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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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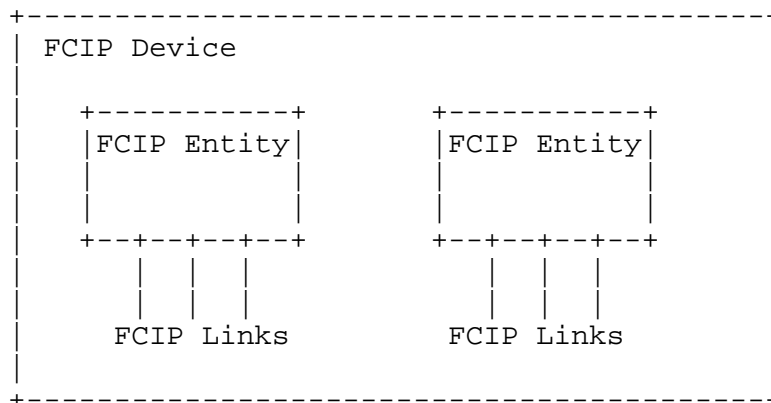
1. The Internet-Standard Management Framework

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.



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 ifHCOctets	The number of octets of FCIP information contained in transmitted frames in TCP streams, starting with FCIP header.
ifOutUcastPkts ifHCOctets	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.

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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,
        fcipLinkLocalFcipEntityType   InetAddressType,
        fcipLinkLocalFcipEntityAddress InetAddress,
        fcipLinkRemFcipEntityWWN      FcNameIdOrZero,
        fcipLinkRemFcipEntityId       FcipEntityId,
        fcipLinkRemFcipEntityType     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 }

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

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

fcipLinkLocalFcipEntityTypeAddress  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
        fcipLinkLocalFcipEntityTypeAddressType object."
    ::= { fcipLinkEntry 6 }

fcipLinkRemFcipEntityTypeWWN  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 }

```

```

fcipLinkRemFcipEntityType  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
         fcipLinkRemFcipEntityType 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 fcipLinkLocalFcipEntityType,
        fcipLinkLocalFcipEntityAddress, fcipLinkRemFcipEntityWWN,
        fcipLinkRemFcipEntityId, fcipLinkRemFcipEntityType,

```

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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9. Informative References

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