MIB for Fibre Channel's Fabric Shortest Path First (FSPF) Protocol

Status of This Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvements. Please refer to the current edition of the "Internet
   Official Protocol Standards" (STD 1) for the standardization state
   and status of this protocol. Distribution of this memo is unlimited.

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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 information related
   to the Fibre Channel network's Fabric Shortest Path First (FSPF)
   routing protocol.

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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 information related
   to the Fibre Channel network's Fabric Shortest Path First (FSPF)
   routing protocol, which is specified in [FC-SW-4].

   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 [RFC2119].

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 [RFC3410].

Managed objects are accessed via a virtual information store, termed
the Management Information Base or MIB. MIB objects are generally
accessed through the Simple Network Management Protocol (SNMP).
Objects in the MIB are defined using the mechanisms defined in the
Structure of Management Information (SMI). This memo specifies a MIB
module that is compliant to the SMIv2, which is described in STD 58,
RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580
[RFC2580].

3. Short Overview of Fibre Channel

3.1. Introduction

The Fibre Channel (FC) is logically a bidirectional point-to-point
serial data channel, structured for high performance. Fibre Channel
provides a general transport vehicle for higher-level protocols, such
as Small Computer System Interface (SCSI) command sets, the High-
Performance Parallel Interface (HIPPI) data framing, IP (Internet
Protocol), IEEE 802.2, and others.

Physically, Fibre Channel is an interconnection of multiple
communication points, called N_Ports, interconnected either by a
switching network, called a Fabric, or by a point-to-point link. A
Fibre Channel "node" consists of one or more N_Ports. A Fabric may
consist of multiple Interconnect Elements, some of which are
switches. An N_Port connects to the Fabric via a port on a switch
called an F_Port. When multiple FC nodes are connected to a single
port on a switch via an "Arbitrated Loop" topology, the switch port
is called an FL_Port, and the nodes' ports are called NL_Ports. The
term Nx_Port is used to refer to either an N_Port or an NL_Port. The
term Fx_Port is used to refer to either an F_Port or an FL_Port. A
switch port, which is interconnected to another switch port via an
Inter-Switch Link (ISL), is called an E_Port. A B_Port connects a
bridge device with an E_Port on a switch; a B_Port provides a subset
of E_Port functionality.

Many Fibre Channel components, including the fabric, each node, and
most ports, have globally-unique names. These globally-unique names
are typically formatted as World Wide Names (WWNs). More information
on WWNs can be found in [FC-FS]. WWNs are expected to be persistent
across agent and unit resets.

Fibre Channel frames contain 24-bit address identifiers that identify
the frame's source and destination ports. Each FC port has both an
address identifier and a WWN. When a fabric is in use, the FC
address identifiers are dynamic and are assigned by a switch. Each
octet of a 24-bit address represents a level in an address hierarchy,
a Domain_ID being the highest level of the hierarchy.

The routing of frames within the Fabric is normally based on a
routing protocol called Fabric Shortest Path First (FSPF). FSPF is a
link state path selection protocol, which is defined in Section 8 of
[FC-SW-4]. FSPF keeps track of the state of the links on all
switches in the Fabric and associates a cost with each link. The
protocol computes paths from a switch to all the other switches in
the Fabric by adding the cost of all the links traversed by the path,
and choosing the path that minimizes the cost. The collection of
link states (including cost) of all the switches in a Fabric
constitutes the topology database (or link-state database).

3.2. FSPF Protocol

FSPF has four major components:

a) A Hello protocol, used to establish connectivity with a neighbor
   switch, to establish the identity of the neighbor switch, and to
   exchange FSPF parameters and capabilities;

b) A replicated topology database, with protocols and mechanisms to
   keep the databases synchronized across the Fabric;

c) A path computation algorithm (e.g., Dijkstra's algorithm);

d) A routing table update.

The topology database synchronization in turn consists of two major
components: an initial database synchronization and an update
mechanism. The initial database synchronization is used when a
switch is initialized, or when an Inter-Switch Link (ISL) comes up.
The update mechanism is used in two circumstances:

a) When there is a link state change; for example, an ISL going down
   or coming up;

b) On a periodic basis, to prevent switches from deleting topology
   information from the database.

Also note that all connections between Fibre Channel switches are
point-to-point.

3.3. Virtual Fabrics

The latest standard for an interconnecting Fabric containing multiple
Fabric Switch elements is [FC-SW-4]. [FC-SW-4] carries forward the
previous version's specification for the operation of a single Fabric
in a physical infrastructure, augmenting it with the definition of
Virtual Fabrics and with the specification of how multiple Virtual

Fabrics can operate within one (or more) physical infrastructures.
The use of Virtual Fabrics provides for each frame to be tagged in
its header to indicate which one of several Virtual Fabrics that
frame is being transmitted on. All frames entering a particular
"Core Switch" [FC-SW-4] (i.e., a physical switch) on the same Virtual
Fabric are processed by the same "Virtual Switch" within that Core
switch.

4. Relationship to Other MIBs

The first standardized MIB module for Fibre Channel [RFC4044] was
focussed on Fibre Channel switches. It is being replaced by the more
generic Fibre Channel Management MIB [FC-MGMT] which defines basic
information for Fibre Channel hosts and switches, including
extensions to the standard IF-MIB [RFC2863] for Fibre Channel
interfaces.

This MIB module extends beyond [FC-MGMT] to cover the operation of
the FSPF routing protocol in Fibre Channel switches.

This MIB module only contains information specific to FSPF.
Information that would still be applicable if any other routing
protocol were used is specified in a separate MIB module.

This MIB module imports some common Textual Conventions from T11-TC-
MIB, defined in [RFC4439].

5. MIB Overview

This MIB module provides the means for monitoring the operation of,
and configuring some parameters of, one or more instances of the FSPF
protocol.

5.1. Fibre Channel Management Instance

A Fibre Channel management instance is defined in [FC-MGMT] as a
separable managed instance of Fibre Channel functionality. Fibre
Channel functionality may be grouped into Fibre Channel management
instances in whatever way is most convenient for the
implementation(s). For example, one such grouping accommodates a
single SNMP agent with multiple AgentX [RFC2741] sub-agents, with
each sub-agent implementing a different Fibre Channel management
instance.

The object, fcmInstanceIndex, is IMPORTed from the FC-MGMT-MIB
[FC-MGMT] as the index value that uniquely identifies each Fibre
Channel management instance within the same SNMP context ([RFC3411],
Section 3.3.1).

5.2. Switch Index

The FC-MGMT-MIB [FC-MGMT] defines the fcmSwitchTable as a table of
information about Fibre Channel switches that are managed by Fibre
Channel management instances. Each Fibre Channel management instance
can manage one or more Fibre Channel switches. The Switch Index,
fcmSwitchIndex, is IMPORTed from the FC-MGMT-MIB as the index value
that uniquely identifies a Fibre Channel switch among those (one or
more) managed by the same Fibre Channel management instance.

5.3. Fabric Index

Whether operating on a physical Fabric (i.e., without Virtual
Fabrics) or within a Virtual Fabric, the operation of FSPF within a
Fabric is identical. Therefore, this MIB module defines all Fabric-
related information in tables that are INDEX-ed by an arbitrary
integer, named a "Fabric Index", the syntax of which is IMPORTed from
the T11-TC-MIB. When a device is connected to a single physical
Fabric, without use of any virtual Fabrics, the value of this Fabric
Index will always be 1. In an environment of multiple virtual and/or
physical Fabrics, this index provides a means to distinguish one
Fabric from another.

It is quite possible, and may even be likely, that a Fibre Channel
switch will have ports connected to multiple virtual and/or physical
Fabrics. Thus, in order to simplify a management protocol query
concerning all the Fabrics to which a single switch is connected,
fcmSwitchIndex will be listed before t11FspfFabricIndex when they
both appear in the same INDEX clause.

5.4. The MIB Groups

This section describes the four MIB groups contained in the MIB
module.

5.4.1. The t11FspfGeneralGroup Group

This group provides for per-Fabric monitoring of the FSPF state and
per-Fabric monitoring/configuration of FSPF parameters.

5.4.2. The t11FspfIfGroup Group

   This group provides for per-interface monitoring of FSPF
   state/statistics and per-interface monitoring/configuration of FSPF
   parameters.

5.4.3. The t11FspfDatabaseGroup Group

   This group permits the monitoring of the information present in the
   FSPF topology database.

5.4.4. The t11FspfNotificationGroup Group

   This group contains the notifications that are generated on
   asynchronous events related to the operation of FSPF.

6. The T11-FC-FSPF-MIB Module

T11-FC-FSPF-MIB DEFINITIONS ::= BEGIN
--
-- For management of FSPF, the Fibre Channel routing protocol.
--

IMPORTS
    MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
    Counter32, Integer32, Unsigned32, TimeTicks,
    Gauge32, mib-2   FROM SNMPv2-SMI   -- [RFC2578]
    MODULE-COMPLIANCE, OBJECT-GROUP,
    NOTIFICATION-GROUP   FROM SNMPv2-CONF -- [RFC2580]
    TEXTUAL-CONVENTION, RowStatus, StorageType,
    TruthValue   FROM SNMPv2-TC   -- [RFC2579]
    ifIndex, InterfaceIndex   FROM IF-MIB   -- [RFC2863]
    fcmInstanceIndex, fcmSwitchIndex,
    FcDomainIdOrZero   FROM FC-MGMT-MIB -- [FC-MGMT]
    T11FabricIndex   FROM T11-TC-MIB   -- [RFC4439]
    t11FamConfigDomainId
                      FROM T11-FC-FABRIC-ADDR-MGR-MIB; -- [RFC4439]

t11FcFspfMIB MODULE-IDENTITY
    LAST-UPDATED "200608140000Z"
    ORGANIZATION "T11"
    CONTACT-INFO
                  "Claudio DeSanti
                   Cisco Systems, Inc.
                   170 West Tasman Drive
                   San Jose, CA 95134 USA
                   EMail: cds@cisco.com

                      Keith McCloghrie
                      Cisco Systems, Inc.
                      170 West Tasman Drive
                      San Jose, CA USA 95134
                      Email: kzm@cisco.com"
        DESCRIPTION
              "The MIB module for managing the Fabric Shortest Path
              First (FSPF) protocol. FSPF is specified in FC-SW-4.

              Copyright (C) The Internet Society (2006). This version of
              this MIB module is part of RFC 4626; see the RFC itself for
              full legal notices."
        REVISION   "200608140000Z"
        DESCRIPTION
              "Initial version of this MIB module published as RFC4626."

        ::= { mib-2 143 }

t11FspfNotifications   OBJECT IDENTIFIER ::= { t11FcFspfMIB 0 }
t11FspfObjects   OBJECT IDENTIFIER ::= { t11FcFspfMIB 1 }
t11FspfConformance   OBJECT IDENTIFIER ::= { t11FcFspfMIB 2 }
t11FspfConfiguration   OBJECT IDENTIFIER ::= { t11FspfObjects 1 }
t11FspfDatabase   OBJECT IDENTIFIER ::= { t11FspfObjects 2 }

--
-- TEXTUAL CONVENTIONS

T11FspfLsrType ::= TEXTUAL-CONVENTION
     STATUS   current
     DESCRIPTION
            "Type of the Link State Record.

            FC-SW-4 defines two types of LSRs and allows for the
            possibility for more will be defined in the future:

                01   - Switch Link Record
                02   - Obsolete
                240 - 255 - Vendor Specific
                others - Reserved.
            "
     REFERENCE
            "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
             ANSI INCITS 418-2006, section 6.1.9.3."
     SYNTAX   Integer32 (0..255)

T11FspfLinkType ::= TEXTUAL-CONVENTION
     STATUS   current
     DESCRIPTION

          "Type of an the FSPF Link. Presently defined values:

               1   - Point-to-Point
               240-255   - Vendor Specific
               all others   - Reserved.
          "
     REFERENCE
          "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
          ANSI INCITS 418-2006, section 6.1.9.4."
     SYNTAX   Integer32 (0..255)

T11FspfInterfaceState ::= TEXTUAL-CONVENTION
     STATUS   current
     DESCRIPTION
          "The state of the FSPF Neighbor Finite State Machine
          for the neighbor (switch) on a particular interface.
          Possible values are :

               down(1)   - Down
               init(2)   - Init
               dbExchange(3) - Database Exchange
               dbAckwait(4)   - Database AckWait
               dbWait(5)   - Database Wait
               full(6)   - Full (Connected)
          "
     REFERENCE
          "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
          ANSI INCITS 418-2006, section 8.7."
     SYNTAX INTEGER {
                 down(1),
                 init(2),
                 dbExchange(3),
                 dbAckwait(4),
                 dbWait(5),
                 full(6)
             }

T11FspfLastCreationTime ::= TEXTUAL-CONVENTION
     STATUS current
     DESCRIPTION
          "This TC describes an object that stores the last time
          it, and the row containing it, was created.

          This can be used by management applications to determine
          that a row has been deleted and re-created between reads,
          causing an otherwise undetectable discontinuity in the
          data."
     SYNTAX TimeTicks

```
--
-- t11FspfTable

t11FspfTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF T11FspfEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
          "This table allows the users to configure and monitor FSPF's
          per-Fabric parameters and statistics on all Fabrics known to
          locally managed switches.

          Entries are created/removed by the agent if and when
          (Virtual) Fabrics are created/deleted."
    ::= { t11FspfConfiguration 1 }

t11FspfEntry OBJECT-TYPE
    SYNTAX      T11FspfEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
          "An entry containing FSPF variables, parameters, and
          statistics on a particular switch (identified by values
          of fcmInstanceIndex and fcmSwitchIndex) for a particular
          Fabric (identified by a t11FspfFabricIndex value).

          (Note that the local switch's per-fabric Domain-ID is
          available in t11FamConfigDomainId, which is defined in
          T11-FC-FABRIC-ADDR-MGR-MIB.)"
    INDEX       { fcmInstanceIndex, fcmSwitchIndex, t11FspfFabricIndex }
    ::= { t11FspfTable 1 }

T11FspfEntry ::= SEQUENCE  {
    t11FspfFabricIndex                 T11FabricIndex,
    t11FspfMinLsArrival                Unsigned32,
    t11FspfMinLsInterval               Unsigned32,
    t11FspfLsRefreshTime               Unsigned32,
    t11FspfMaxAge                      Unsigned32,
    t11FspfMaxAgeDiscards              Counter32,
    t11FspfPathComputations            Counter32,
    t11FspfChecksumErrors              Counter32,
    t11FspfLsrs                        Gauge32,
    t11FspfCreateTime                  T11FspfLastCreationTime,
    t11FspfAdminStatus                 INTEGER,
    t11FspfOperStatus                  INTEGER,
    t11FspfNbrStateChangNotifyEnable   TruthValue,
    t11FspfSetToDefault                INTEGER,
    t11FspfStorageType                 StorageType
```

}

t11FspfFabricIndex OBJECT-TYPE
    SYNTAX   T11FabricIndex
    MAX-ACCESS   not-accessible
    STATUS   current
    DESCRIPTION
            "A unique index value that uniquely identifies a
            particular Fabric.

            In a Fabric conformant to FC-SW-4, multiple Virtual Fabrics
            can operate within one (or more) physical infrastructures.
            In such a case, index value is used to uniquely identify a
            particular Fabric within a physical infrastructure.

            In a Fabric that has (can have) only a single Fabric
            operating within the physical infrastructure, the
            value of this Fabric Index will always be 1."
    ::= { t11FspfEntry 1 }

t11FspfMinLsArrival OBJECT-TYPE
    SYNTAX   Unsigned32 (0..65535)
    UNITS   "milliSeconds"
    MAX-ACCESS   read-write
    STATUS   current
    DESCRIPTION
            "The minimum time after accepting a Link State Record
            (LSR) on this Fabric before accepting another update of
            the same LSR on the same Fabric.

            An LSR update that is not accepted because of this time
            interval is discarded."
    REFERENCE "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
               ANSI INCITS 418-2006, sections 8.6.4.5 & 15.1."
    DEFVAL   {1000}
    ::= { t11FspfEntry 2 }

t11FspfMinLsInterval OBJECT-TYPE
    SYNTAX   Unsigned32 (0..65535)
    UNITS   "milliSeconds"
    MAX-ACCESS   read-write
    STATUS   current
    DESCRIPTION
            "The minimum time after this switch sends an LSR on this
            Fabric before it will send another update of the same LSR
            on the same Fabric."
    REFERENCE "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
               ANSI INCITS 418-2006, section 15.1."

```
        DEFVAL      {5000}
        ::= { t11FspfEntry 3 }

t11FspfLsRefreshTime OBJECT-TYPE
        SYNTAX      Unsigned32
        UNITS       "Minutes"
        MAX-ACCESS  read-only
        STATUS      current
        DESCRIPTION
                "The interval between transmission of refresh LSRs on this
                Fabric."
        REFERENCE   "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
                    ANSI INCITS 418-2006, sections 8.5.1 & 15.1."
        DEFVAL      {30}
        ::= { t11FspfEntry 4 }

t11FspfMaxAge OBJECT-TYPE
        SYNTAX      Unsigned32
        UNITS       "Minutes"
        MAX-ACCESS  read-only
        STATUS      current
        DESCRIPTION
                "The maximum age an LSR will be retained in the FSPF
                database on this Fabric.  An LSR is removed from the
                database after MaxAge is reached."
        REFERENCE   "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
                    ANSI INCITS 418-2006, section 15.1."
        DEFVAL      {60}
        ::= { t11FspfEntry 5 }

t11FspfMaxAgeDiscards OBJECT-TYPE
        SYNTAX      Counter32
        MAX-ACCESS  read-only
        STATUS      current
        DESCRIPTION
                "The number of LSRs discarded due to their age reaching
                t11FspfMaxAge in this Fabric.  The last discontinuity of
                this counter is indicated by t11FspfCreateTime."
        ::= { t11FspfEntry 6 }

t11FspfPathComputations OBJECT-TYPE
        SYNTAX      Counter32
        MAX-ACCESS  read-only
        STATUS      current
        DESCRIPTION
                "The number of times that the path computation algorithm
                has been invoked by this Switch on this Fabric to compute
                a set of minimum cost paths for this Fabric.  The last
```

            discontinuity of this counter is indicated by
            t11FspfCreateTime."
    REFERENCE   "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
                ANSI INCITS 418-2006, section 8.1.1."
    ::= { t11FspfEntry 7 }

t11FspfChecksumErrors OBJECT-TYPE
    SYNTAX   Counter32
    MAX-ACCESS read-only
    STATUS   current
    DESCRIPTION
            "The number of FSPF checksum errors that were detected
            locally (and therefore discarded) on this Fabric.
            The last discontinuity of this counter is indicated by
            t11FspfCreateTime."
    REFERENCE   "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
                ANSI INCITS 418-2006, section 8.5.4."
    ::= { t11FspfEntry 8 }

t11FspfLsrs OBJECT-TYPE
    SYNTAX   Gauge32
    MAX-ACCESS read-only
    STATUS   current
    DESCRIPTION
            "The current number of entries for this Fabric in the
            t11FspfLsrTable."
    ::= { t11FspfEntry 9 }

t11FspfCreateTime OBJECT-TYPE
    SYNTAX   T11FspfLastCreationTime
    MAX-ACCESS read-only
    STATUS   current
    DESCRIPTION
            "The value of sysUpTime when this entry was last created."
    ::= { t11FspfEntry 10 }

t11FspfAdminStatus OBJECT-TYPE
    SYNTAX   INTEGER {
                    up(1),
                    down(2)
                    }
    MAX-ACCESS read-write
    STATUS   current
    DESCRIPTION
            "The desired state of FSPF in this Fabric. If value of
            this object is set to 'up', then FSPF is enabled in
            this Fabric. If set to 'down', then FSPF is disabled
            in this Fabric -- when FSPF is disabled, FSPF provides

            no routes to be included in the T11-FC-ROUTE-MIB module.
            (see the T11-FC-ROUTE-MIB)."
    REFERENCE   "T11-FC-ROUTE-MIB, The Fibre Channel Routing
                 Information MIB, RFC4625."
    DEFVAL {up}
    ::= { t11FspfEntry 11 }

t11FspfOperStatus OBJECT-TYPE
    SYNTAX   INTEGER {
                        up(1),
                        down(2)
                     }
    MAX-ACCESS read-only
    STATUS   current
    DESCRIPTION
            "State of FSPF in this Fabric. If 't11FspfAdminStatus' is
            'down', then the 't11FspfOperStatus' should be 'down'.
            If 't11FspfAdminStatus' is changed to 'up', then
            't11FspfOperStatus' should change to 'up' as and when
            FSPF is active in this Fabric."
    ::= { t11FspfEntry 12 }

t11FspfNbrStateChangNotifyEnable OBJECT-TYPE
    SYNTAX   TruthValue
    MAX-ACCESS read-write
    STATUS   current
    DESCRIPTION
            "Specifies whether or not the local agent should
            issue the notification 't11FspfNbrStateChangNotify'
            when the local switch learns of a change of state
            in the FSPF Neighbor Finite State Machine on an
            interface in this Fabric.
            If the value of the object is 'true, then the
            notification is generated. If the value is 'false',
            notification is not generated."
    DEFVAL { false }
    ::= { t11FspfEntry 13 }

t11FspfSetToDefault OBJECT-TYPE
    SYNTAX   INTEGER {
                        default(1),
                        noOp(2)
                     }
    MAX-ACCESS read-write
    STATUS   current
    DESCRIPTION
            "Setting this value to 'default' changes the value of each
            and every writable object in this row to its default

                value.

                No action is taken if this object is set to 'noOp'.
                The value of the object, when read, is always 'noOp'."
        ::= { t11FspfEntry 14 }

t11FspfStorageType OBJECT-TYPE
        SYNTAX   StorageType
        MAX-ACCESS read-write
        STATUS   current
        DESCRIPTION
                "The storage type for read-write objects in this
                conceptual row.

                Conceptual rows having the value 'permanent' need not
                allow write-access to any columnar objects in the row."
        DEFVAL { nonVolatile }
        ::= { t11FspfEntry 15 }

--
-- t11FspfIfTable

t11FspfIfTable OBJECT-TYPE
        SYNTAX   SEQUENCE OF T11FspfIfEntry
        MAX-ACCESS not-accessible
        STATUS   current
        DESCRIPTION
                "This table allows the users to configure and monitor
                the FSPF parameters that are per-interface (identified
                by a t11FspfIfIndex value), per-Fabric (identified by a
                t11FspfFabricIndex value), and per-switch (identified by
                values of fcmInstanceIndex and fcmSwitchIndex).

                Creating a row in this table via t11FspfIfRowStatus
                provides the means to specify non-default parameter value(s)
                for an interface at a time when the relevant row in this
                table would not otherwise exist because the interface is
                either down or it is not an E_Port, but the corresponding
                row in the t11FspfTable must already exist.

                After the non-default values have been specified for a
                port's parameters, they need to be retained in this table,
                even when the port becomes 'isolated'. However, having
                unnecessary rows in this table clutters it up and makes
                those rows that are useful harder for an NMS to find.
                Therefore, when an E_Port becomes isolated, its row gets
                deleted if and only if all of its parameter values are the
                default values; also, when an E_Port becomes non-isolated

                in a particular Fabric, a row in this table needs to exist
                and is automatically created, if necessary.

                The specific conditions for an automated/implicit deletion
                of a row are:
                a) if the corresponding interface is no longer an E_Port
                   (e.g., a G_Port which is dynamically determined to be an
                   F_Port), and all configurable parameters have default
                   values; or
                b) if the interface identified by t11FspfIfIndex no longer
                   exists (e.g., because a line-card is physically removed);
                   or
                c) if the corresponding row in the t11FspfTable is deleted.
                "
        ::= { t11FspfConfiguration 2 }

t11FspfIfEntry OBJECT-TYPE
    SYNTAX   T11FspfIfEntry
    MAX-ACCESS not-accessible
    STATUS   current
    DESCRIPTION
            "An entry containing FSPF information for the interface
            identified by t11FspfIfIndex, on the fabric identified
            by t11FspfFabricIndex, on the switch identified by
            fcmSwitchIndex."
    INDEX   { fcmInstanceIndex, fcmSwitchIndex,
                  t11FspfFabricIndex, t11FspfIfIndex }
    ::= { t11FspfIfTable 1 }

T11FspfIfEntry ::= SEQUENCE {
    t11FspfIfIndex   InterfaceIndex,
    t11FspfIfHelloInterval   Unsigned32,
    t11FspfIfDeadInterval   Unsigned32,
    t11FspfIfRetransmitInterval   Unsigned32,
    t11FspfIfInLsuPkts   Counter32,
    t11FspfIfInLsaPkts   Counter32,
    t11FspfIfOutLsuPkts   Counter32,
    t11FspfIfOutLsaPkts   Counter32,
    t11FspfIfOutHelloPkts   Counter32,
    t11FspfIfInHelloPkts   Counter32,
    t11FspfIfRetransmittedLsuPkts   Counter32,
    t11FspfIfInErrorPkts   Counter32,
    t11FspfIfNbrState   T11FspfInterfaceState,
    t11FspfIfNbrDomainId   FcDomainIdOrZero,
    t11FspfIfNbrPortIndex   Unsigned32,
    t11FspfIfAdminStatus   INTEGER,
    t11FspfIfCreateTime   T11FspfLastCreationTime,
    t11FspfIfSetToDefault   INTEGER,

```
    t11FspfIfLinkCostFactor                Unsigned32,
    t11FspfIfStorageType                   StorageType,
    t11FspfIfRowStatus                     RowStatus
}

t11FspfIfIndex OBJECT-TYPE
    SYNTAX      InterfaceIndex
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The value of ifIndex that identifies the local
            Fibre Channel interface for which this entry
            contains FSPF information."
    ::= { t11FspfIfEntry 1 }

t11FspfIfHelloInterval OBJECT-TYPE
    SYNTAX      Unsigned32 (1..65535)
    UNITS       "Seconds"
    MAX-ACCESS  read-create
    STATUS      current
    DESCRIPTION
            "Interval between the periodic HELLO messages sent on this
            interface in this Fabric to verify the link health.  Note
            that this value must be same at both ends of a link in
            this Fabric."
    DEFVAL {20}
    ::= { t11FspfIfEntry 2 }

t11FspfIfDeadInterval OBJECT-TYPE
    SYNTAX      Unsigned32 (2..65535)
    UNITS       "Seconds"
    MAX-ACCESS  read-create
    STATUS      current
    DESCRIPTION
            "Maximum time for which no HELLO messages can be received
            on this interface in this Fabric.  After this time, the
            interface is assumed to be broken and removed from the
            database.  Note that this value must be greater than the
            HELLO interval specified on this interface in this Fabric."
    DEFVAL {80}
    ::= { t11FspfIfEntry 3 }

t11FspfIfRetransmitInterval OBJECT-TYPE
    SYNTAX      Unsigned32 (1..65535)
    UNITS       "Seconds"
    MAX-ACCESS  read-create
    STATUS      current
    DESCRIPTION
```

```
                    "The time after which an unacknowledged LSR is
                    retransmitted on this interface in this Fabric."
          DEFVAL {5}
          ::= { t11FspfIfEntry 4 }

t11FspfIfInLsuPkts OBJECT-TYPE
     SYNTAX        Counter32
     MAX-ACCESS  read-only
     STATUS        current
     DESCRIPTION
              "Number of Link State Update (LSU) packets received on
              this interface in this Fabric.  The last discontinuity
              of this counter is indicated by t11FspfIfCreateTime."
          ::= { t11FspfIfEntry 5 }

t11FspfIfInLsaPkts OBJECT-TYPE
     SYNTAX        Counter32
     MAX-ACCESS  read-only
     STATUS        current
     DESCRIPTION
              "Number of Link State Acknowledgement (LSA) packets
              received on this interface in this Fabric.  The last
              discontinuity of this counter is indicated by
              t11FspfIfCreateTime."
          ::= { t11FspfIfEntry 6 }

t11FspfIfOutLsuPkts OBJECT-TYPE
     SYNTAX        Counter32
     MAX-ACCESS  read-only
     STATUS        current
     DESCRIPTION
              "Number of Link State Update (LSU) packets transmitted
              on this interface in this Fabric.  The last
              discontinuity of this counter is indicated by
              t11FspfIfCreateTime."
          ::= { t11FspfIfEntry 7 }

t11FspfIfOutLsaPkts OBJECT-TYPE
     SYNTAX        Counter32
     MAX-ACCESS  read-only
     STATUS        current
     DESCRIPTION
              "Number of Link State Acknowledgement (LSA) packets
              transmitted on this interface in this Fabric.  The
              last discontinuity of this counter is indicated by
              t11FspfIfCreateTime."
          ::= { t11FspfIfEntry 8 }
```

t11FspfIfOutHelloPkts OBJECT-TYPE
    SYNTAX   Counter32
    MAX-ACCESS read-only
    STATUS   current
    DESCRIPTION
            "Number of HELLO packets transmitted on this interface in
            this Fabric. The last discontinuity of this counter is
            indicated by t11FspfIfCreateTime."
    ::= { t11FspfIfEntry 9 }

t11FspfIfInHelloPkts OBJECT-TYPE
    SYNTAX   Counter32
    MAX-ACCESS read-only
    STATUS   current
    DESCRIPTION
            "Number of HELLO packets received on this interface in
            this Fabric. The last discontinuity of this counter is
            indicated by t11FspfIfCreateTime."
    ::= { t11FspfIfEntry 10 }

t11FspfIfRetransmittedLsuPkts OBJECT-TYPE
    SYNTAX   Counter32
    MAX-ACCESS read-only
    STATUS   current
    DESCRIPTION
            "The number of LSU packets that contained one or more
            retransmitted LSRs, and that were transmitted on this
            interface in this Fabric. The last discontinuity of
            this counter is indicated by t11FspfIfCreateTime."
    ::= { t11FspfIfEntry 11 }

t11FspfIfInErrorPkts OBJECT-TYPE
    SYNTAX   Counter32
    MAX-ACCESS read-only
    STATUS   current
    DESCRIPTION
            "Number of invalid FSPF control packets received on this
            interface in this Fabric. The last discontinuity of
            this counter is indicated by t11FspfIfCreateTime."
    ::= { t11FspfIfEntry 12 }

t11FspfIfNbrState OBJECT-TYPE
    SYNTAX   T11FspfInterfaceState
    MAX-ACCESS read-only
    STATUS   current
    DESCRIPTION
            "The state of FSPF's 'neighbor state machine', which is
            the operational state of the interaction with the

              neighbor's interface that is connected to this interface.

              If the 't11FspfIfAdminStatus' is 'down', then this object
              should be 'down'. If the 't11FspfIfAdminStatus' is 'up',
              then this object's value depends on the state of FSPF's
              'neighbor state machine' on this interface in this
              Fabric."
        REFERENCE   "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
                    ANSI INCITS 418-2006, section 8.7"
        ::= { t11FspfIfEntry 13 }

    t11FspfIfNbrDomainId OBJECT-TYPE
        SYNTAX   FcDomainIdOrZero
        MAX-ACCESS read-only
        STATUS   current
        DESCRIPTION
              "The Domain Id of the neighbor in this Fabric."
        ::= { t11FspfIfEntry 14 }

    t11FspfIfNbrPortIndex OBJECT-TYPE
        SYNTAX   Unsigned32 (0..16777215)
        MAX-ACCESS read-only
        STATUS   current
        DESCRIPTION
              "The index, as known by the neighbor, of the neighbor's
              interface that is connected to this interface in this
              Fabric."
        REFERENCE   "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
                    ANSI INCITS 418-2006, section 6.1.9.4."
        ::= { t11FspfIfEntry 15 }

    t11FspfIfAdminStatus OBJECT-TYPE
        SYNTAX   INTEGER {
                    up(1),
                    down(2)
                    }
        MAX-ACCESS read-create
        STATUS   current
        DESCRIPTION
              "The desired state of FSPF on this interface in this
              Fabric, whenever 't11FspfAdminStatus' is 'up'.
              If the value of this object is set to 'up', then FSPF is
              enabled on this interface in this Fabric. If set to
              'down', then FSPF is disabled on this interface in this
              Fabric. Note that the operational state of FSPF on an
              interface is given by t11FspfIfNbrState."
        DEFVAL {up}
        ::= { t11FspfIfEntry 16 }

```
t11FspfIfCreateTime OBJECT-TYPE
    SYNTAX       T11FspfLastCreationTime
    MAX-ACCESS   read-only
    STATUS       current
    DESCRIPTION
            "The value of sysUpTime when this entry was last
            created."
    ::= { t11FspfIfEntry 17 }

t11FspfIfSetToDefault OBJECT-TYPE
    SYNTAX       INTEGER {
                     default(1),
                     noOp(2)
                 }
    MAX-ACCESS   read-create
    STATUS       current
    DESCRIPTION
            "Setting this value to 'default' changes the value of each
            and every writable object in this row to its default
            value.

            If all the configuration parameters have their default
            values, and if the interface is down, then the row is
            deleted automatically.

            No action is taken if this object is set to 'noOp'.
            The value of the object, when read, is always 'noOp'."
    ::= { t11FspfIfEntry 18 }

t11FspfIfLinkCostFactor OBJECT-TYPE
    SYNTAX       Unsigned32 (1..65535)
    MAX-ACCESS   read-create
    STATUS       current
    DESCRIPTION
            "The administrative factor used in calculating the cost
            of sending a frame on this interface in this Fabric.

            The formula used to calculate the link cost is:
```

$$\text{Link Cost} = S \times (1.0625\text{e}12 \, / \, ifSpeed)$$

```
            where:
              S = (the value of this object / 100)
              ifSpeed = interface speed (as defined in the IF-MIB).
            "
    REFERENCE
            "Fibre Channel - Switch Fabric - 4 (FC-SW-4),
             ANSI INCITS 418-2006, section 8.5.5; and
             IF-MIB, RFC 2863."
```

```
     DEFVAL { 100 }
     ::= { t11FspfIfEntry 19 }

t11FspfIfStorageType 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."
        DEFVAL { nonVolatile }
     ::= { t11FspfIfEntry 20 }

t11FspfIfRowStatus OBJECT-TYPE
    SYNTAX        RowStatus
    MAX-ACCESS  read-create
    STATUS        current
    DESCRIPTION
            "The status of the conceptual row.

            This object can be used to create an entry only if there
            is an entry in the t11FspfTable for the corresponding
            Fabric, and if the interface is either isolated or is a
            non-E_port.

            Setting this object to 'destroy' will typically fail;
            to reverse the creation process, set the corresponding
            instance of t11FspfIfSetToDefault to 'default'."
     ::= { t11FspfIfEntry 21 }

--
-- t11FspfLsrTable

t11FspfLsrTable OBJECT-TYPE
    SYNTAX        SEQUENCE OF T11FspfLsrEntry
    MAX-ACCESS  not-accessible
    STATUS        current
    DESCRIPTION
            "This table is the database of all the latest
            incarnations of the Link State Records (LSRs) that
            are currently contained in the topology database,
            for all interfaces on all Fabrics known to
            locally managed switches.

            A Fabric's topology database contains the LSRs that
            have been either issued or received by a local switch on
            that Fabric, and that have not reached t11FspfMaxAge."
```

```
    ::= { t11FspfDatabase 1 }

t11FspfLsrEntry OBJECT-TYPE
    SYNTAX      T11FspfLsrEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This gives information for the most recent update of an
            LSR.  There is one entry for every LSR issued or received
            by a locally managed switch (identified by
            fcmInstanceIndex and fcmSwitchIndex) in a Fabric
            (identified by t11FspfFabricIndex)."
    INDEX       { fcmInstanceIndex, fcmSwitchIndex, t11FspfFabricIndex,
                  t11FspfLsrDomainId, t11FspfLsrType }
    ::= { t11FspfLsrTable 1 }

T11FspfLsrEntry ::= SEQUENCE {
    t11FspfLsrDomainId          FcDomainIdOrZero,
    t11FspfLsrType              T11FspfLsrType,
    t11FspfLsrAdvDomainId       FcDomainIdOrZero,
    t11FspfLsrAge               Unsigned32,
    t11FspfLsrIncarnationNumber Unsigned32,
    t11FspfLsrCheckSum          Unsigned32,
    t11FspfLsrLinks             Unsigned32
}

t11FspfLsrDomainId OBJECT-TYPE
    SYNTAX      FcDomainIdOrZero
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Domain Id of the LSR owner in this Fabric.  It is the
            Link State Id of this LSR."
    ::= { t11FspfLsrEntry 1 }

t11FspfLsrType OBJECT-TYPE
    SYNTAX      T11FspfLsrType
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Type of this LSR."
    ::= { t11FspfLsrEntry 2 }

t11FspfLsrAdvDomainId OBJECT-TYPE
    SYNTAX      FcDomainIdOrZero
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
```

                    "Domain Id of the switch that is advertising the LSR on
                    the behalf of the switch owning it."
        ::= { t11FspfLsrEntry 3 }

t11FspfLsrAge OBJECT-TYPE
    SYNTAX   Unsigned32 (0..65535)
    UNITS   "Seconds"
    MAX-ACCESS   read-only
    STATUS   current
    DESCRIPTION
            "The time since this LSR was inserted into the database."
    ::= { t11FspfLsrEntry 4 }

t11FspfLsrIncarnationNumber OBJECT-TYPE
    SYNTAX   Unsigned32 (0..4294967295)
    MAX-ACCESS   read-only
    STATUS   current
    DESCRIPTION
            "The link state incarnation number of this LSR. This is
            used to identify most recent instance of an LSR while
            updating the topology database when an LSR is received.
            The updating of an LSR includes incrementing its
            incarnation number prior to transmission of the updated
            LSR. So, the most recent LSR is the one with the
            largest incarnation number."
    ::= { t11FspfLsrEntry 5 }

t11FspfLsrCheckSum OBJECT-TYPE
    SYNTAX   Unsigned32 (0..65535)
    MAX-ACCESS   read-only
    STATUS   current
    DESCRIPTION
            "The checksum of the LSR."
    ::= { t11FspfLsrEntry 6 }

t11FspfLsrLinks OBJECT-TYPE
    SYNTAX   Unsigned32 (0..65355)
    MAX-ACCESS   read-only
    STATUS   current
    DESCRIPTION
            "Number of entries in the t11FspfLinkTable associated with
            this LSR."
    ::= { t11FspfLsrEntry 7 }
--
-- t11FspfLinkTable

t11FspfLinkNumber OBJECT-TYPE
    SYNTAX   Unsigned32 (0..2147483647)

```
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
           "The number of rows in the t11FspfLinkTable."
       ::= { t11FspfDatabase 3 }

t11FspfLinkTable OBJECT-TYPE
    SYNTAX        SEQUENCE OF T11FspfLinkEntry
    MAX-ACCESS  not-accessible
    STATUS        current
    DESCRIPTION
           "This table contains the list of Inter-Switch Links and
            their information that is part of an LSR, either
            received or transmitted."
    ::= { t11FspfDatabase 4 }

t11FspfLinkEntry OBJECT-TYPE
    SYNTAX      T11FspfLinkEntry
    MAX-ACCESS  not-accessible
    STATUS        current
    DESCRIPTION
           "An entry that contains information about a link
            contained in an LSR in this Fabric.  An entry is created
            whenever a new link appears in an (issued or received)
            LSR.  An entry is deleted when a link no longer appears
            in an (issued or received) LSR."
    INDEX      { fcmInstanceIndex, fcmSwitchIndex, t11FspfFabricIndex,
                 t11FspfLsrDomainId, t11FspfLsrType, t11FspfLinkIndex}
    ::= { t11FspfLinkTable 1 }

T11FspfLinkEntry ::= SEQUENCE {
    t11FspfLinkIndex              Unsigned32,
    t11FspfLinkNbrDomainId        FcDomainIdOrZero,
    t11FspfLinkPortIndex          Unsigned32,
    t11FspfLinkNbrPortIndex       Unsigned32,
    t11FspfLinkType               T11FspfLinkType,
    t11FspfLinkCost               Integer32
}

t11FspfLinkIndex OBJECT-TYPE
    SYNTAX      Unsigned32 (1..4294967295)
    MAX-ACCESS  not-accessible
    STATUS        current
    DESCRIPTION
           "An arbitrary index of this link."
    ::= { t11FspfLinkEntry 1 }

t11FspfLinkNbrDomainId OBJECT-TYPE
```

```
    SYNTAX        FcDomainIdOrZero
    MAX-ACCESS  read-only
    STATUS        current
    DESCRIPTION
            "The Domain Id of the neighbor on the other end of this
            link in this Fabric."
    ::= { t11FspfLinkEntry 2 }

t11FspfLinkPortIndex OBJECT-TYPE
    SYNTAX        Unsigned32 (0..16777215)
    MAX-ACCESS  read-only
    STATUS        current
    DESCRIPTION
            "The source E_port of this link, as indicated by the index
            value in the LSR received from the switch identified by
            't11FspfLsrDomainId'."
    ::= { t11FspfLinkEntry 3 }

t11FspfLinkNbrPortIndex OBJECT-TYPE
    SYNTAX        Unsigned32 (0..16777215)
    MAX-ACCESS  read-only
    STATUS        current
    DESCRIPTION
            "The destination E_port of this link, as indicated by the
            index value in the LSR received from the switch identified
            by 't11FspfLinkNbrDomainId'."
    ::= { t11FspfLinkEntry 4 }

t11FspfLinkType OBJECT-TYPE
    SYNTAX        T11FspfLinkType
    MAX-ACCESS  read-only
    STATUS        current
    DESCRIPTION
            "The type of this link."
    ::= { t11FspfLinkEntry 5 }

t11FspfLinkCost OBJECT-TYPE
    SYNTAX        Integer32 (0..65535)
    MAX-ACCESS  read-only
    STATUS        current
    DESCRIPTION
            "The cost of sending a frame on this link in this Fabric.
            Link cost is calculated using the formula:

                link cost = S * (1.0625e12 / Signalling Rate)

            For issued LSRs, S is determined by the value of
            t11FspfIfLinkCostFactor for the corresponding interface
```

```
               and Fabric."
         ::= { t11FspfLinkEntry 6 }

--
-- Notification-related object

t11FspfIfPrevNbrState OBJECT-TYPE
     SYNTAX        T11FspfInterfaceState
     MAX-ACCESS  accessible-for-notify
     STATUS        current
     DESCRIPTION
             "The previous state of FSPF's Neighbor Finite State
             Machine on an interface.

             This object is only used in the
             't11FspfNbrStateChangNotify' notification."
         ::= { t11FspfConfiguration 3 }

--
-- Notifications

t11FspfNbrStateChangNotify NOTIFICATION-TYPE
     OBJECTS      { ifIndex,
                     t11FamConfigDomainId,
                     t11FspfIfNbrDomainId,
                     t11FspfIfNbrState,
                     t11FspfIfPrevNbrState
     }
     STATUS        current
     DESCRIPTION
             "This notification signifies that there has been a change in
             the state of an FSPF neighbor.  This is generated when the
             FSPF state changes to a terminal state, through either
             regression (i.e., goes from Full to Init or Down) or
             progression (i.e., from any state to Full).  The value of
             't11FspfIfNbrState' is the state of the neighbor after the
             change."
         ::= { t11FspfNotifications 1 }

--
-- Conformance

t11FspfMIBCompliances
     OBJECT IDENTIFIER ::= { t11FspfConformance 1 }

t11FspfMIBGroups
     OBJECT IDENTIFIER ::= { t11FspfConformance 2 }
```

```
t11FspfMIBCompliance MODULE-COMPLIANCE
    STATUS      current
    DESCRIPTION
            "The compliance statement for entities that
            implement the FSPF."
    MODULE -- this module
        MANDATORY-GROUPS { t11FspfGeneralGroup,
                           t11FspfIfGroup,
                           t11FspfDatabaseGroup,
                           t11FspfNotificationGroup }

        GROUP       t11FspfIfCounterGroup
        DESCRIPTION
                "These counters, for particular FSPF-packet
                occurrences on an interface, are mandatory only
                for those systems that count such events."

        OBJECT      t11FspfIfRowStatus
        SYNTAX      INTEGER { active(1) }
        MIN-ACCESS  read-only
        DESCRIPTION
                "Write access is not required, so only
                one value needs to be supported."

        OBJECT      t11FspfIfStorageType
        MIN-ACCESS  read-only
        DESCRIPTION
                "Write access is not required."

        OBJECT      t11FspfNbrStateChangNotifyEnable
        MIN-ACCESS  read-only
        DESCRIPTION
                "Write access is not required."

        OBJECT      t11FspfMinLsArrival
        MIN-ACCESS  read-only
        DESCRIPTION
                "Write access is not required."

        OBJECT      t11FspfMinLsInterval
        MIN-ACCESS  read-only
        DESCRIPTION
                "Write access is not required."

        OBJECT      t11FspfAdminStatus
        MIN-ACCESS  read-only
        DESCRIPTION
                "Write access is not required."
```

```
        OBJECT      t11FspfSetToDefault
        MIN-ACCESS read-only
        DESCRIPTION
              "Write access is not required."

        OBJECT      t11FspfStorageType
        MIN-ACCESS read-only
        DESCRIPTION
              "Write access is not required."

        OBJECT      t11FspfIfHelloInterval
        MIN-ACCESS read-only
        DESCRIPTION
              "Write access is not required."

        OBJECT      t11FspfIfDeadInterval
        MIN-ACCESS read-only
        DESCRIPTION
              "Write access is not required."

        OBJECT      t11FspfIfRetransmitInterval
        MIN-ACCESS read-only
        DESCRIPTION
              "Write access is not required."

        OBJECT      t11FspfIfAdminStatus
        MIN-ACCESS read-only
        DESCRIPTION
              "Write access is not required."

        OBJECT      t11FspfIfSetToDefault
        MIN-ACCESS read-only
        DESCRIPTION
              "Write access is not required."

        OBJECT      t11FspfIfLinkCostFactor
        MIN-ACCESS read-only
        DESCRIPTION
              "Write access is not required."

        ::= { t11FspfMIBCompliances 1 }

-- Units of Conformance

t11FspfGeneralGroup OBJECT-GROUP
    OBJECTS  { t11FspfMinLsArrival,
               t11FspfMinLsInterval,
               t11FspfLsRefreshTime,
```

```
                    t11FspfMaxAge,
                    t11FspfMaxAgeDiscards,
                    t11FspfPathComputations,
                    t11FspfChecksumErrors,
                    t11FspfLsrs,
                    t11FspfCreateTime,
                    t11FspfAdminStatus,
                    t11FspfOperStatus,
                    t11FspfNbrStateChangNotifyEnable,
                    t11FspfSetToDefault,
                    t11FspfStorageType }
    STATUS    current
    DESCRIPTION
            "A collection of objects for displaying and
             configuring FSPF parameters."
    ::= { t11FspfMIBGroups 1 }

t11FspfIfGroup OBJECT-GROUP
    OBJECTS  { t11FspfIfHelloInterval,
                    t11FspfIfDeadInterval,
                    t11FspfIfRetransmitInterval,
                    t11FspfIfNbrState,
                    t11FspfIfNbrDomainId,
                    t11FspfIfNbrPortIndex,
                    t11FspfIfAdminStatus,
                    t11FspfIfCreateTime,
                    t11FspfIfSetToDefault,
                    t11FspfIfLinkCostFactor,
                    t11FspfIfRowStatus,
                    t11FspfIfStorageType,
                    t11FspfIfPrevNbrState }
    STATUS    current
    DESCRIPTION
            "A collection of objects for displaying the FSPF
             interface information."
    ::= { t11FspfMIBGroups 2 }

t11FspfIfCounterGroup OBJECT-GROUP
    OBJECTS  { t11FspfIfInLsuPkts,
                    t11FspfIfInLsaPkts,
                    t11FspfIfOutLsuPkts,
                    t11FspfIfOutLsaPkts,
                    t11FspfIfOutHelloPkts,
                    t11FspfIfInHelloPkts,
                    t11FspfIfRetransmittedLsuPkts,
                    t11FspfIfInErrorPkts  }
    STATUS    current
    DESCRIPTION
```

```
                 "A collection of objects for counting particular
                  FSPF-packet occurrences on an interface."
        ::= { t11FspfMIBGroups 3 }

t11FspfDatabaseGroup OBJECT-GROUP
    OBJECTS  { t11FspfLsrAdvDomainId,
               t11FspfLsrAge,
               t11FspfLsrIncarnationNumber,
               t11FspfLsrCheckSum,
               t11FspfLsrLinks,
               t11FspfLinkNbrDomainId,
               t11FspfLinkPortIndex,
               t11FspfLinkNbrPortIndex,
               t11FspfLinkType,
               t11FspfLinkCost,
               t11FspfLinkNumber }
    STATUS    current
    DESCRIPTION
            "A collection of objects for displaying the FSPF
             topology database information."
        ::= { t11FspfMIBGroups 4 }
t11FspfNotificationGroup NOTIFICATION-GROUP
    NOTIFICATIONS  { t11FspfNbrStateChangNotify }
    STATUS    current
    DESCRIPTION
            "A collection of notifications for FSPF."
        ::= { t11FspfMIBGroups 5 }
END
```

7. Acknowledgements

   This document was originally developed and approved by the INCITS
   Task Group T11.5 (http://www.t11.org) as the SM-FSM project. We wish
   to acknowledge the many contributions and comments from the INCITS
   Technical Committee T11, including the following:

      T11 Chair: Robert Snively, Brocade
      T11 Vice Chair: Claudio DeSanti, Cisco Systems
      T11.5 Chair: Roger Cummings, Symantec
      T11.5 members, especially:
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   The document was subsequently approved by the IETF's IMSS Working
   Group, chaired by David Black (EMC Corporation). We also wish to
   acknowledge Bert Wijnen (Lucent Technologies), the IETF Area
   Director, for his review of the document.

8. IANA Considerations

   The IANA assigned a MIB OID for the T11-FC-FSPF-MIB module under the
   appropriate subtree.

9. Security Considerations

   There are several 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 objects and their
   sensitivity/vulnerability are:

        t11FspfMinLsArrival, t11FspfMinLsInterval,
        t11FspfIfHelloInterval, t11FspfIfDeadInterval &
        t11FspfIfRetransmitInterval
           -- alter the responsiveness of the FSPF protocol

        t11FspfAdminStatus & t11FspfIfAdminStatus
           -- enable/disable dynamic routing via FSPF

        t11FspfSetToDefault & t11FspfIfSetToDefault
           -- nullify valid configuration changes

        t11FspfIfLinkCostFactor
           -- alter the choice of links

        t11FspfNbrStateChangNotifyEnable
           -- enable/disable notifications.

   The support for SET operations in a non-secure environment without
   proper protection can have a negative effect on network operations.

   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:

      t11FspfTable -- contains per-Fabric parameters and statistics

      t11FspfIfTable -- contains per-interface parameters and statistics

      t11FspfLsrTable & t11FspfLinkTable -- database of LSR information,

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 implementors consider the security features as
provided by the SNMPv3 framework (see [RFC3410], section 8),
including full support for the SNMPv3 cryptographic mechanisms (for
authentication and privacy).

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

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