

Network Working Group
Request for Comments: 4626
Category: Standards Track

C. DeSanti
V. Gaonkar
K. McCloghrie
Cisco Systems
S. Gai
Retired
September 2006

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.

Copyright Notice

Copyright (C) The Internet Society (2006).

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.

Table of Contents

1. Introduction	2
2. The Internet-Standard Management Framework	2
3. Short Overview of Fibre Channel	3
3.1. Introduction	3
3.2. FSPF Protocol	4
3.3. Virtual Fabrics	4
4. Relationship to Other MIBs	5
5. MIB Overview	5
5.1. Fibre Channel Management Instance	5
5.2. Switch Index	6
5.3. Fabric Index	6
5.4. The MIB Groups	6
5.4.1. The t11FspfGeneralGroup Group	6
5.4.2. The t11FspfIfGroup Group	7
5.4.3. The t11FspfDatabaseGroup Group	7
5.4.4. The t11FspfNotificationGroup Group	7
6. The T11-FC-FSPF-MIB Module	7
7. Acknowledgements	31
8. IANA Considerations	32
9. Security Considerations	32
10. Normative References	33
11. Informative References	34

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 t1lFspfIfGroup Group

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

5.4.3. The t1lFspfDatabaseGroup Group

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

5.4.4. The t1lFspfNotificationGroup 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]
    t1lFamConfigDomainId
        FROM T11-FC-FABRIC-ADDR-MGR-MIB;
        -- [RFC4439]

t1lFcFspfMIB 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:

                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
  Elizabeth G. Rodriguez, Dot Hill

```

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.

10. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.
- [RFC2578] McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M., and S. Waldbusser, "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, April 1999.
- [RFC2579] McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M., and S. Waldbusser, "Textual Conventions for SMIv2", STD 58, RFC 2579, April 1999.
- [RFC2580] McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M., and S. Waldbusser, "Conformance Statements for SMIv2", STD 58, RFC 2580, April 1999.
- [RFC2863] McCloghrie, K. and F. Kastenholz, "The Interfaces Group MIB", RFC 2863, June 2000.
- [RFC3411] Harrington, D., Presuhn, R., and B. Wijnen, "An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks", STD 62, RFC 3411, December 2002.
- [FC-FS] "Fibre Channel - Framing and Signaling (FC-FS)" ANSI INCITS 373-2003, April 2003.

- [FC-SW-4] "Fibre Channel - Switch Fabric - 4 (FC-SW-4)", ANSI INCITS 418-2006, 2006.
- [FC-MGMT] McCloghrie, K., "Fibre Channel Management MIB", RFC 4044, May 2005.
- [RFC4439] DeSanti, C., Gaonkar, V., McCloghrie, K., and S. Gai, "Fibre Channel Fabric Address Manager MIB", RFC 4439, March 2006.

11. Informative References

- [RFC2741] Daniele, M., Wijnen, B., Ellison, M., and D. Francisco, "Agent Extensibility (AgentX) Protocol Version 1", RFC 2741, January 2000.
- [RFC4044] McCloghrie, K., "Fibre Channel Management MIB", RFC 4044, May 2005.
- [RFC3410] Case, J., Mundy, R., Partain, D. and B. Stewart, "Introduction and Applicability Statements for Internet-Standard Management Framework", RFC 3410, December 2002.

Authors' Addresses

Claudio DeSanti
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134 USA

Phone: +1 408 853-9172
EMail: cds@cisco.com

Vinay Gaonkar
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134 USA

Phone: +1 408 527-8576
EMail: vgaonkar@cisco.com

Keith McCloghrie
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA USA 95134

Phone: +1 408-526-5260
EMail: kzm@cisco.com

Silvano Gai
Retired

Full Copyright Statement

Copyright (C) The Internet Society (2006).

This document is subject to the rights, licenses and restrictions contained in BCP 78, and except as set forth therein, the authors retain all their rights.

This document and the information contained herein are provided on an "AS IS" basis and THE CONTRIBUTOR, THE ORGANIZATION HE/SHE REPRESENTS OR IS SPONSORED BY (IF ANY), THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Intellectual Property

The IETF takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights. Information on the procedures with respect to rights in RFC documents can be found in BCP 78 and BCP 79.

Copies of IPR disclosures made to the IETF Secretariat and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF on-line IPR repository at <http://www.ietf.org/ipr>.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights that may cover technology that may be required to implement this standard. Please address the information to the IETF at ietf-ipr@ietf.org.

Acknowledgement

Funding for the RFC Editor function is provided by the IETF Administrative Support Activity (IASA).