    Definitions of Managed Objects for Fibre Channel Over TCP/IP (FCIP)

Status of This Memo

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

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Abstract

   This memo defines a portion of the Management Information Base (MIB)
   for use with network management protocols in TCP/IP-based internets.
   In particular, it defines objects for managing Fibre Channel Over
   TCP/IP (FCIP) entities, which are used to interconnect Fibre Channel
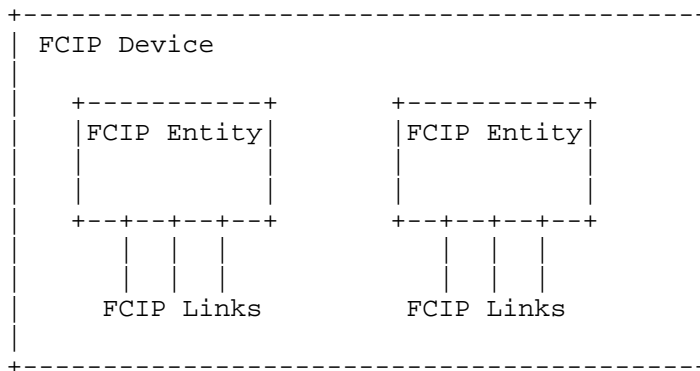   (FC) fabrics with IP networks.

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1. 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].

2. Overview of FCIP Management Model

    Note that the Fibre Channel Over TCP/IP (FCIP) Entity is fully
    described in [RFC3821] from a functional point of view. A collection
    of multiple instances of FCIP Entities and the corresponding FC
    Entities, described in [FCBB2], within an SNMP Context is referred to
    as an FCIP device here. This section describes FCIP from a
    management point of view.

```
          +-----------------------------------------+
          | FCIP Device                             |
          |                                         |
          |    +-----------+    +-----------+       |
          |    |FCIP Entity|    |FCIP Entity|       |
          |    |           |    |           |       |
          |    |           |    |           |       |
          |    +--+--+--+--+    +--+--+--+--+       |
          |       |  |  |          |  |  |          |
          |       |  |  |          |  |  |          |
          |        FCIP Links       FCIP Links      |
          |                                         |
          +-----------------------------------------+
```

    The FCIP device provides an IP-based interconnection model for
    interconnecting FC fabric elements. In this model, the FCIP devices
    along with the IP network on which they are running provide a new
    FCIP transport network.

    This IP-based FCIP Interconnection Model supports the following
    topology:

    o The FCIP-based transport network is formed by interconnecting the
      FCIP devices.

   o Each FCIP device has one or more FCIP Entities or Instances.

   o Peer FCIP Entities are connected by FCIP Links attached to
     VE_ports/B_Access.

   o Each FCIP Link Endpoint contains one or more Data Engines.

   o The FCIP device can work as a stand-alone box or as part of a FC
     fabric element.

   Each FCIP Entity managed by this MIB is referred to as an FCIP
   Instance.   The MIB is broken up as follows:

2.1. FCIP Entity Instances Table

   The FCIP Entity table contains information about this entity's
   existing instances of FCIP entities.

2.2. FCIP Link Table

   The FCIP link table contains information about this FCIP device's
   existing FCIP links.

2.3. FCIP TCP Connection Table

   The FCIP TCP Connection table contains information about existing TCP
   connections.   Each FCIP link within an FCIP entity contains one or
   more TCP connections.   The FCIP entity employs a Data Engine for each
   TCP connection for handling FC frame encapsulation, de-encapsulation,
   and transmission of FCIP frames on the connection.

2.4. FCIP Dynamic Route Table

   The FCIP dynamic route table contains routing information that is
   dynamically discovered by this FCIP device.   The FCIP device may use
   the SLPv2 protocol [RFC3822] in conjunction with other protocols,
   such as Fabric Shortest Path First (FSPF), to dynamically discover
   other FCIP entities and populate this table to map destination
   domains to FCIP Links.

2.5. FCIP Static Route Table

   The FCIP static route table contains routing information that is
   statically configured into this FCIP device by the Network Admin.   In
   the absence of dynamic discovery of remote FCIP entities, the Network
   Manager can configure remote domains and FCIP Entities that are
   reachable by this device into this table.

At any point in time, both the static and dynamic routing tables can
be active. If a DID is present in both tables, information in the
static route table will take precedence over the entry in the dynamic
route table for the same DID.

2.6. FCIP Discovery Domain Table

The FCIP Discovery Domain Table maps this device's FCIP Entities into
FCIP Discovery Domains.

2.7. FCIP Link Error Table

The FCIP Link Errors Table contains counters that indicate error
conditions on an FCIP Link.

3. Relationship to Other MIBs

Objects accessible from other MIB modules applicable to FCIP devices
have not been included in this MIB module. The following subsections
list all applicable MIB modules that should be present with FCIP-
MGMT-MIB.

3.1. Relationship to the 'TCP' Group

This group is mandatory for all systems that implement TCP. Objects
relevant to TCP must be obtained from this group [RFC4022].

3.2. Relationship to the 'interfaces' MIB

The 'interfaces' group is defined as being mandatory for all systems
and contains information on an entity's interfaces. Each
logical/virtual interface created as an FCIP Link should be
represented as a row in the ifTable with a unique ifIndex value and a
value of ifType 'fcipLink' (224) for each such interface. For a
complete list of interface types, refer to the IANA registry at
"http://www.iana.org/assignments/smi-numbers". These are the only
ifIndex values of relevance to an FCIP Entity because FCIP runs on
top of TCP/IP.

FCIP runs over TCP. Thus, by definition, there is no ifTable
interface directly beneath it, and so ifStackLowerLayer is always 0.
For any protocol using FCIP (i.e., above FCIP), FCIP appears to be a
regular FC interface. As stated in [RFC4044], a regular "FC
interface will typically have no other ifTable rows stacked on top of
it", and thus, ifStackHigherLayer is typically zero.

3.3. Relationship to the Fibre Channel Management MIB

   The Fibre Channel Management MIB [RFC4044] is assumed for FC
   functionality managed objects.

3.4. Specific Interface Group MIB Objects

   The following table provides specific implementation guidelines for
   applying the objects defined in the Interfaces Group MIB to FCIP
   Links. For those objects not listed here, refer to their generic
   definitions in [RFC2863].

Object	Guidelines
ifType	'fcipLink' (224)
ifSpeed	The ifSpeed for the physical interface(s) over which the FCIP Link runs.
ifPhysAddress	There is no physical address corresponding to an FCIP Link (only World Wide Name, WWN). Reported as 0.
ifAdminStatus	Write access is not required, and support for 'testing' is not required.
ifOperStatus	Support for 'testing' is not required. The value 'dormant' has no meaning for FCIP Links.
ifInOctets ifHCInOctets	The number of octets of FCIP information contained in received frames in TCP streams, starting with FCIP header.
ifInUcastPkts ifHCInUcastPkts	The number of FCIP frames received on this FCIP Link.
ifOutOctets ifHCOutOctets	The number of octets of FCIP information contained in transmitted frames in TCP streams, starting with FCIP header.
ifOutUcastPkts ifHCOutUcastPkts	The number of FCIP frames transmitted on this FCIP Link.

```
     ifInMulticastPkts        These counters are not incremented.
     ifInBroadcastPkts
     ifOutMulticastPkts
     ifOutBroadcastPkts
     ifHCInMulticastPkts
     ifHCInBroadcastPkts
     ifHCOutMulticastPkts
     ifHCOutBroadcastPkts

     ifLinkUpDownTrapEnable   Default is 'disabled'.

     ifPromiscuousMode        This will be 'false'.

     ifConnectorPresent       This will be 'false'.
```

4. MIB Definitions

    The following MIB module has IMPORTS from [RFC2578], [RFC2579],
    [RFC4001], [RFC4044], [RFC2863], [RFC2580], and [RFC3411]. In
    REFERENCE clauses, it refers to [FC-SW-3], [RFC3821], [RFC2883],
    [RFC1323], [RFC2474] and [RFC3822].

```
     FCIP-MGMT-MIB DEFINITIONS ::= BEGIN

     IMPORTS
         OBJECT-TYPE,
         MODULE-IDENTITY,
         Unsigned32,
         Counter32,
         mib-2                 FROM SNMPv2-SMI
         TEXTUAL-CONVENTION,
         TruthValue, RowStatus, TimeStamp  FROM SNMPv2-TC
         InetAddressType,
         InetAddress,
         InetPortNumber FROM INET-ADDRESS-MIB
         FcNameIdOrZero FROM FC-MGMT-MIB
         InterfaceIndex FROM IF-MIB
         MODULE-COMPLIANCE,
         OBJECT-GROUP FROM SNMPv2-CONF
         SnmpAdminString FROM SNMP-FRAMEWORK-MIB;

     fcipMIB MODULE-IDENTITY
         LAST-UPDATED "200602060000Z"
         ORGANIZATION "IETF IPFC Working Group"
         CONTACT-INFO "Anil Rijhsinghani
                       Accton Technology Corporation
                       5 Mount Royal Ave
                       Marlboro, MA 01752 USA.
```

```
                     Ravi Natarajan
                     F5 Networks
                     2460 North First Street, Suite 100
                     San Jose, CA 95131 USA."
        DESCRIPTION
            "The module defines management information specific to
             FCIP devices.

             Copyright(C) The Internet Society (2006).  This version
             of this MIB module is part of RFC 4404; see the RFC
             itself for full legal notices."
        REVISION          "200602060000Z"
        DESCRIPTION
            "Initial version of this module, published as RFC 4404."
        ::= { mib-2 224 }

   fcipObjects        OBJECT IDENTIFIER ::= { fcipMIB 1 }
   fcipConformance    OBJECT IDENTIFIER ::= { fcipMIB 2 }
   fcipConfig         OBJECT IDENTIFIER ::= { fcipObjects 1 }


   -- ****************************************************************
   -- Textual conventions
   --

   FcipDomainIdInOctetForm ::= TEXTUAL-CONVENTION
       STATUS    current
       DESCRIPTION
           "The Domain ID of a FC entity in octet form
            to support the concatenation(000000h||Domain_ID)
            format defined in the FSPF routing protocol."
       REFERENCE
           "FC-SW-3 section 4.8"
       SYNTAX    OCTET STRING (SIZE(1))

   FcipEntityMode ::= TEXTUAL-CONVENTION
       STATUS current
       DESCRIPTION
           "The type of port mode provided by an FCIP Entity
            for an FCIP Link.  An FCIP Entity can be an E-Port
            mode for one of its FCIP Link Endpoints or a B-Port
            mode for another of its FCIP Link Endpoints."
       REFERENCE
           "FC-BB, rev 4.7, 2 May 1997, section 3."
       SYNTAX INTEGER {
                   ePortMode(1),
                   bPortMode(2)
                      }
```

```
FcipEntityId  ::= TEXTUAL-CONVENTION
    STATUS current
    DESCRIPTION
        "The FCIP entity identifier as defined in RFC 3821."
    REFERENCE
        "RFC 3821, Section 7.1, FCIP Special Frame Format"
    SYNTAX OCTET STRING (SIZE(8))


-- ****************************************************************
-- The FCIP group
--
-- This group defines the global scalar objects applicable to FCIP
-- devices only
--

fcipDynIpConfType   OBJECT-TYPE
    SYNTAX INTEGER {
                slpv2(1),
                none(2)
    }
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
        "The type of discovery protocol used to discover remote
         FCIP entities.  The value of this object is persistent
         across system restarts."
    ::= { fcipConfig 1 }

fcipDeviceWWN   OBJECT-TYPE
    SYNTAX FcNameIdOrZero
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "The World Wide Name of this FCIP device."
    ::= { fcipConfig 2 }

fcipEntitySACKOption   OBJECT-TYPE
    SYNTAX INTEGER {
                enabled(1),
                disabled(2)
    }
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "Indication of whether the TCP Selective Acknowledgement
         Option is enabled at this FCIP device to let the receiver
         acknowledge multiple lost packets in a single ACK for faster
```

```
            recovery."
       REFERENCE
           "The Selective Ack option is defined in RFC 2883."
       ::= { fcipConfig 3 }


   -- ****************************************************************
   -- The FCIP Entity Table
   --

   fcipEntityInstanceTable OBJECT-TYPE
       SYNTAX SEQUENCE OF FcipEntityInstanceEntry
       MAX-ACCESS not-accessible
       STATUS current
       DESCRIPTION
           "Information about this FCIP device's existing instances of
            FCIP entities."
       REFERENCE
           "RFC 3821, Section 5.4, FCIP Entity"
       ::= { fcipConfig 4 }

   fcipEntityInstanceEntry OBJECT-TYPE
       SYNTAX FcipEntityInstanceEntry
       MAX-ACCESS not-accessible
       STATUS current
       DESCRIPTION
           "A conceptual row of the FCIP entity table with information
            about a particular FCIP entity.  Once a row has been
            created, it is non-volatile across agent restarts until it
            is deleted."
       INDEX { fcipEntityId }
       ::= { fcipEntityInstanceTable 1 }

   FcipEntityInstanceEntry ::=
       SEQUENCE {
                   fcipEntityId                FcipEntityId,
                   fcipEntityName              SnmpAdminString,
                   fcipEntityAddressType       InetAddressType,
                   fcipEntityAddress           InetAddress,
                   fcipEntityTcpConnPort       InetPortNumber,
                   fcipEntitySeqNumWrap        TruthValue,
                   fcipEntityPHBSupport        TruthValue,
                   fcipEntityStatus            RowStatus
            }

   fcipEntityId   OBJECT-TYPE
       SYNTAX FcipEntityId
       MAX-ACCESS not-accessible
```

```
         STATUS current
         DESCRIPTION
             "The FCIP entity identifier."
         REFERENCE
             "RFC 3821, Section 7.1, FCIP Special Frame Format"
         ::= { fcipEntityInstanceEntry 1 }

     fcipEntityName    OBJECT-TYPE
         SYNTAX SnmpAdminString (SIZE (0..32))
         MAX-ACCESS read-create
         STATUS current
         DESCRIPTION
             "An administratively-assigned name for this FCIP entity."
         ::= { fcipEntityInstanceEntry 2 }

     fcipEntityAddressType    OBJECT-TYPE
         SYNTAX InetAddressType
         MAX-ACCESS read-create
         STATUS current
         DESCRIPTION
             "The type of Internet address by which the entity is
              reachable.  Only address types IPv4 and IPv6 are supported."
         ::= { fcipEntityInstanceEntry 3 }

     fcipEntityAddress    OBJECT-TYPE
         SYNTAX InetAddress
         MAX-ACCESS read-create
         STATUS current
         DESCRIPTION
             "The Internet address for the entity, if configured.  The
              format of this address is determined by the value of the
              fcipEntityAddressType object."
         ::= { fcipEntityInstanceEntry 4 }

     fcipEntityTcpConnPort    OBJECT-TYPE
         SYNTAX InetPortNumber
         MAX-ACCESS read-create
         STATUS current
         DESCRIPTION
             "A TCP port other than the FCIP Well-Known port on which the
              FCIP entity listens for new TCP connection requests.  It
              contains the value zero(0) if the FCIP Entity only listens
              on the Well-Known port."
         DEFVAL  { 0 }
         ::= { fcipEntityInstanceEntry 5 }

     fcipEntitySeqNumWrap    OBJECT-TYPE
         SYNTAX TruthValue
```

        MAX-ACCESS read-only
        STATUS current
        DESCRIPTION
            "An indication of whether the FCIP Entity supports protection
             against sequence number wrap."
        REFERENCE
            "The PAWS option is defined in RFC 1323."
        ::= { fcipEntityInstanceEntry 6 }

    fcipEntityPHBSupport   OBJECT-TYPE
        SYNTAX TruthValue
        MAX-ACCESS read-only
        STATUS current
        DESCRIPTION
            "An indication of whether the FCIP Entity supports PHB IP
             quality of service (QoS)."
        REFERENCE
            "Per hop behavior is defined in RFC 2474, definition of the
             Differentiated Services Field."
        ::= { fcipEntityInstanceEntry 7 }

    fcipEntityStatus   OBJECT-TYPE
        SYNTAX RowStatus
        MAX-ACCESS   read-create
        STATUS   current
        DESCRIPTION
            "This object specifies the operational status of the row.

             When a management station sets the status to active(1), then
             the values for the objects fcipEntityName,
             fcipEntityAddressType, and fcipEntityAddress should be
             supplied as part of the set request. The values of the
             objects fcipEntityName, fcipEntityAddressType, and
             fcipEntityAddress can be changed if the row status is in
             active state. The object fcipEntityTcpConnPort takes the
             default value zero(0), if no value is supplied at the time
             of row creation.

             Setting the status to destroy(6) deletes the specified FCIP
             entity instance row from the table. It also deletes all the
             rows corresponding to the specified FCIP entity from the
             fcipLinkTable and fcipTcpConnTable tables."
        ::= { fcipEntityInstanceEntry 8 }

```
    -- ****************************************************************
    -- The FCIP Link Table
    --

    fcipLinkTable OBJECT-TYPE
        SYNTAX SEQUENCE OF FcipLinkEntry
        MAX-ACCESS not-accessible
        STATUS current
        DESCRIPTION
            "Information about FCIP links that exist on this device."
        ::= { fcipConfig 5 }

    fcipLinkEntry OBJECT-TYPE
        SYNTAX FcipLinkEntry
        MAX-ACCESS not-accessible
        STATUS current
        DESCRIPTION
            "A conceptual row of the FCIP link table containing
             information about a particular FCIP link.  The values of the
             read-create objects in this table are persistent across
             system restarts."
        INDEX { fcipEntityId, fcipLinkIndex }
        ::= { fcipLinkTable 1 }

    FcipLinkEntry ::=
        SEQUENCE {
                    fcipLinkIndex                       Unsigned32,
                    fcipLinkIfIndex                     InterfaceIndex,
                    fcipLinkCost                        Unsigned32,
                    fcipLinkLocalFcipEntityMode         FcipEntityMode,
                    fcipLinkLocalFcipEntityAddressType  InetAddressType,
                    fcipLinkLocalFcipEntityAddress      InetAddress,
                    fcipLinkRemFcipEntityWWN            FcNameIdOrZero,
                    fcipLinkRemFcipEntityId            FcipEntityId,
                    fcipLinkRemFcipEntityAddressType    InetAddressType,
                    fcipLinkRemFcipEntityAddress        InetAddress,
                    fcipLinkStatus                      RowStatus,
                    fcipLinkCreateTime                  TimeStamp
    }

    fcipLinkIndex     OBJECT-TYPE
        SYNTAX Unsigned32 (1..4294967295)
        MAX-ACCESS not-accessible
        STATUS current
        DESCRIPTION
            "An arbitrary integer that uniquely identifies one FCIP link
             within an FCIP entity."
        ::= { fcipLinkEntry 1 }
```

```
    fcipLinkIfIndex      OBJECT-TYPE
        SYNTAX InterfaceIndex
        MAX-ACCESS read-only
        STATUS current
        DESCRIPTION
            "The ifIndex value of the virtual interface corresponding to
             the FCIP Link running over TCP/IP."
        ::= { fcipLinkEntry 2 }

    fcipLinkCost      OBJECT-TYPE
        SYNTAX Unsigned32
        MAX-ACCESS read-create
        STATUS current
        DESCRIPTION
            "The FSPF cost associated with this FCIP Link."
        DEFVAL  { 0 }
        ::= { fcipLinkEntry 3 }

    fcipLinkLocalFcipEntityMode   OBJECT-TYPE
        SYNTAX FcipEntityMode
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
            "The mode of the local end of the FCIP link."
        ::= { fcipLinkEntry 4 }

    fcipLinkLocalFcipEntityAddressType   OBJECT-TYPE
        SYNTAX InetAddressType
        MAX-ACCESS read-create
        STATUS current
        DESCRIPTION
            "The type of Internet address contained in the corresponding
             instance of fcipLinkLocalFcipEntityAddress.  Only address
             types IPv4 and IPv6 are supported."
        ::= { fcipLinkEntry 5 }

    fcipLinkLocalFcipEntityAddress   OBJECT-TYPE
        SYNTAX InetAddress
        MAX-ACCESS read-create
        STATUS current
        DESCRIPTION
            "The Internet address for the local end of this FCIP Link.
             The format of this object is determined by the value of the
             fcipLinkLocalFcipEntityAddressType object."
        ::= { fcipLinkEntry 6 }

    fcipLinkRemFcipEntityWWN   OBJECT-TYPE
        SYNTAX FcNameIdOrZero
```

```
    MAX-ACCESS read-create
    STATUS current
    DESCRIPTION
        "The World Wide Name of the remote FC Fabric Entity."
    REFERENCE
        "RFC 3821, Section 7.1, FCIP Special Frame Format"
    ::= { fcipLinkEntry 7 }

fcipLinkRemFcipEntityId   OBJECT-TYPE
    SYNTAX FcipEntityId
    MAX-ACCESS read-create
    STATUS current
    DESCRIPTION
        "The remote FCIP entity's identifier."
    REFERENCE
        "RFC 3821, Section 7.1, FCIP Special Frame Format"
    ::= { fcipLinkEntry 8 }

fcipLinkRemFcipEntityAddressType   OBJECT-TYPE
    SYNTAX InetAddressType
    MAX-ACCESS read-create
    STATUS current
    DESCRIPTION
        "The type of Internet address contained in the corresponding
         instance of fcipLinkRemFcipEntityAddress.  Only address
         types IPv4 and IPv6 are supported."
    ::= { fcipLinkEntry 9 }

fcipLinkRemFcipEntityAddress   OBJECT-TYPE
    SYNTAX InetAddress
    MAX-ACCESS read-create
    STATUS current
    DESCRIPTION
        "The Internet address for the remote end of this FCIP Link.
         The format of this object is determined by the value of the
         fcipLinkRemFcipEntityAddressType object."
    ::= { fcipLinkEntry 10 }

fcipLinkStatus   OBJECT-TYPE
    SYNTAX RowStatus
    MAX-ACCESS   read-create
    STATUS   current
    DESCRIPTION
        "This object specifies the operational status of the row.

         The values of objects fcipLinkLocalFcipEntityAddressType,
         fcipLinkLocalFcipEntityAddress, fcipLinkRemFcipEntityWWN,
         fcipLinkRemFcipEntityId, fcipLinkRemFcipEntityAddressType,
```

             and fcipLinkRemFcipEntityAddress can be changed if the row
             is in active(1) state. The object fcipLinkCost is set to
             the value zero(0) if no value is supplied at the time of row
             creation.

             Setting the status to destroy(6) deletes the specified FCIP
             link from the table. It also deletes all rows corresponding
             to the specified FCIP link from the fcipTcpConnTable table."
        ::= { fcipLinkEntry 11 }

    fcipLinkCreateTime OBJECT-TYPE
        SYNTAX   TimeStamp
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
            "The value of sysUpTime when this entry was last created."
        ::= { fcipLinkEntry 12 }

    -- **
    -- The TCP Connection Table
    --

    fcipTcpConnTable OBJECT-TYPE
        SYNTAX SEQUENCE OF FcipTcpConnEntry
        MAX-ACCESS not-accessible
        STATUS current
        DESCRIPTION
            "Information about existing TCP connections. Each FCIP link
             within an FCIP entity manages one or more TCP connections.
             The FCIP entity employs a Data Engine for each TCP
             connection for handling FC frame encapsulation,
             de-encapsulation, and transmission of FCIP frames on the
             connection."
        ::= { fcipConfig 6 }

    fcipTcpConnEntry OBJECT-TYPE
        SYNTAX FcipTcpConnEntry
        MAX-ACCESS not-accessible
        STATUS current
        DESCRIPTION
            "A conceptual row of the FCIP TCP Connection table containing
             information about a particular TCP connection."
        INDEX { fcipEntityId,
                fcipLinkIndex,
                fcipTcpConnLocalPort,
                fcipTcpConnRemPort}
        ::= { fcipTcpConnTable 1 }

```
    FcipTcpConnEntry ::=
        SEQUENCE {
                    fcipTcpConnLocalPort        InetPortNumber,
                    fcipTcpConnRemPort          InetPortNumber,
                    fcipTcpConnRWSize           Unsigned32,
                    fcipTcpConnMSS              Unsigned32
        }

    fcipTcpConnLocalPort    OBJECT-TYPE
        SYNTAX InetPortNumber
        MAX-ACCESS not-accessible
        STATUS current
        DESCRIPTION
            "The local port number for this TCP connection."
        ::= { fcipTcpConnEntry 1 }

    fcipTcpConnRemPort     OBJECT-TYPE
        SYNTAX InetPortNumber
        MAX-ACCESS not-accessible
        STATUS current
        DESCRIPTION
            "The remote port number for this TCP connection."
        ::= { fcipTcpConnEntry 2 }

    fcipTcpConnRWSize      OBJECT-TYPE
        SYNTAX Unsigned32
        MAX-ACCESS read-only
        STATUS current
        DESCRIPTION
            "The default maximum TCP Receiver Window size for this TCP
             connection."
        ::= { fcipTcpConnEntry 3 }

    fcipTcpConnMSS      OBJECT-TYPE
        SYNTAX Unsigned32
        MAX-ACCESS read-only
        STATUS current
        DESCRIPTION
            "The TCP Maximum Segment Size (MSS) for this TCP connection."
        ::= { fcipTcpConnEntry 4 }
```

```
-- *****************************************************************
-- The Dynamic Route Table
--

fcipDynamicRouteTable OBJECT-TYPE
    SYNTAX SEQUENCE OF FcipDynamicRouteEntry
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "Information about dynamically discovered routing
         information.  The FCIP device may use the SLPv2 protocol in
         conjunction with other protocols (say, FSPF) for dynamically
         discovering other FCIP entities and may populate this table
         with FCIP link information for each Destination Address
         Identifier."
    ::= { fcipConfig 7 }

fcipDynamicRouteEntry OBJECT-TYPE
    SYNTAX FcipDynamicRouteEntry
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "A conceptual row of the FCIP Dynamic Route Table containing
         information about a particular FCIP route."
    INDEX { fcipEntityId, fcipDynamicRouteDID }
    ::= { fcipDynamicRouteTable 1 }

FcipDynamicRouteEntry ::=
    SEQUENCE {
                fcipDynamicRouteDID         FcipDomainIdInOctetForm,
                fcipDynamicRouteLinkIndex   Unsigned32
             }

fcipDynamicRouteDID    OBJECT-TYPE
    SYNTAX FcipDomainIdInOctetForm
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "8-bit ID of a Fibre Channel Domain that is reachable from
         this FCIP device."
    ::= { fcipDynamicRouteEntry  1 }

fcipDynamicRouteLinkIndex    OBJECT-TYPE
    SYNTAX Unsigned32 (1..4294967295)
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "The FCIP Link used to reach the domain specified by the
```

```
            corresponding instance of fcipDynamicRouteDID.  The link
            identified by a value of this object is the same FCIP link
            as identified by the same value of fcipLinkIndex for the
            same FCIP entity."
       ::= { fcipDynamicRouteEntry  2 }


    -- ****************************************************************
    -- The Static Route Table
    --

    fcipStaticRouteTable OBJECT-TYPE
        SYNTAX SEQUENCE OF FcipStaticRouteEntry
        MAX-ACCESS not-accessible
        STATUS current
        DESCRIPTION
            "Information about static route entries configured by the
             Network Admin.  In the absence of dynamic discovery of
             remote FCIP entities, the Network Manager will figure out
             all remote FCIP devices that are reachable from this device
             and populate this table with FCIP link information for each
             Domain ID.  At any time, both static and dynamic routing
             can be active, and an entry in the static route table for a
             given DID takes precedence over the entry in the dynamic
             route table for the same Domain ID."
        ::= { fcipConfig 8 }

    fcipStaticRouteEntry OBJECT-TYPE
        SYNTAX FcipStaticRouteEntry
        MAX-ACCESS not-accessible
        STATUS current
        DESCRIPTION
            "A conceptual row of the FCIP Static Route Table containing
             information about a particular FCIP route.  The values of
             the read-create objects in this table are persistent across
             system restarts."
        INDEX { fcipEntityId, fcipStaticRouteDID }
        ::= { fcipStaticRouteTable 1 }

    FcipStaticRouteEntry ::=
        SEQUENCE {
                fcipStaticRouteDID            FcipDomainIdInOctetForm,
                fcipStaticRouteLinkIndex      Unsigned32,
                fcipStaticRouteStatus         RowStatus
              }

    fcipStaticRouteDID    OBJECT-TYPE
        SYNTAX FcipDomainIdInOctetForm
```

```
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "8-bit ID of a Fibre Channel Domain that is reachable from
         this FCIP device."
    ::= { fcipStaticRouteEntry  1 }

fcipStaticRouteLinkIndex    OBJECT-TYPE
    SYNTAX Unsigned32 (1..4294967295)
    MAX-ACCESS read-create
    STATUS current
    DESCRIPTION
        "The FCIP Link used to reach the domain specified by the
         corresponding instance of fcipStaticRouteDID.  The link
         identified by a value of this object is the same FCIP link
         as identified by the same value of fcipLinkIndex for the
         same FCIP entity."
    ::= { fcipStaticRouteEntry  2 }

fcipStaticRouteStatus   OBJECT-TYPE
    SYNTAX RowStatus
    MAX-ACCESS   read-create
    STATUS   current
    DESCRIPTION
        "This object specifies the operational status of the row.

         When a management station sets the status to active(1),
         the values for the object fcipStaticRouteLinkIndex should be
         supplied as part of the set request.

         Setting the status to destroy(6) deletes the specified FCIP
         static route entry from the table."
    ::= { fcipStaticRouteEntry  3 }


-- ****************************************************************
-- The FCIP Discovery Domain Table
--

fcipDiscoveryDomainTable OBJECT-TYPE
    SYNTAX SEQUENCE OF FcipDiscoveryDomainEntry
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "Information about FCIP Discovery Domains.  Each FCIP
         Discovery Domain is associated with one or more FCIP
         entities."
    ::= { fcipConfig 9 }
```

```
   fcipDiscoveryDomainEntry OBJECT-TYPE
       SYNTAX FcipDiscoveryDomainEntry
       MAX-ACCESS not-accessible
       STATUS current
       DESCRIPTION
           "A conceptual row of the FCIP Discovery Domain Table
            containing information about a particular FCIP Discovery
            Domain that is associated with one or more FCIP entities.
            The values of the read-write object fcipDiscoveryDomainName
            are persistent across system restarts."
       INDEX { fcipEntityId, fcipDiscoveryDomainIndex }
       ::= { fcipDiscoveryDomainTable 1 }

   FcipDiscoveryDomainEntry ::=
       SEQUENCE {
           fcipDiscoveryDomainIndex         Unsigned32,
           fcipDiscoveryDomainName          SnmpAdminString
       }

   fcipDiscoveryDomainIndex OBJECT-TYPE
       SYNTAX     Unsigned32 (1..4294967295)
       MAX-ACCESS not-accessible
       STATUS     current
       DESCRIPTION
           "An integer that uniquely identifies an FCIP Discovery Domain
            associated with this FCIP entity."
       ::= { fcipDiscoveryDomainEntry 1 }

   fcipDiscoveryDomainName   OBJECT-TYPE
       SYNTAX SnmpAdminString (SIZE (0..128))
       MAX-ACCESS read-write
       STATUS current
       DESCRIPTION
           "The name of this FCIP Discovery Domain."
       REFERENCE
           "RFC 3822, Section 4.1.1, FCIP Discovery Domains"
       ::= { fcipDiscoveryDomainEntry 2 }
```

```
   -- *****************************************************************
   -- The FCIP Link Errors
   --

   fcipLinkErrorsTable OBJECT-TYPE
       SYNTAX SEQUENCE OF FcipLinkErrorsEntry
       MAX-ACCESS not-accessible
       STATUS current
       DESCRIPTION
           "A list of error counters for FCIP Links.  Each counter
            records the number of times a particular error happened that
            caused a TCP connection to close down."
       REFERENCE
           "RFC 3821, Section 5.2, FCIP Link"
       ::= { fcipConfig 10 }

   fcipLinkErrorsEntry OBJECT-TYPE
       SYNTAX FcipLinkErrorsEntry
       MAX-ACCESS not-accessible
       STATUS current
       DESCRIPTION
           "A conceptual row of the FCIP Link Errors Table containing
            error counters for an FCIP Link."
       INDEX { fcipEntityId, fcipLinkIndex }
       ::= { fcipLinkErrorsTable 1 }

   FcipLinkErrorsEntry ::=
       SEQUENCE {
           fcipLinkFcipLossofFcSynchs          Counter32,
           fcipLinkFcipEncapErrors             Counter32,
           fcipLinkFcipNotReceivedSfResps      Counter32,
           fcipLinkFcipSfRespMismatches        Counter32,
           fcipLinkFcipSfInvalidNonces         Counter32,
           fcipLinkFcipReceivedSfDuplicates    Counter32,
           fcipLinkFcipSfInvalidWWNs           Counter32,
           fcipLinkFcipBB2LkaTimeOuts          Counter32,
           fcipLinkFcipSntpExpiredTimeStamps   Counter32,
           fcipLinkTcpTooManyErrors            Counter32,
           fcipLinkTcpExcessiveDroppedDatagrams Counter32,
           fcipLinkTcpSaParamMismatches        Counter32
       }

   fcipLinkFcipLossofFcSynchs OBJECT-TYPE
       SYNTAX     Counter32
       MAX-ACCESS read-only
       STATUS     current
       DESCRIPTION
           "The number of times FC synchronization was lost on this FCIP
```

```
         Link.  The last discontinuity of this counter is indicated
         by fcipLinkCreateTime."
     ::= { fcipLinkErrorsEntry 1 }

  fcipLinkFcipEncapErrors OBJECT-TYPE
     SYNTAX      Counter32
     MAX-ACCESS read-only
     STATUS      current
     DESCRIPTION
         "The number of FCIP frames received with encapsulation errors
          such as improper header, format, or length.  The last
          discontinuity of this counter is indicated by
          fcipLinkCreateTime."
     ::= { fcipLinkErrorsEntry 2 }

  fcipLinkFcipNotReceivedSfResps OBJECT-TYPE
     SYNTAX      Counter32
     MAX-ACCESS read-only
     STATUS      current
     DESCRIPTION
         "The number of times an FCIP Special Frame Response was
          expected but not received on this FCIP Link.  The last
          discontinuity of this counter is indicated by
          fcipLinkCreateTime."
     ::= { fcipLinkErrorsEntry 3 }

  fcipLinkFcipSfRespMismatches OBJECT-TYPE
     SYNTAX      Counter32
     MAX-ACCESS read-only
     STATUS      current
     DESCRIPTION
         "The number of times FCIP Special Frame Bytes mismatch
          happened on this FCIP Link.  The last discontinuity of this
          counter is indicated by fcipLinkCreateTime."
     ::= { fcipLinkErrorsEntry 4 }

  fcipLinkFcipSfInvalidNonces OBJECT-TYPE
     SYNTAX      Counter32
     MAX-ACCESS read-only
     STATUS      current
     DESCRIPTION
         "The number of times FCIP Special Frame Invalid Connection
          Nonce happened on this FCIP Link.  The last discontinuity
          of this counter is indicated by fcipLinkCreateTime."
     ::= { fcipLinkErrorsEntry 5 }

  fcipLinkFcipReceivedSfDuplicates OBJECT-TYPE
     SYNTAX      Counter32
```

```
    MAX-ACCESS read-only
    STATUS      current
    DESCRIPTION
        "The number of times duplicate FCIP Special Frames were
         received on this FCIP Link.  The last discontinuity of this
         counter is indicated by fcipLinkCreateTime."
    ::= { fcipLinkErrorsEntry 6 }

fcipLinkFcipSfInvalidWWNs OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS read-only
    STATUS      current
    DESCRIPTION
        "The number of times FCIP Special Frames with invalid
         destination FC Fabric Entity WWN were received on this FCIP
         Link.  The last discontinuity of this counter is indicated
         by fcipLinkCreateTime."
    ::= { fcipLinkErrorsEntry 7 }

fcipLinkFcipBB2LkaTimeOuts OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS read-only
    STATUS      current
    DESCRIPTION
        "The number of FC Keep Alive Time-outs that occurred on
         this FCIP Link.  The last discontinuity of this counter
         is indicated by fcipLinkCreateTime."
    ::= { fcipLinkErrorsEntry 8 }

fcipLinkFcipSntpExpiredTimeStamps OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS read-only
    STATUS      current
    DESCRIPTION
        "The number of frames discarded due to an expired Simple
         Network Time Protocol (SNTP) timestamp on this FCIP Link.
         The last discontinuity of this counter is indicated by
         fcipLinkCreateTime."
    ::= { fcipLinkErrorsEntry 9 }

fcipLinkTcpTooManyErrors OBJECT-TYPE
    SYNTAX      Counter32
    MAX-ACCESS read-only
    STATUS      current
    DESCRIPTION
        "The number of TCP connections that closed down on this
         FCIP Link due to too many errors on the connection.  The
         last discontinuity of this counter is indicated by
```

```
             fcipLinkCreateTime."
        ::= { fcipLinkErrorsEntry 10  }

    fcipLinkTcpExcessiveDroppedDatagrams OBJECT-TYPE
        SYNTAX     Counter32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "The number of TCP connections that closed down on this
             FCIP Link due to an excessive number of dropped FCIP
             packets.  The last discontinuity of this counter is
             indicated by fcipLinkCreateTime."
        ::= { fcipLinkErrorsEntry 11  }

    fcipLinkTcpSaParamMismatches OBJECT-TYPE
        SYNTAX     Counter32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "The number of times TCP connections with Security
             Association parameter mismatches were closed down on this
             FCIP Link.  The last discontinuity of this counter is
             indicated by fcipLinkCreateTime."
        REFERENCE
            "RFC 3821, Section 9.4.2, TCP Connection Security
             Associations (SAs)"
        ::= { fcipLinkErrorsEntry 12  }


    -- ****************************************************************
    -- Conformance Statements
    --

    fcipCompliances   OBJECT IDENTIFIER ::= { fcipConformance 1 }
    fcipGroups        OBJECT IDENTIFIER ::= { fcipConformance 2 }

    fcipCompliance MODULE-COMPLIANCE
        STATUS current
        DESCRIPTION
            "Compliance statement for FCIP MIB."
        MODULE        -- this module
            MANDATORY-GROUPS {
                fcipEntityScalarGroup,
                fcipEntityInstanceGroup,
                fcipLinkGroup,
                fcipTcpConnGroup,
                fcipDiscoveryDomainGroup,
                fcipLinkErrorsGroup
```

```
        }

        GROUP    fcipDynamicRouteGroup
        DESCRIPTION
            "This group is mandatory only for systems that do not
             have these objects in any other FC MIB.  It may be
             implemented even in that case for convenience."

        GROUP    fcipStaticRouteGroup
        DESCRIPTION
            "This group is mandatory only for systems that do not
             have these objects in any other FC MIB.  It may be
             implemented even in that case for convenience."

        OBJECT    fcipEntityAddressType
        SYNTAX    INTEGER { ipv4(1), ipv6(2) }
        DESCRIPTION
            "Only IPv4 and IPv6 address types need to be supported for
             addressing FCIP entities."

        OBJECT    fcipEntityAddress
        SYNTAX    InetAddress (SIZE(4|16))
        DESCRIPTION
            "Size of FCIP entity's IP address depends on address type.
             FCIP entity address size is four if the IP address is
             IPv4 and sixteen if the IP address type is IPv6."

        OBJECT    fcipLinkLocalFcipEntityAddressType
        SYNTAX    INTEGER { ipv4(1), ipv6(2) }
        DESCRIPTION
            "Only IPv4 and IPv6 address types need to be supported for
             addressing the local FCIP entities."

        OBJECT    fcipLinkLocalFcipEntityAddress
        SYNTAX    InetAddress (SIZE(4|16))
        DESCRIPTION
            "Size of FCIP entity's IP address depends on address type.
             FCIP entity address size is four if the IP address is
             IPv4 and sixteen if the IP address type is IPv6."

        OBJECT    fcipLinkRemFcipEntityAddressType
        SYNTAX    INTEGER { ipv4(1), ipv6(2) }
        DESCRIPTION
            "Only IPv4 and IPv6 address types need to be supported for
             addressing the remote FCIP entities."

        OBJECT    fcipLinkRemFcipEntityAddress
        SYNTAX    InetAddress (SIZE(4|16))
```

```
        DESCRIPTION
            "Size of FCIP entity's IP address depends on the address
             type.  FCIP entity address size is four if the IP address
             is IPv4 and sixteen if the IP address type is IPv6."

    ::= { fcipCompliances 1 }

fcipEntityScalarGroup OBJECT-GROUP
    OBJECTS {   fcipDynIpConfType,
                fcipDeviceWWN,
                fcipEntitySACKOption
    }
    STATUS current
    DESCRIPTION
        "Collection of scalar objects applicable to all FCIP
         instances."
::= { fcipGroups 1 }

fcipEntityInstanceGroup OBJECT-GROUP
    OBJECTS {
                fcipEntityName,
                fcipEntityAddressType,
                fcipEntityAddress,
                fcipEntityTcpConnPort,
                fcipEntitySeqNumWrap,
                fcipEntityPHBSupport,
                fcipEntityStatus
    }
    STATUS current
    DESCRIPTION
        "A collection of objects providing information about FCIP
         instances."
::= { fcipGroups 2 }

fcipLinkGroup OBJECT-GROUP
    OBJECTS {
                fcipLinkIfIndex,
                fcipLinkCost,
                fcipLinkLocalFcipEntityMode,
                fcipLinkLocalFcipEntityAddressType,
                fcipLinkLocalFcipEntityAddress,
                fcipLinkRemFcipEntityWWN,
                fcipLinkRemFcipEntityId,
                fcipLinkRemFcipEntityAddressType,
                fcipLinkRemFcipEntityAddress,
                fcipLinkStatus,
                fcipLinkCreateTime
    }
```

```
      STATUS current
      DESCRIPTION
          "A collection of objects providing information about FCIP
          Links."
   ::= { fcipGroups 3 }

   fcipTcpConnGroup OBJECT-GROUP
      OBJECTS {
                  fcipTcpConnRWSize,
                  fcipTcpConnMSS
      }
      STATUS current
      DESCRIPTION
          "A collection of objects providing information about FCIP
          TCP connections."
   ::= { fcipGroups 4 }

   fcipDiscoveryDomainGroup OBJECT-GROUP
      OBJECTS {
                  fcipDiscoveryDomainName
      }
      STATUS current
      DESCRIPTION
          "A collection of objects providing information about FCIP
          Discovery Domains."
   ::= { fcipGroups 5 }

   fcipLinkErrorsGroup OBJECT-GROUP
      OBJECTS {
          fcipLinkFcipLossofFcSynchs,
          fcipLinkFcipEncapErrors,
          fcipLinkFcipNotReceivedSfResps,
          fcipLinkFcipSfRespMismatches,
          fcipLinkFcipSfInvalidNonces,
          fcipLinkFcipReceivedSfDuplicates,
          fcipLinkFcipSfInvalidWWNs,
          fcipLinkFcipBB2LkaTimeOuts,
          fcipLinkFcipSntpExpiredTimeStamps,
          fcipLinkTcpTooManyErrors,
          fcipLinkTcpExcessiveDroppedDatagrams,
          fcipLinkTcpSaParamMismatches
      }
      STATUS current
      DESCRIPTION
          "A collection of objects providing information about FCIP
          link errors."
   ::= { fcipGroups 6 }
```

```
fcipDynamicRouteGroup OBJECT-GROUP
    OBJECTS {
                fcipDynamicRouteLinkIndex
    }
    STATUS current
    DESCRIPTION
        "A collection of objects providing information about FCIP
         dynamic routes."
::= { fcipGroups 7 }

fcipStaticRouteGroup OBJECT-GROUP
    OBJECTS {
                fcipStaticRouteLinkIndex,
                fcipStaticRouteStatus
    }
    STATUS current
    DESCRIPTION
        "A collection of objects providing information about FCIP
         static routes."
::= { fcipGroups 8 }

END
```

5. Security Considerations

   There are a number of management objects defined in this MIB that
   have a MAX-ACCESS clause of read-write and/or read-create. Such
   objects may be considered sensitive or vulnerable in some network
   environments. The support for SET operations in a non-secure
   environment without proper protection can have a negative effect on
   network operations. In particular, write access to
   fcipDiscoveryDomainName and fcipEntityAddress can cause a loss of
   reachability to portions of the Fibre Channel fabric, while write
   access to fcipStaticRouteStatus can create incorrect routes to remote
   devices.

   There are a number of managed objects in this MIB that contain what
   could be considered as sensitive information. In particular, the
   objects which provide information on identification and network
   topology:

   fcipDeviceWWN, fcipEntityName, fcipEntityAddress,
   fcipLinkLocalFcipEntityAddress, fcipLinkRemFcipEntityWWN,
   and fcipLinkRemFcipEntityAddress
   -- information on identification;

   fcipDiscoveryDomainName
   -- information on discovery domains;

   fcipDynamicRouteLinkIndex
   -- information on dynamic routes;

   fcipStaticRouteLinkIndex and fcipStaticRouteStatus
   -- information on static routes

   SNMP versions prior to SNMPv3 did not include adequate security.
   Even if the network itself is secure (for example by using IPSec),
   even then, there is no control as to who on the secure network is
   allowed to access and GET/SET (read/change/create/delete) the objects
   in this MIB module.

   It is RECOMMENDED that implementers consider the security features as
   provided by the SNMPv3 framework (see [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.

6. IANA Considerations

The IANA has assigned a MIB OID assignment under the transmission
branch. Specifically, { transmission 224 } for fcipMIB since this
MIB contains the media-specific definitions that correspond to the
ifType value of fcipLink(224).

7. Acknowledgements

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