 2579](#) [\[RFC2579\]](#) and STD 58, [RFC 2580](#) [\[RFC2580\]](#).

- Message protocols for transferring management information. The first version of the SNMP message protocol is called SNMPv1 and described in STD 15, [RFC 1157](#) [\[RFC1157\]](#). A second version of the SNMP message protocol, which is not an Internet standards track protocol, is called SNMPv2c and described in [RFC 1901](#) [\[RFC1901\]](#) and [RFC 1906](#) [\[RFC1906\]](#). The third version of the

message protocol is called SNMPv3 and described in [RFC 1906](#) [[RFC1906](#)], [RFC 2572](#) [[RFC2572](#)] and [RFC 2574](#) [[RFC2574](#)].

- Protocol operations for accessing management information. The first set of protocol operations and associated PDU formats is described in STD 15, [RFC 1157](#) [[RFC1157](#)]. A second set of protocol operations and associated PDU formats is described in [RFC 1905](#) [[RFC1905](#)].
- A set of fundamental applications described in [RFC 2573](#) [[RFC2573](#)] and the view-based access control mechanism described in [RFC 2575](#) [[RFC2575](#)].

A more detailed introduction to the current SNMP Management Framework can be found in [RFC 2570](#) [[RFC2570](#)].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. Objects in the MIB are defined using the mechanisms defined in the SMI.

This memo specifies a MIB module that is compliant to the SMIV2. A MIB conforming to the SMIV1 can be produced through the appropriate translations. The resulting translated MIB must be semantically equivalent, except where objects or events are omitted because no translation is possible (use of Counter64). Some machine readable information in SMIV2 will be converted into textual descriptions in SMIV1 during the translation process. However, this loss of machine readable information is not considered to change the semantics of the MIB.

5. Feature Checklist

The link bundling MIB (LINK-BUNDLING-MIB) is designed to satisfy the following requirements and constraints:

- The MIB supports the management of TE links, including bundled links.
- Support is provided for configuration of traffic engineering parameters associated with TE links.
- The MIB is used to monitor the priority-based component link and TE link bandwidth values.

6. Outline

Configuring bundled links involves the following steps:

- Creating a bundled link.
- Creating TE links.
- Optionally specifying the shared risk link groups associated with the TE links.
- Configuring the component links including the bandwidth parameters and associating the component links with the appropriate TE link.
- Associating the TE links with the appropriate bundled link.

6.1. Summary of Link Bundling MIB

The MIB objects for performing these actions consist of the following tables:

- The TE link table (teLinkTable), which is used to specify TE links, including bundled links, and their generic traffic engineering parameters.
- The TE link descriptor table (teLinkDescriptorTable), which is used to enumerate the TE link descriptors.
- The TE link OSPF traffic engineering table (teLinkOspfTeTable), which is used for configuring OSPF traffic engineering parameters associated with TE links.
- The shared risk link group (SRLG) table (teLinkSrlgTable), which is used to specify the SRLGs associated with TE links.
- The TE link bandwidth table (teLinkBandwidthTable), which is used for reporting priority-based bandwidth values associated with TE links.
- The component link table (componentLinkTable), which is used to identify the component links that are associated with the TE links and specify the component link generic traffic engineering parameters.
- The component link descriptor table (componentLinkDescriptorTable), which is used to enumerate the component link descriptors.
- The component link bandwidth table (componentLinkBandwidthTable), which is used to report priority-based bandwidth values associated with component links.

These tables are described in the subsequent sections.

7. Brief Description of MIB Objects

Sections [7.1-7.5](#) describe objects pertaining to TE links. The MIB objects were derived from the link bundling document [[BUNDLING](#)].

7.1. teLinkTable

This table represents the TE links, including bundled links.

7.2. teLinkDescriptorTable

This table represents the TE link descriptors.

7.3. teLinkOspfTeTable

This table represents the OSPF traffic engineering parameters that are associated with the TE links.

7.4. teLinkSrlgTable

This table represents the shared risk link groups (SRLGs) associated with TE links.

7.5. teLinkBandwidthTable

This table specifies the priority-based bandwidth traffic engineering parameters associated with TE links.

7.6. componentLinkTable

This table enumerates the component links and their association with TE link.

7.7. componentLinkDescriptorTable

This table enumerates the link descriptors that each component link supports.

7.8. componentLinkBandwidthTable

The component link bandwidth table specifies the priority-based bandwidth values associated with the component links.

8. Example of Bundled Link Setup

In this section we provide a brief example of using the MIB objects described in [section 10](#) to set up a bundled link. While this example is not meant to illustrate every nuance of the MIB, it is intended as an aid to understanding some of the key concepts. It is meant to be read after going through the MIB itself.

Suppose that one would like to manually create a bundled link out of two 1:1 TE links. Assume that the bundled link is associated with SRLGs 10 and 50. Finally, let the component links be port entity interfaces (lambdas). The following example illustrates which rows and corresponding objects might be created to accomplish this.

First, a bundled link entry is created. An ifEntry with the same ifIndex and with ifType teLink needs to be created beforehand.

In teLinkTable:

```
{
    ifIndex                = 25,
    teLinkIpAddrType       = unknown(0),
    teLinkRowStatus        = createAndGo(4)
}
```

In ifStackTable:

```
{
    ifStackHigherLayer     = 0,
    ifStackLowerLayer      = 25,
    ifStackStatus          = createAndGo(4)
}
```

Next, the two TE links are created.

In teLinkTable:

```
{
    ifIndex                = 20,
    teLinkIpAddrType       = unknown(0),
    teLinkMetric           = 5,
    teLinkResourceClass    = 3,
    teLinkRowStatus        = createAndWait(5)
}
```

In ifStackTable:

```
{
    ifStackHigherLayer     = 25,
    ifStackLowerLayer      = 20,
    ifStackStatus          = createAndGo(4)
}
```



```
}
```

```
In teLinkTable:
```

```
{
    ifIndex                = 21,
    teLinkIpAddrType       = unknown(0),
    teLinkMetric           = 5,
    teLinkResourceClass    = 3,
    teLinkRowStatus        = createAndWait(5)
}
```

```
In ifStackTable:
```

```
{
    ifStackHigherLayer     = 25,
    ifStackLowerLayer      = 21,
    ifStackStatus          = createAndGo(4)
}
```

The OSPF traffic engineering parameters are configured for the TE links.

```
In teLinkOspfTeTable:
```

```
{
    ifIndex                = 20,
    teLinkOspfLinkId       = 'c0010101'H, -- 192.1.1.1
    teLinkRowStatus        = createAndGo(4)
}
```

```
In teLinkOspfTeTable:
```

```
{
    ifIndex                = 21,
    teLinkOspfLinkId       = 'c0010101'H, -- 192.1.1.1
    teLinkRowStatus        = createAndGo(4)
}
```

We assign SRLGs to the TE links.

```
In the teLinkSrlgTable:
```

```
{
    ifIndex                = 20,
    srlg                   = 10,
    srlgRowStatus          = createAndGo(4)
}
```

```
In the teLinkSrlgTable:
```

```
{
    ifIndex                = 21,
    srlg                   = 50,
}
```



```
    srlgRowStatus                = createAndGo(4)
}
```

The bundled link inherits the OSPF and SRLG properties from the associated TE links.

Next, for each TE link, two component links are created.
An ifEntry with the same ifIndex needs to be created beforehand.

In componentLinkTable:

```
{
    ifIndex                      = 40,
    componentLinkPreferredProtection = primary(1),
    componentLinkRowStatus        = createAndGo(4)
}
```

In ifStackTable:

```
{
    ifStackHigherLayer          = 20,
    ifStackLowerLayer           = 40,
    ifStackStatus                = createAndGo(4)
}
```

In componentLinkTable:

```
{
    ifIndex                      = 43,
    componentLinkPreferredProtection = secondary(2),
    componentLinkRowStatus        = createAndGo(4)
}
```

In ifStackTable:

```
{
    ifStackHigherLayer          = 20,
    ifStackLowerLayer           = 43,
    ifStackStatus                = createAndGo(4)
}
```

In componentLinkTable:

```
{
    ifIndex                      = 44,
    componentLinkPreferredProtection = primary(1),
    componentLinkRowStatus        = createAndGo(4)
}
```

In ifStackTable:

```
{
    ifStackHigherLayer          = 21,
    ifStackLowerLayer           = 44,
```



```
        ifStackStatus                = createAndGo(4)
    }

In componentLinkTable:
{
    ifIndex                          = 48,
    componentLinkPreferredProtection = secondary(2),
    componentLinkRowStatus           = createAndGo(4)
}

In ifStackTable:
{
    ifStackHigherLayer               = 21,
    ifStackLowerLayer                = 48,
    ifStackStatus                    = createAndGo(4)
}
```

In this example, once a component link is added to the componentLinkTable, the associated link descriptors are implicitly added to the componentLinkDescriptorTable.

TE link link descriptors are derived from their component link descriptors.

Note that the bandwidth attributes in teLinkDescriptorTable, componentLinkDescriptorTable, teLinkBandwidthTable and componentLinkBandwidthTable are maintained by the device according to LSP creation/deletion at different priorities. The values in the teLinkBandwidthTable are an aggregation of the values for the component links of the TE links and the TE links of the bundled link.

9. Application of the Interfaces Group to TE Links

The Interfaces Group [[RFC2863](#)] defines generic managed objects for managing interfaces. This memo contains the media-specific extensions to the Interfaces Group for managing TE Link interfaces as logical interfaces.

This memo assumes the interpretation of the Interfaces Group to be in accordance with [[RFC2863](#)] which states that the interfaces table (ifTable) contains information on the managed resource's interfaces and that each sub-layer below the internetwork layer of a network interface is considered an interface. Thus, the TE Link interface is represented as an entry in the ifTable. The inter-relation of entries in the ifTable is defined by Interfaces Stack Group defined in [[RFC2863](#)].

When using TE Link interfaces, the interface stack table might appear as follows:

```
+-----+
| TE link-interface ifType = teLink(200) +
+-----+
| Underlying Layer...                    +
+-----+
```

In the above diagram, "Underlying Layer..." refers to the ifIndex of any interface type, which has been defined for TE Link interworking. Examples include ATM, Frame Relay, Ethernet, etc.

9.1. Support of the TE Link Layer by ifTable

Some specific interpretations of ifTable for the TE Link layer follow.

Object	Use for the TE Link layer
ifIndex	Each TE Link interface is represented by an ifEntry.
ifDescr	Description of the TE Link interface.
ifType	The value that is allocated for TE Link is 200 [IANAFamily].
ifSpeed	The total bandwidth in bits per second for use by the TE Link layer.
ifPhysAddress	Unused.
ifAdminStatus	This variable indicates the administrator's intent as to whether TE Link should be enabled, disabled, or running in some diagnostic testing mode on this interface. Also see [RFC2863].
ifOperStatus	This value reflects the actual or operational status of TE Link on this interface.
ifLastChange	See [RFC2863].
ifInOctets	The number of received octets over the interface, i.e., the number of received octets in all component links associated with the interface.
ifOutOctets	The number of transmitted octets over the interface, i.e., the number of octets transmitted

over all component links associated with the interface.

ifInErrors The number of packets dropped due to uncorrectable errors.

ifInUnknownProtos
The number of received packets discarded during packet header validation.

ifOutErrors See [[RFC2863](#)].

ifName Textual name (unique on this system) of the interface or an octet string of zero length.

ifLinkUpDownTrapEnable
Default is disabled (2).

ifConnectorPresent
Set to false (2).

ifHighSpeed See [[RFC2863](#)].

ifHCInOctets The 64-bit version of ifInOctets; supported if required by the compliance statements in [[RFC2863](#)].

ifHCOctets The 64-bit version of ifOutOctets; supported if required by the compliance statements in [[RFC2863](#)].

ifAlias The non-volatile 'alias' name for the interface as specified by a network manager.

ifCounterDiscontinuityTime
See [[RFC2863](#)].

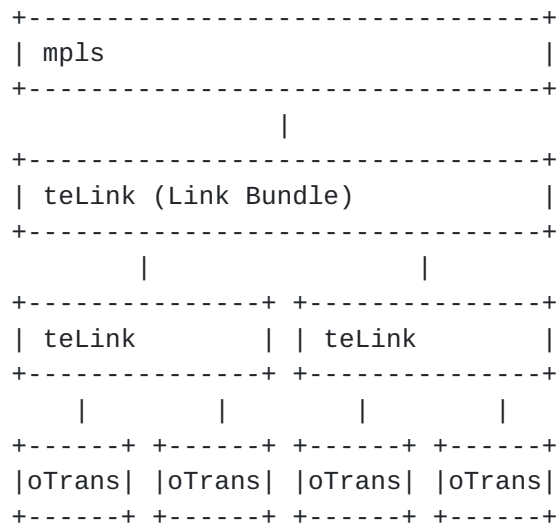
Support for ifInOctets, ifOutOctets, ifInErrors, ifInUnknownProtos, ifOutErrors, ifHCInOctets and ifHCOctets objects is not required if encoding type is clear. For other encoding types, traffic counters on a TE link are cumulative for all subinterfaces which it binds together.

9.2. Using ifStackTable

This section describes by example how to use ifStackTable to represent the relationship of TE links with underlying TE-enabled interfaces. Implementors of the stack table for TE link interfaces should look at the appropriate RFC for the service being stacked on TE links. Examples given below are for illustration purposes

only.

Example: MPLS is being carried on 2 bundled TE links.
Each bundled TE link runs over a 1:1 optical
transport interface.



The assignment of the index values could for example be:

ifIndex	Description
1	mpls (type 166)
2	teLink (type 200)
3	teLink (type 200)
4	teLink (type 200)
5	opticalTransport (type 196)
6	opticalTransport (type 196)
7	opticalTransport (type 196)
8	opticalTransport (type 196)

The ifStackTable is then used to show the relationships between the various interfaces.

ifStackTable Entries

HigherLayer	LowerLayer
0	1
1	2
2	3
2	4
3	5
3	6
4	7
4	8

5	0
6	0
7	0
8	0

In the case where MPLS is using a single TE link, then the upper TE link layer (link bundle) is not required.

```

+-----+
| mpls   |
+-----+
      |
+-----+
| teLink  |
+-----+
      |      |
+-----+ +-----+
|oTrans| |oTrans|
+-----+ +-----+

```

The assignment of the index values could for example be:

ifIndex	Description
1	mpls (type 166)
2	teLink (type 200)
3	opticalTransport (type 196)
4	opticalTransport (type 196)

The ifStackTable is then used to show the relationships between the various interfaces.

ifStackTable Entries

HigherLayer	LowerLayer
0	1
1	2
2	3
2	4
3	0
4	0

10. Link Bundling MIB Definitions

```
LINK-BUNDLING-MIB DEFINITIONS ::= BEGIN
```

```
IMPORTS
```

```
    MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
```


mib-2, Unsigned32
FROM SNMPv2-SMI

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

TruthValue, RowStatus, StorageType
FROM SNMPv2-TC

InterfaceIndexOrZero, ifIndex
FROM IF-MIB

RouterID
FROM OSPF-MIB

InetAddressType, InetAddress
FROM INET-ADDRESS-MIB;

linkBundlingMIB MODULE-IDENTITY
LAST-UPDATED "200211011200Z" -- 1 November 2002 12:00:00 EST
ORGANIZATION "Multiprotocol Label Switching (MPLS) Working Group"
CONTACT-INFO
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DESCRIPTION

"This MIB contains managed object definitions for
MPLS traffic engineering link bundling as
defined in: Kompella, K., Rekhter, Y., Berger, L.,
Link Bundling in MPLS Traffic Engineering
Internet Draft <[draft-ietf-mpls-bundling-04.txt](#)>,"

July 2002."

-- Revision history.

REVISION

"200211011200Z" -- 1 November 2002 12:00:00 EST

DESCRIPTION

"Initial version published as RFC xxxx (to be assigned by RFC Editor)"

::= { mib-2 xxx } -- To be assigned by IANA (experimental 114 can be used
-- in the interim)

-- Textual Conventions

-- Top level components of this MIB

-- Notifications

linkBundlingNotifications OBJECT IDENTIFIER ::= { linkBundlingMIB 0 }

-- Tables, Scalars

linkBundlingObjects OBJECT IDENTIFIER ::= { linkBundlingMIB 1 }

-- Conformance

linkBundlingConformance OBJECT IDENTIFIER ::= { linkBundlingMIB 2 }

-- TE Link Table

teLinkTable OBJECT-TYPE

SYNTAX SEQUENCE OF TeLinkEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table specifies the grouping of component links into
TE links and grouping of TE links into bundled links."

::= { linkBundlingObjects 1 }

teLinkEntry OBJECT-TYPE

SYNTAX TeLinkEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table exists for each ifEntry with an
ifType of teLink(TBD), i.e. for every TE link. An ifEntry
in the ifTable must exist before a teLinkEntry is created with
the corresponding ifIndex. If a TE link entry in the ifTable is
destroyed, then so is the corresponding entry in the
teLinkTable. The administrative and operational status values
are controlled from the ifEntry. If the link is unnumbered,
ifIndex is also used as the outgoing interface identifier."

INDEX { ifIndex }


```
::= { teLinkTable 1 }
```

```
TeLinkEntry ::= SEQUENCE {  
    teLinkIpAddrType      InetAddressType,  
    teLinkIpAddr          InetAddress,  
    teLinkRemoteIpAddr    InetAddress,  
    teLinkMetric          Unsigned32,  
    teLinkMuxCapability   INTEGER,  
    teLinkProtectionType  INTEGER,  
    teLinkWorkingPriority  Unsigned32,  
    teLinkResourceClass   Unsigned32,  
    teLinkIncomingIfId    InterfaceIndexOrZero,  
    teLinkOutgoingIfId    InterfaceIndexOrZero,  
    teLinkFlooding         InterfaceIndexOrZero,  
    teLinkRowStatus       RowStatus,  
    teLinkStorageType     StorageType  
}
```

teLinkIpAddrType OBJECT-TYPE

SYNTAX InetAddressType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"For IPv4 and IPv6 numbered links, this object represents the
IP address type associated with the TE link. For
unnumbered links, a value of unknown(0) must be used."

```
::= { teLinkEntry 1 }
```

teLinkIpAddr OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"For IPv4 and IPv6 numbered links, this object represents the
IP address associated with the TE link."

```
::= { teLinkEntry 2 }
```

teLinkRemoteIpAddr OBJECT-TYPE

SYNTAX InetAddress

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The remote IP address associated with the TE link (IPv4 and
IPv6 numbered links)."

```
::= { teLinkEntry 3 }
```

teLinkMetric OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The traffic engineering metric for the TE link is derived from its component links. All component links within the TE link must have the same traffic engineering metric."

REFERENCE

"[[BUNDLING](#)]"

::= { teLinkEntry 4 }

teLinkMuxCapability OBJECT-TYPE

SYNTAX INTEGER {
packetSwitch1(1),
packetSwitch2(2),
packetSwitch3(3),
packetSwitch4(4),
layer2Switch(51),
tdm(100),
lambdaSwitch(150),
fiberSwitch(200)
}

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This attribute specifies link multiplex capability of the TE link, which is derived from its component links. All component links within the same TE link must have the same link multiplex capability."

REFERENCE

"[[GMPLS-OSPF](#)]"

::= { teLinkEntry 5 }

teLinkProtectionType OBJECT-TYPE

SYNTAX INTEGER {
extraTraffic(1),
unprotected(2),
shared(3),
dedicated1For1(4),
dedicated1Plus1(5),
enhanced(6)
}

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This attribute specifies link protection type of the TE link."

REFERENCE

"[[GMPLS-OSPF](#)]"
::= { teLinkEntry 6 }

teLinkWorkingPriority OBJECT-TYPE

SYNTAX Unsigned32 (0..7)
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This object represents a priority value such that a new connection with a higher priority, i.e. numerically lower than this value, is guaranteed to be setup on a primary link and not on a secondary link."

REFERENCE

"[[GMPLS-OSPF](#)]"
::= { teLinkEntry 7 }

teLinkResourceClass OBJECT-TYPE

SYNTAX Unsigned32
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This attribute specifies the TE link resource class. The resource class is a 32 bit bitfield. The resource class for a link bundle is derived from the resource class of its TE links. All TE links within a link bundle must have the same resource class."

::= { teLinkEntry 8 }

teLinkIncomingIfId OBJECT-TYPE

SYNTAX InterfaceIndexOrZero
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"For unnumbered links, the incoming interface is set to the outgoing interface identifier chosen by the neighboring LSR for the reverse link corresponding to this TE link."

REFERENCE

"[[BUNDLING](#)]"
::= { teLinkEntry 9 }

teLinkOutgoingIfId OBJECT-TYPE

SYNTAX InterfaceIndexOrZero
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"If the link is unnumbered, the outgoing interface identifier is set to the outgoing interface identifier chosen for the TE link by the advertising LSR."

REFERENCE

"[[BUNDLING](#)]"
::= { teLinkEntry 10 }

teLinkFlooding OBJECT-TYPE

SYNTAX InterfaceIndexOrZero

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This object only has significance for link bundles which encoding type is not clear. For these link bundles, this object identifies the TE link on which to restrict flooding. If the value is zero, then flooding must be done on all TE links within the link bundle."

REFERENCE

"[[FLOOD](#)]"
DEFVAL { 0 }
::= { teLinkEntry 11 }

teLinkRowStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This variable is used to create, modify, and/or delete a row in this table. All read-create objects can only be changed when teLinkRowStatus is active."

::= { teLinkEntry 12 }

teLinkStorageType OBJECT-TYPE

SYNTAX StorageType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The storage type for this conceptual row in the teLinkTable. Conceptual rows having the value 'permanent' need not allow write-access to any columnar object in the row."

::= { teLinkEntry 13 }

-- End of teLinkTable

-- TE Link Descriptor Table

teLinkDescriptorTable OBJECT-TYPE

SYNTAX SEQUENCE OF TeLinkDescriptorEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table specifies the link descriptors associated with the TE links."

::= { linkBundlingObjects 2 }

teLinkDescriptorEntry OBJECT-TYPE

SYNTAX TeLinkDescriptorEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table is created for every TE link descriptor. An ifEntry in the ifTable must exist before a teLinkDescriptorEntry using the same ifIndex is created. If a TE link entry in the ifTable is destroyed, then so are all entries in the teLinkDescriptorTable that use the ifIndex of this TE link."

INDEX { ifIndex, teLinkDescriptorId }

::= { teLinkDescriptorTable 1 }

TeLinkDescriptorEntry ::= SEQUENCE {

teLinkDescriptorId Unsigned32,

teLinkEncodingType INTEGER,

teLinkDescrPriority Unsigned32,

teLinkMinReservableBandwidth Unsigned32,

teLinkMaxReservableBandwidth Unsigned32,

teLinkDescrRowStatus RowStatus,

teLinkDescrStorageType StorageType

}

teLinkDescriptorId OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This object specifies the link descriptor identifier."

::= { teLinkDescriptorEntry 1 }

teLinkEncodingType OBJECT-TYPE

SYNTAX INTEGER {

packet(1),

ethernet(2),

ansiEtsiPdh(3),

sdhItuSonetAnsi(5),

digitalWrapper(7),

lambda(8),

fiber(9),

fiberChannel(11)


```
    }
MAX-ACCESS      read-create
STATUS          current
DESCRIPTION
    "This attribute specifies the TE link encoding type."
REFERENCE
    "[GMPLS]"
::= { teLinkDescriptorEntry 2 }
```

```
teLinkDescrPriority OBJECT-TYPE
SYNTAX          Unsigned32 (0..7)
MAX-ACCESS      read-create
STATUS          current
DESCRIPTION
    "This object specifies the lowest priority at which that link
    encoding type is available."
REFERENCE
    "[GMPLS-OSPF]"
::= { teLinkDescriptorEntry 3 }
```

```
teLinkMinReservableBandwidth OBJECT-TYPE
SYNTAX          Unsigned32
MAX-ACCESS      read-create
STATUS          current
DESCRIPTION
    "This attribute specifies the minimum reservable bandwidth on
    the TE link. This is derived from the union of the
    minimum reservable bandwidth of all the component links
    associated with the TE link that can be used to carry
    live traffic. This value is an estimate in units of 1,000 bits
    per second."
REFERENCE
    "[GMPLS-OSPF]"
::= { teLinkDescriptorEntry 4 }
```

```
teLinkMaxReservableBandwidth OBJECT-TYPE
SYNTAX          Unsigned32
MAX-ACCESS      read-create
STATUS          current
DESCRIPTION
    "This attribute specifies the maximum reservable bandwidth on
    the TE link. This is the union of the maximum reservable
    bandwidth of all the component links within the
    TE link that can be used to carry live traffic. This value
    is an estimate in units of 1,000 bits per second."
REFERENCE
    "[GMPLS-OSPF]"
::= { teLinkDescriptorEntry 5 }
```


teLinkDescrRowStatus OBJECT-TYPE

SYNTAX RowStatus
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This variable is used to create, modify, and/or delete a row in this table. All read-create objects can only be changed when teLinkDescrRowStatus is active."

::= { teLinkDescriptorEntry 6 }

teLinkDescrStorageType OBJECT-TYPE

SYNTAX StorageType
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"The storage type for this conceptual row in the teLinkDescriptorTable. Conceptual rows having the value 'permanent' need not allow write-access to any columnar object in the row."

::= { teLinkDescriptorEntry 7 }

-- End of teLinkDescriptorTable

-- OSPF Traffic Engineering Parameters for TE Links

teLinkOspfTeTable OBJECT-TYPE

SYNTAX SEQUENCE OF TeLinkOspfTeEntry
MAX-ACCESS not-accessible
STATUS current

DESCRIPTION

"This table specifies the OSPF traffic engineering information associated with TE links."

::= { linkBundlingObjects 3 }

teLinkOspfTeEntry OBJECT-TYPE

SYNTAX TeLinkOspfTeEntry
MAX-ACCESS not-accessible
STATUS current

DESCRIPTION

"If OSPF is enabled, an entry in this table is created for every TE link."

AUGMENTS { teLinkEntry }

::= { teLinkOspfTeTable 1 }

TeLinkOspfTeEntry ::= SEQUENCE {

 teLinkOspfLinkType INTEGER,
 teLinkOspfLinkId RouterID


```
}
```

```
teLinkOspfLinkType OBJECT-TYPE
```

```
    SYNTAX          INTEGER {  
                                pointToPoint(1),  
                                multiAccess(2)  
                                }
```

```
    MAX-ACCESS      read-create
```

```
    STATUS          current
```

```
    DESCRIPTION
```

```
        "This attribute specifies the OSPF link type for the TE link.  
        All TE links within the same bundle must have the same  
        link type."
```

```
    ::= { teLinkOspfTeEntry 1 }
```

```
teLinkOspfLinkId OBJECT-TYPE
```

```
    SYNTAX          RouterID
```

```
    MAX-ACCESS      read-create
```

```
    STATUS          current
```

```
    DESCRIPTION
```

```
        "On point-to-point link, the link identifier is the Router ID  
        of the neighbor. For bundled link, is derived from the link  
        identifier associated with its TE links."
```

```
    REFERENCE
```

```
        "[BUNDLING]"
```

```
    ::= { teLinkOspfTeEntry 2 }
```

```
-- End of teLinkOspfTeTable
```

```
-- TE Link Shared Risk Link Group Table
```

```
teLinkSrlgTable OBJECT-TYPE
```

```
    SYNTAX          SEQUENCE OF TeLinkSrlgEntry
```

```
    MAX-ACCESS      not-accessible
```

```
    STATUS          current
```

```
    DESCRIPTION
```

```
        "This table specifies the SRLGs associated with TE links."
```

```
    ::= { linkBundlingObjects 4 }
```

```
teLinkSrlgEntry OBJECT-TYPE
```

```
    SYNTAX          TeLinkSrlgEntry
```

```
    MAX-ACCESS      not-accessible
```

```
    STATUS          current
```

```
    DESCRIPTION
```

```
        "An entry in this table contains information about a  
        SRLG associated with a TE link.  
        An ifEntry in the ifTable must exist before a
```


teLinkSrlgEntry using the same ifIndex is created.

If a TE link entry in the ifTable is destroyed, then so are all entries in the teLinkSrlgTable that use the ifIndex of this TE link."

```
INDEX          { ifIndex, srlg }
::= { teLinkSrlgTable 1 }
```

```
TeLinkSrlgEntry ::= SEQUENCE {
    srlg          Unsigned32,
    srlgRowStatus RowStatus,
    srlgStorageType StorageType
}
```

srlg OBJECT-TYPE

```
SYNTAX          Unsigned32
MAX-ACCESS      not-accessible
STATUS          current
DESCRIPTION
    "This identifies a SRLG supported by the TE link."
REFERENCE
    "[GMPLS-OSPF]"
::= { teLinkSrlgEntry 1 }
```

srlgRowStatus OBJECT-TYPE

```
SYNTAX          RowStatus
MAX-ACCESS      read-create
STATUS          current
DESCRIPTION
    "This variable is used to create, modify, and/or
    delete a row in this table. All read-create objects
    can only be changed when srlgRowStatus is active."
::= { teLinkSrlgEntry 2 }
```

srlgStorageType OBJECT-TYPE

```
SYNTAX          StorageType
MAX-ACCESS      read-create
STATUS          current
DESCRIPTION
    "The storage type for this conceptual row in the
    teLinkSrlgTable. Conceptual rows having the value
    'permanent' need not allow write-access to any
    columnar object in the row."
::= { teLinkSrlgEntry 3 }
```

-- End of teLinkSrlgTable

-- TE Link Bandwidth Table

teLinkBandwidthTable OBJECT-TYPE

SYNTAX SEQUENCE OF TeLinkBandwidthEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table specifies the priority-based bandwidth table for TE links."

::= { linkBundlingObjects 5 }

teLinkBandwidthEntry OBJECT-TYPE

SYNTAX TeLinkBandwidthEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table contains information about the priority-based bandwidth of TE links. An ifEntry in the ifTable must exist before a teLinkBandwidthEntry using the same ifIndex is created. If a TE link entry in the ifTable is destroyed, then so are all entries in the teLinkBandwidthTable that use the ifIndex of this TE link."

INDEX { ifIndex, teLinkPriority }

::= { teLinkBandwidthTable 1 }

TeLinkBandwidthEntry ::= SEQUENCE {

teLinkPriority Unsigned32,

teLinkUnreservedBandwidth Unsigned32,

teLinkMaximumLspBandwidth Unsigned32,

teLinkBandwidthRowStatus RowStatus,

teLinkBandwidthStorageType StorageType

}

teLinkPriority OBJECT-TYPE

SYNTAX Unsigned32 (1..8)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This attribute specifies the priority. It should be mapped to a number between 0 and 7"

REFERENCE

"[[GMPLS-OSPF](#)]"

::= { teLinkBandwidthEntry 1 }

teLinkUnreservedBandwidth OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This attribute specifies the TE link unreserved

bandwidth at priority p. It is the sum of the unreserved bandwidths at priority p of all component links associated with the TE link (excludes all links that are strictly used as protecting links). This value is an estimate in units of 1,000 bits per second."

REFERENCE

"[[BUNDLING](#)]"

::= { teLinkBandwidthEntry 2 }

teLinkMaximumLspBandwidth OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This attribute specifies the TE link maximum LSP bandwidth at priority p. It is the maximum of all maximum LSP bandwidth at priority p of the component links associated with the TE link (excludes all links that are strictly used as protecting links). This value is an estimate in units of 1,000 bits per second."

REFERENCE

"[[BUNDLING](#)]"

::= { teLinkBandwidthEntry 3 }

teLinkBandwidthRowStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This variable is used to create, modify, and/or delete a row in this table. All read-create objects can only be changed when teLinkBandwidthRowStatus is active."

::= { teLinkBandwidthEntry 4 }

teLinkBandwidthStorageType OBJECT-TYPE

SYNTAX StorageType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The storage type for this conceptual row in the teLinkBandwidthTable. Conceptual rows having the value 'permanent' need not allow write-access to any columnar object in the row."

::= { teLinkBandwidthEntry 5 }

-- End of teLinkBandwidthTable

-- Component Link Table

componentLinkTable OBJECT-TYPE

SYNTAX SEQUENCE OF ComponentLinkEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table specifies the component link parameters."

::= { linkBundlingObjects 6 }

componentLinkEntry OBJECT-TYPE

SYNTAX ComponentLinkEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry in this table exists for each ifEntry that represents a component link. An ifEntry must exist in the ifTable before a componentLinkEntry is created with the corresponding ifIndex. If an entry representing a component link is destroyed in the ifTable, then so is the corresponding entry in the componentLinkTable. The administrative and operational status values are controlled from the ifEntry."

INDEX { ifIndex }

::= { componentLinkTable 1 }

ComponentLinkEntry ::= SEQUENCE {

componentLinkMuxCapability INTEGER,
componentLinkPreferredProtection INTEGER,
componentLinkCurrentProtection INTEGER,
componentLinkRowStatus RowStatus,
componentLinkStorageType StorageType

}

componentLinkMuxCapability OBJECT-TYPE

SYNTAX INTEGER {
packetSwitch1(1),
packetSwitch2(2),
packetSwitch3(3),
packetSwitch4(4),
layer2Switch(51),
tdm(100),
lambdaSwitch(150),
fiberSwitch(200)

}

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This attribute specifies link multiplexing capabilities of the component link."

REFERENCE

"[[GMPLS-OSPF](#)]"

::= { componentLinkEntry 1 }

componentLinkPreferredProtection OBJECT-TYPE

SYNTAX INTEGER {
 primary(1),
 secondary(2)
 }

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This attribute specifies whether this component link is a primary or secondary entity."

::= { componentLinkEntry 2 }

componentLinkCurrentProtection OBJECT-TYPE

SYNTAX INTEGER {
 primary(1),
 secondary(2)
 }

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This attribute specifies whether this component link is currently used as primary or secondary link."

::= { componentLinkEntry 3 }

componentLinkRowStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This variable is used to create, modify, and/or delete a row in this table. All read-create objects can only be changed when componentLinkRowStatus is active."

::= { componentLinkEntry 4 }

componentLinkStorageType OBJECT-TYPE

SYNTAX StorageType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The storage type for this conceptual row in the componentLinkTable. Conceptual rows having the value 'permanent' need not allow write-access to any


```
        columnar object in the row."
 ::= { componentLinkEntry 5 }

-- End of componentLinkTable

-- Component Link Descriptor Table

componentLinkDescriptorTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF ComponentLinkDescriptorEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "This table specifies the link descriptors associated with the
        component links."
    ::= { linkBundlingObjects 7 }

componentLinkDescriptorEntry OBJECT-TYPE
    SYNTAX          ComponentLinkDescriptorEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "An entry in this table is created for every component link
        descriptor. An ifEntry in the ifTable must exist before a
        componentLinkDescriptorEntry using the same ifIndex is created.
        If a component link entry in the ifTable is destroyed,
        then so are all entries in the componentLinkDescriptorTable
        that use the ifIndex of this component link."
    INDEX           { ifIndex, componentLinkDescrId }
    ::= { componentLinkDescriptorTable 1 }

ComponentLinkDescriptorEntry ::= SEQUENCE {
    componentLinkDescrId          Unsigned32,
    componentLinkEncodingType     INTEGER,
    componentLinkDescrPriority     Unsigned32,
    componentLinkMinReservBandwidth Unsigned32,
    componentLinkMaxReservBandwidth Unsigned32,
    componentLinkDescrRowStatus   RowStatus,
    componentLinkDescrStorageType StorageType
}

componentLinkDescrId OBJECT-TYPE
    SYNTAX          Unsigned32
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "This object specifies the link descriptor identifier."
    ::= { componentLinkDescriptorEntry 1 }
```


componentLinkEncodingType OBJECT-TYPE

```
SYNTAX      INTEGER {
                packet(1),
                ethernet(2),
                ansiEtsiPdh(3),
                sdhItuSonetAnsi(5),
                digitalWrapper(7),
                lambda(8),
                fiber(9),
                fiberChannel(11)
            }
MAX-ACCESS   read-create
STATUS       current
DESCRIPTION
    "This attribute specifies the component link encoding type."
REFERENCE
    "[GMPLS]"
 ::= { componentLinkDescriptorEntry 2 }
```

componentLinkDescrPriority OBJECT-TYPE

```
SYNTAX      Unsigned32 (0..7)
MAX-ACCESS   read-create
STATUS       current
DESCRIPTION
    "This object specifies the lowest priority at which that link
    encoding type is available for the component link."
REFERENCE
    "[GMPLS-OSPF]"
 ::= { componentLinkDescriptorEntry 3 }
```

componentLinkMinReservBandwidth OBJECT-TYPE

```
SYNTAX      Unsigned32
MAX-ACCESS   read-create
STATUS       current
DESCRIPTION
    "This attribute specifies the minimum reservable bandwidth on
    the component link. This value is an estimate
    in units of 1,000 bits per second."
REFERENCE
    "[GMPLS-OSPF]"
 ::= { componentLinkDescriptorEntry 4 }
```

componentLinkMaxReservBandwidth OBJECT-TYPE

```
SYNTAX      Unsigned32
MAX-ACCESS   read-create
STATUS       current
DESCRIPTION
    "This attribute specifies the maximum reservable bandwidth on
```


the component link. This value is an estimate
in units of 1,000 bits per second."

REFERENCE

"[[GMPLS-OSPF](#)]"

::= { componentLinkDescriptorEntry 5 }

componentLinkDescrRowStatus OBJECT-TYPE

SYNTAX RowStatus
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"This variable is used to create, modify, and/or
delete a row in this table. All read-create objects
can only be changed when componentLinkDescrRowStatus
is active."

::= { componentLinkDescriptorEntry 6 }

componentLinkDescrStorageType OBJECT-TYPE

SYNTAX StorageType
MAX-ACCESS read-create
STATUS current

DESCRIPTION

"The storage type for this conceptual row in the
componentLinkDescriptorTable. Conceptual rows
having the value 'permanent' need not allow write-access
to any columnar object in the row."

::= { componentLinkDescriptorEntry 7 }

-- End of componentLinkDescriptorTable

-- Component Link Bandwidth Table

componentLinkBandwidthTable OBJECT-TYPE

SYNTAX SEQUENCE OF ComponentLinkBandwidthEntry
MAX-ACCESS not-accessible
STATUS current

DESCRIPTION

"This table specifies the priority-based bandwidth
for component links."

::= { linkBundlingObjects 8 }

componentLinkBandwidthEntry OBJECT-TYPE

SYNTAX ComponentLinkBandwidthEntry
MAX-ACCESS not-accessible
STATUS current

DESCRIPTION

"An entry in this table contains information about

the priority-based bandwidth on component links.

An ifEntry in the ifTable must exist before a componentLinkBandwidthEntry using the same ifIndex is created. If a component link entry in the ifTable is destroyed, then so are all entries in the componentLinkBandwidthTable that use the ifIndex of this component link."

```
INDEX          { ifIndex, componentLinkPriority }
::= { componentLinkBandwidthTable 1 }
```

```
ComponentLinkBandwidthEntry ::= SEQUENCE {
    componentLinkPriority          Unsigned32,
    componentLinkUnreservedBandwidth Unsigned32,
    componentLinkMaximumLspBandwidth Unsigned32,
    componentLinkBandwidthRowStatus RowStatus,
    componentLinkBwStorageType     StorageType
}
```

componentLinkPriority OBJECT-TYPE

SYNTAX Unsigned32 (1..8)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This attribute specifies the priority. It should be mapped to a number between 0 and 7."

REFERENCE

"[[GMPLS-OSPF](#)]"

```
::= { componentLinkBandwidthEntry 1 }
```

componentLinkUnreservedBandwidth OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This attribute specifies the component link unreserved bandwidth at priority p. This value is an estimate in units of 1,000 bits per second."

REFERENCE

"[[GMPLS-OPSF](#)]"

```
::= { componentLinkBandwidthEntry 2 }
```

componentLinkMaximumLspBandwidth OBJECT-TYPE

SYNTAX Unsigned32

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This attribute specifies the component link maximum LSP bandwidth at priority p. This value is an estimate

in units of 1,000 bits per second."

REFERENCE

"[[GMPLS-OSPF](#)]"

::= { componentLinkBandwidthEntry 3 }

componentLinkBandwidthRowStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"This variable is used to create, modify, and/or delete a row in this table. All read-create objects can only be changed when componentLinkBandwidthRowStatus is active."

::= { componentLinkBandwidthEntry 4 }

componentLinkBwStorageType OBJECT-TYPE

SYNTAX StorageType

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The storage type for this conceptual row in the componentLinkBandwidthTable. Conceptual rows having the value 'permanent' need not allow write-access to any columnar object in the row."

::= { componentLinkBandwidthEntry 5 }

-- End of componentLinkBandwidthTable

-- Notification Configuration

linkBundlingNotifEnable OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"If this object is true, then it enables the generation of the link bundling notifications, otherwise these notifications are not emitted."

DEFVAL { false }

::= { linkBundlingObjects 9 }

-- Notifications

-- Bundled Link Notifications

linkBundleMismatch NOTIFICATION-TYPE

OBJECTS { teLinkIpAddrType, teLinkIpAddr, teLinkRemoteIpAddr }

STATUS current

DESCRIPTION

"This notification is generated when a mismatch is found on a bundled link. Such mismatch can be detected for instance if one of the traffic engineering parameters is not consistent across all TE links within a bundled link (resource class, OSPF link type, etc.)."

::= { linkBundlingNotifications 1 }

-- End of notifications

-- Module compliance

linkBundlingGroups

OBJECT IDENTIFIER ::= { linkBundlingConformance 1 }

linkBundlingCompliances

OBJECT IDENTIFIER ::= { linkBundlingConformance 2 }

linkBundlingFullModuleCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION

"Compliance statement for agents that support the configuration and monitoring of link bundling MIB."

MODULE -- this module

-- The mandatory groups have to be implemented
-- by all devices supporting link bundling. However, they may all
-- be supported as read-only objects in the case where automatic
-- configuration is supported.

MANDATORY-GROUPS { linkBundlingGroup,
teLinkBandwidthGroup,
componentLinkBandwidthGroup }

GROUP teLinkOspfTeGroup

DESCRIPTION

"This group is mandatory for OSPF enabled devices."

GROUP teLinkSrlgGroup

DESCRIPTION

"This group is mandatory for G-MPLS enabled devices."

GROUP linkBundlingNotificationGroup

DESCRIPTION

"This group is mandatory for equipment that support link bundling notifications."

-- teLinkTable

OBJECT teLinkIpAddrType
SYNTAX INTEGER { unknown(0), ipv4(1), ipv6(2) }
MIN-ACCESS read-only
DESCRIPTION
 "The dns(16) address type need not be supported.
 The ipv4(1) and ipv6(2) address types need not be supported if numbered links are not supported. The unknown(0) address type need not be supported if unnumbered links are not supported."

OBJECT teLinkIpAddr
SYNTAX InetAddress (SIZE(0|4|16))
DESCRIPTION
 "Size of TE link IP address depends on type of TE link. TE link IP address size is zero if link is unnumbered, four if link IP address is IPv4 and sixteen if link IP address is IPv6."

OBJECT teLinkRemoteIpAddr
SYNTAX InetAddress (SIZE(0|4|16))
DESCRIPTION
 "Size of TE link IP address depends on type of TE link. TE link IP address size is zero if link is unnumbered, four if link IP address is IPv4 and sixteen if link IP address is IPv6."

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

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

OBJECT teLinkRowStatus
SYNTAX INTEGER { active(1), notInService(2),
 createAndGo(4), destroy(6) }
DESCRIPTION
 "The notReady(3) state need not be supported."

OBJECT teLinkStorageType


```
SYNTAX      INTEGER { other(1) }
DESCRIPTION
    "Only other(1) needs to be supported."

-- teLinkDescriptorTable

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

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

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

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

OBJECT      teLinkDescrRowStatus
SYNTAX      INTEGER { active(1), notInService(2),
                    createAndGo(4), destroy(6) }
DESCRIPTION
    "The notReady(3) state need not be supported."

OBJECT      teLinkDescrStorageType
SYNTAX      INTEGER { other(1) }
DESCRIPTION
    "Only other(1) needs to be supported."

-- teLinkOspfTeTable

OBJECT      teLinkOspfLinkType
SYNTAX      INTEGER { pointToPoint(1) }
MIN-ACCESS  read-only
DESCRIPTION
    "A value of multiAccess(2) need not be supported."

OBJECT      teLinkOspfLinkId
MIN-ACCESS  read-only
DESCRIPTION
```



```
"Write access is not required."

-- teLinkSrlgTable

OBJECT      srlgRowStatus
SYNTAX      INTEGER { active(1), notInService(2),
                      createAndGo(4), destroy(6) }
DESCRIPTION
    "The notReady(3) and createAndWait(5) states need
    not be supported."

OBJECT      srlgStorageType
SYNTAX      INTEGER { other(1) }
DESCRIPTION
    "Only other(1) needs to be supported."

-- teLinkBandwidthTable

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

OBJECT      teLinkBandwidthRowStatus
SYNTAX      INTEGER { active(1), notInService(2),
                      createAndGo(4), destroy(6) }
DESCRIPTION
    "The notReady(3) and createAndWait(5) states need
    not be supported."

OBJECT      teLinkBandwidthStorageType
SYNTAX      INTEGER { other(1) }
DESCRIPTION
    "Only other(1) needs to be supported."

-- componentLinkTable

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

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

OBJECT      componentLinkRowStatus
```


SYNTAX INTEGER { active(1), notInService(2),
 createAndGo(4), destroy(6) }

DESCRIPTION

"The notReady(3) and createAndWait(5) states need
not be supported."

OBJECT componentLinkStorageType

SYNTAX INTEGER { other(1) }

DESCRIPTION

"Only other(1) needs to be supported."

-- componentLinkDescriptorTable

OBJECT componentLinkDescrRowStatus

SYNTAX INTEGER { active(1), notInService(2),
 createAndGo(4), destroy(6) }

DESCRIPTION

"The notReady(3) state need not be supported."

OBJECT componentLinkDescrStorageType

SYNTAX INTEGER { other(1) }

DESCRIPTION

"Only other(1) needs to be supported."

-- componentLinkBandwidthTable

OBJECT componentLinkMaximumLspBandwidth

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT componentLinkBandwidthRowStatus

SYNTAX INTEGER { active(1), notInService(2),
 createAndGo(4), destroy(6) }

DESCRIPTION

"The notReady(3) and createAndWait(5) states need
not be supported."

OBJECT componentLinkBwStorageType

SYNTAX INTEGER { other(1) }

DESCRIPTION

"Only other(1) needs to be supported."

::= { linkBundlingCompliances 1 }

linkBundlingMonModuleCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION


```
"Compliance statement for agents that support the
  monitoring of link bundling MIB."
MODULE -- this module

-- The mandatory groups have to be implemented
-- by all devices supporting link bundling. However, they may all
-- be supported as read-only objects in the case where manual
-- configuration is unsupported.

MANDATORY-GROUPS    { linkBundlingGroup,
                      teLinkBandwidthGroup,
                      componentLinkBandwidthGroup }

GROUP teLinkOspfTeGroup
DESCRIPTION
  "This group is mandatory for OSPF enabled devices."

GROUP teLinkSrlgGroup
DESCRIPTION
  "This group is mandatory for G-MPLS enabled devices."

GROUP linkBundlingNotificationGroup
DESCRIPTION
  "This group is optional."

-- teLinkTable

OBJECT      teLinkIpAddrType
SYNTAX      INTEGER { unknown(0), ipv4(1), ipv6(2) }
MIN-ACCESS  read-only
DESCRIPTION
  "The dns(16) address type need not be supported.
  The ipv4(1) and ipv6(2) address types need not be
  supported if numbered links are not supported. The
  unknown(0) address type need not be supported if
  unnumbered links are not supported."

OBJECT      teLinkIpAddr
SYNTAX      InetAddress (SIZE(0|4|16))
DESCRIPTION
  "Size of TE link IP address depends on type of TE link.
  TE link IP address size is zero if link is unnumbered,
  four if link IP address is IPv4 and sixteen if link IP
  address is IPv6."

OBJECT      teLinkRemoteIpAddr
SYNTAX      InetAddress (SIZE(0|4|16))
DESCRIPTION
```


"Size of TE link IP address depends on type of TE link.
TE link IP address size is zero if link is unnumbered,
four if link IP address is IPv4 and sixteen if link IP
address is IPv6."

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

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

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

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

OBJECT teLinkRowStatus
SYNTAX INTEGER { active(1), notInService(2),
 createAndGo(4), destroy(6) }
MIN-ACCESS read-only
DESCRIPTION
 "The notReady(3) state need not be supported."

OBJECT teLinkStorageType
SYNTAX INTEGER { other(1) }
MIN-ACCESS read-only
DESCRIPTION
 "Only other(1) needs to be supported."

-- teLinkDescriptorTable

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

OBJECT teLinkDescrPriority
MIN-ACCESS read-only
DESCRIPTION

"Write access is not required."

OBJECT teLinkMinReservableBandwidth

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT teLinkMaxReservableBandwidth

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

OBJECT teLinkDescrRowStatus

SYNTAX INTEGER { active(1), notInService(2),
 createAndGo(4), destroy(6) }

MIN-ACCESS read-only

DESCRIPTION

"The notReady(3) state need not be supported."

OBJECT teLinkDescrStorageType

SYNTAX INTEGER { other(1) }

MIN-ACCESS read-only

DESCRIPTION

"Only other(1) needs to be supported."

-- teLinkOspfTeTable

OBJECT teLinkOspfLinkType

SYNTAX INTEGER { pointToPoint(1) }

DESCRIPTION

"A value of multiAccess(2) need not be supported."

OBJECT teLinkOspfLinkId

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

-- teLinkSrlgTable

OBJECT srlgRowStatus

SYNTAX INTEGER { active(1), notInService(2),
 createAndGo(4), destroy(6) }

MIN-ACCESS read-only

DESCRIPTION

"The notReady(3) and createAndWait(5) states need
not be supported."

OBJECT srlgStorageType


```
SYNTAX      INTEGER { other(1) }
MIN-ACCESS  read-only
DESCRIPTION
    "Only other(1) needs to be supported."

-- teLinkBandwidthTable

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

OBJECT      teLinkBandwidthRowStatus
SYNTAX      INTEGER { active(1), notInService(2),
                    createAndGo(4), destroy(6) }
MIN-ACCESS  read-only
DESCRIPTION
    "The notReady(3) and createAndWait(5) states need
    not be supported."

OBJECT      teLinkBandwidthStorageType
SYNTAX      INTEGER { other(1) }
MIN-ACCESS  read-only
DESCRIPTION
    "Only other(1) needs to be supported."

-- componentLinkTable

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

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

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

OBJECT      componentLinkRowStatus
SYNTAX      INTEGER { active(1), notInService(2),
                    createAndGo(4), destroy(6) }
MIN-ACCESS  read-only
DESCRIPTION
```


"The notReady(3) and createAndWait(5) states need not be supported."

OBJECT componentLinkStorageType
SYNTAX INTEGER { other(1) }
MIN-ACCESS read-only
DESCRIPTION
 "Only other(1) needs to be supported."

-- componentLinkDescriptorTable

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

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

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

OBJECT componentLinkDescrRowStatus
SYNTAX INTEGER { active(1), notInService(2),
 createAndGo(4), destroy(6) }
MIN-ACCESS read-only
DESCRIPTION
 "The notReady(3) state need not be supported."

OBJECT componentLinkDescrStorageType
SYNTAX INTEGER { other(1) }
MIN-ACCESS read-only
DESCRIPTION
 "Only other(1) needs to be supported."

-- componentLinkBandwidthTable

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

OBJECT componentLinkBandwidthRowStatus
SYNTAX INTEGER { active(1), notInService(2),


```
                                createAndGo(4), destroy(6) }
MIN-ACCESS  read-only
DESCRIPTION
    "The notReady(3) and createAndWait(5) states need
    not be supported."

OBJECT      componentLinkBwStorageType
SYNTAX      INTEGER { other(1) }
MIN-ACCESS  read-only
DESCRIPTION
    "Only other(1) needs to be supported."

 ::= { linkBundlingCompliances 2 }

-- Units of conformance

linkBundlingGroup OBJECT-GROUP
  OBJECTS { teLinkIpAddrType,
            teLinkIpAddr,
            teLinkRemoteIpAddr,
            teLinkMetric,
            teLinkMuxCapability,
            teLinkProtectionType,
            teLinkWorkingPriority,
            teLinkResourceClass,
            teLinkIncomingIfId,
            teLinkOutgoingIfId,
            teLinkFlooding,
            teLinkRowStatus,
            teLinkStorageType,
            teLinkEncodingType,
            teLinkDescrPriority,
            teLinkMinReservableBandwidth,
            teLinkMaxReservableBandwidth,
            teLinkDescrRowStatus,
            teLinkDescrStorageType,
            componentLinkMuxCapability,
            componentLinkPreferredProtection,
            componentLinkCurrentProtection,
            componentLinkRowStatus,
            componentLinkStorageType,
            linkBundlingNotifEnable
          }

STATUS  current
DESCRIPTION
    "Collection of objects needed for the monitoring of
    resources associated with TE links."
```



```
::= { linkBundlingGroups 1 }
```

```
teLinkOspfTeGroup OBJECT-GROUP  
  OBJECTS { teLinkOspfLinkType,  
            teLinkOspfLinkId  
          }
```

```
STATUS current
```

```
DESCRIPTION
```

```
  "Collection of objects needed for the OSPF traffic  
  engineering parameters of TE links."
```

```
::= { linkBundlingGroups 2 }
```

```
teLinkSrlgGroup OBJECT-GROUP  
  OBJECTS { srlgRowStatus,  
            srlgStorageType  
          }
```

```
STATUS current
```

```
DESCRIPTION
```

```
  "Collection of objects needed for the monitoring of  
  SRLG resources associated with TE links."
```

```
::= { linkBundlingGroups 3 }
```

```
teLinkBandwidthGroup OBJECT-GROUP  
  OBJECTS { teLinkUnreservedBandwidth,  
            teLinkMaximumLspBandwidth,  
            teLinkBandwidthRowStatus,  
            teLinkBandwidthStorageType  
          }
```

```
STATUS current
```

```
DESCRIPTION
```

```
  "Collection of objects needed for the monitoring of  
  the priority-based bandwidth resources associated with  
  TE links and component links."
```

```
::= { linkBundlingGroups 4 }
```

```
componentLinkBandwidthGroup OBJECT-GROUP  
  OBJECTS { componentLinkEncodingType,  
            componentLinkDescrPriority,  
            componentLinkMinReservBandwidth,  
            componentLinkMaxReservBandwidth,  
            componentLinkDescrRowStatus,  
            componentLinkDescrStorageType,  
            componentLinkUnreservedBandwidth,  
            componentLinkMaximumLspBandwidth,  
            componentLinkBandwidthRowStatus,
```



```
        componentLinkBwStorageType
    }

    STATUS current
    DESCRIPTION
        "Collection of objects needed for the monitoring of
        bandwidth parameters associated with component links."
    ::= { linkBundlingGroups 5 }

linkBundlingNotificationGroup NOTIFICATION-GROUP
    NOTIFICATIONS { linkBundleMismatch }
    STATUS current
    DESCRIPTION
        "Set of notifications implemented in this module.
        None is mandatory."
    ::= { linkBundlingGroups 6 }

-- End of LINK-BUNDLING-MIB
END
```

11. Intellectual Property Considerations

The IETF takes no position regarding the validity or scope of any intellectual property or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; neither does it represent that it has made any effort to identify any such rights. Information on the IETF's procedures with respect to rights in standards-track and standards-related documentation can be found in [BCP-11](#). Copies of claims of rights made available for publication and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF Secretariat.

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12. Security Considerations

It is clear that this MIB is potentially useful for monitoring of link bundling enabled devices. This MIB can also be used for configuration of certain objects, and anything that can be configured can be incorrectly configured, with potentially disastrous results.

At this writing, no security holes have been identified beyond those that SNMP Security [[RFC2571](#)] is itself intended to address. These relate to primarily controlled access to sensitive information and the ability to configure a device - or which might result from operator error, which is beyond the scope of any security architecture.

There are a number of management objects defined in this MIB which have a MAX-ACCESS clause of read-write and/or read-create. Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations. The use of SNMP Version 3 is recommended over prior versions, for configuration control, as its security model is improved.

SNMPv1 or SNMPv2 are by themselves not a secure environment. Even if the network itself is secure (for example by using IPSec [[RFC2401](#)]), 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. It is recommended that the implementers consider the security features as provided by the SNMPv3 framework. Specifically, the use of the User-based Security Model [[RFC2574](#)] and the View-based Access Control [[RFC2575](#)] is recommended. It is then a customer/user responsibility to ensure that the SNMP entity giving access to an instance of this MIB 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.

There are a number of managed objects in this MIB that may contain information that may be sensitive from a business perspective, in that they can be used to derive the network topology, e.g. list of nodes and their IP address (teLinkTable), list of component links (componentLinkTable) in addition to usage of network resources (teLinkBandwidthTable and componentLinkBandwidthTable). Allowing uncontrolled access to these objects could result in malicious and unwanted disruptions of network traffic, incorrect network configuration or theft of competitive business information. There are no objects that are particularly sensitive in their own right, such as passwords or monetary amounts.

13. Acknowledgments

The general structure of this draft has been modeled around [draft-ietf-mpls-lsr-mib-06.txt](#). The authors would like to acknowledge the contribution of Dmitry Ryumkin.

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