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

Status of This Memo

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Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects for 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
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```
            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
```

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            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:

                    Link Cost = S * (1.0625e12 / 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:
Ken Hirata, Emulex
Scott Kipp, McData
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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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