Network Working Group
Request for Comments: 4404
Category: Standards Track

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February 2006

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

Status of This Memo

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Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in 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.

Table of Contents

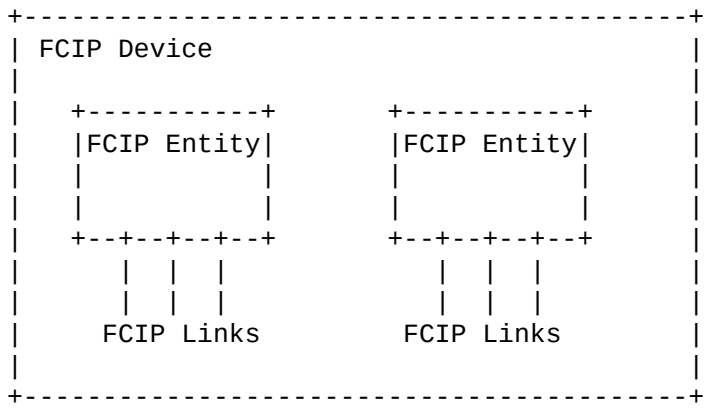
1. The Internet-Standard Management Framework

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:

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

- Each FCIP device has one or more FCIP Entities or Instances.
- Peer FCIP Entities are connected by FCIP Links attached to VE_ports/B_Access.
- Each FCIP Link Endpoint contains one or more Data Engines.
- 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

The authors acknowledge significant feedback and guidance from NM Area advisor Keith McCloghrie, Cisco. Comments and input from members of the FCIP Working Group have also been incorporated.

8. Normative References

[RFC3821] Rajagopal, M., Rodriguez, E., and R. Weber, "Fibre Channel Over TCP/IP (FCIP)", RFC 3821, July 2004.

[FCBB2] Fibre Channel Backbone -2 v6 (FC-BB-2), T11/03-078v0, February 2003.

[FC-SW-3] Fibre Channel Switch Fabric -3 (FC-SW-3), T11/03-018v4, December 2003.

[RFC4044] McCloghrie, K., "Fibre Channel Management MIB", RFC 4044, May 2005.

[RFC2863] McCloghrie, K. and F. Kastenholz, "The Interfaces Group MIB", RFC 2863, June 2000.

[RFC2578] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, April 1999.

[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.

[RFC2579] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Textual Conventions for SMIv2", STD 58, RFC 2579, April 1999.

[RFC2580] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Conformance Statements for SMIv2", STD 58, RFC 2580, April 1999.

[RFC2474] Nichols, K., Blake, S., Baker, F., and D. Black, "Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers", RFC 2474, December 1998.

[RFC4022] Raghunarayan, R., "Management Information Base for the Transmission Control Protocol (TCP)", RFC 4022, March 2005.

[RFC3822] Peterson, D., "Finding Fibre Channel over TCP/IP (FCIP) Entities Using Service Location Protocol version 2 (SLPv2)", RFC 3822, July 2004.

[RFC2883] Floyd, S., Mahdavi, J., Mathis, M., and M. Podolsky, "An Extension to the Selective Acknowledgement (SACK) Option for TCP", RFC 2883, July 2000.

[RFC1323] Jacobson, V., Braden, R., and D. Borman, "TCP Extensions for High Performance", RFC 1323, May 1992.

[RFC4001] Daniele, M., Haberman, B., Routhier, S., and J. Schoenwaelder, "Textual Conventions for Internet Network Addresses", RFC 4001, February 2005.

9. Informative References

[RFC3410] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction and Applicability Statements for Internet-Standard Management Framework", RFC 3410, December 2002.

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Acknowledgement

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