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## Forwarding and Control Element Separation (ForCES) MIB

### Abstract

This memo defines a Management Information Base (MIB) module for use with network management protocols in the Internet community. In particular, it defines managed objects for the Forwarding and Control Element Separation (ForCES) Network Element (NE).

### Status of This Memo

This is an Internet Standards Track document.

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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 [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, [RFC2578], STD 58, [RFC2579] and STD 58, [RFC2580].

## 2. Introduction

The ForCES MIB module is a read-only MIB module that captures information related to the ForCES protocol ([RFC3654], [RFC3746], [FORCES-APP], and [RFC5810]).

The ForCES MIB module does not include information that is specified in other MIB modules, such as packet counters for interfaces, etc.

More specifically, the information in the ForCES MIB module relative to associations (between Control Elements and Forwarding Elements) that are in the UP state includes:

- o identifiers of the elements in the association,
- o configuration parameters of the association, and
- o statistics of the association.

### 3. Requirements Notation

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

### 4. ForCES MIB Overview

The MIB module contains the latest ForCES protocol version supported by the Control Element (CE) (`forcesLatestProtocolVersionSupported`). Note that the CE must also allow interaction with Forwarding Elements (FEs) supporting earlier versions.

For each association identified by the pair CE ID and FE ID, the following associated information is provided by the MIB module as an entry (`forcesAssociationEntry`) in the association table (`forcesAssociationTable`):

- o Version number of the ForCES protocol running in this association (`forcesAssociationRunningProtocolVersion`).
- o Time when the association entered the UP state (`forcesAssociationTimeUp`).
- o Time when the association left the UP state (`forcesAssociationTimeDown`). Note that this is only used for notification purposes as the association is removed from the MIB immediately after it leaves the UP state.
- o Number of ForCES Heartbeat messages sent from the CE (`forcesAssociationHBMsgSent`) and received by the CE (`forcesAssociationHBMsgReceived`) since the association entered the UP state.
- o Number of operational ForCES messages sent from the CE (`forcesAssociationOperMsgSent`) and received by the CE (`forcesAssociationOperMsgReceived`) since the association entered the UP state. Only messages other than Heartbeat, Association Setup, Association Setup Response, and Association Teardown are counted.

Finally, the MIB module defines the following notifications:

- o Whenever an association enters the UP state, a notification (`forcesAssociationEntryUp`) is issued containing the version of the ForCES protocol running. CE ID and FE ID are concatenated to form the table index, hence they appear in the OID of the ForCES-protocol running-version object. Optionally, a notification

(forcesAssociationEntryUpStats) can instead be issued with all associated information for this association, except forcesAssociationTimeDown.

- o Whenever an association leaves the UP state, a notification (forcesAssociationEntryDown) is issued containing the version of the ForCES protocol running. Optionally, a notification (forcesAssociationEntryDownStats) can instead be issued with all associated information for this association. The reason is that the association and all its associated information will be removed from the MIB immediately after this notification has been issued.

## 5. ForCES MIB Definition

```
FORCES-MIB DEFINITIONS ::= BEGIN
```

```
IMPORTS
```

```
    MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,  
        mib-2, Integer32  
    FROM SNMPv2-SMI
```

```
    TEXTUAL-CONVENTION, TimeStamp  
    FROM SNMPv2-TC
```

```
    MODULE-COMPLIANCE, OBJECT-GROUP,  
    NOTIFICATION-GROUP  
    FROM SNMPv2-CONF
```

```
    ZeroBasedCounter32  
    FROM RMON2-MIB;
```

```
forcesMib MODULE-IDENTITY
```

```
    LAST-UPDATED "201003100000Z" -- March 10, 2010  
    ORGANIZATION "IETF Forwarding and Control Element  
        Separation (ForCES) Working Group"
```

```
    CONTACT-INFO
```

```
        "WG Charter:  
        http://www.ietf.org/html.charters/forces-charter.html
```

```
        Mailing lists:
```

```
            General Discussion: forces@ietf.org
```

```
            To Subscribe:
```

```
            https://www.ietf.org/mailman/listinfo/forces
```

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        Chairs: Patrick Droz
```

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            Email: dro@zurich.ibm.com
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            Jamal Hadi Salim
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            Email: hadi@mojatatu.com
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Editor: Robert Haas  
IBM  
Email: rha@zurich.ibm.com"

## DESCRIPTION

"This MIB module contains managed object definitions  
for the ForCES Protocol.

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This version of this MIB module is part of RFC 5813;  
see the RFC itself for full legal notices."

REVISION "201003100000Z" -- March 10, 2010

## DESCRIPTION

"Initial version, published as RFC 5813."  
::= { mib-2 187 }

--\*\*\*\*\*

forcesMibNotifications OBJECT IDENTIFIER ::= { forcesMib 0 }  
forcesMibObjects OBJECT IDENTIFIER ::= { forcesMib 1 }  
forcesMibConformance OBJECT IDENTIFIER ::= { forcesMib 2 }

ForcesID ::= TEXTUAL-CONVENTION

STATUS current

## DESCRIPTION

"The ForCES identifier is a 4-octet quantity."

SYNTAX OCTET STRING (SIZE (4))

ForcesProtocolVersion ::= TEXTUAL-CONVENTION

DISPLAY-HINT "d"

STATUS current

## DESCRIPTION

"ForCES protocol version number.

The version numbers used are defined in the  
specifications of the respective protocol:

1 - ForCESv1, RFC 5810."

SYNTAX Integer32 (1..255)

-- Notifications

```
forcesAssociationEntryUp NOTIFICATION-TYPE
  OBJECTS      {
    forcesAssociationRunningProtocolVersion
  }
  STATUS      current
  DESCRIPTION
    "This notification is generated as soon
     as an association enters the UP state.
     Note that these notifications are not
     throttled as the CE itself should
     throttle the setup of associations."
 ::= { forcesMibNotifications 1 }

forcesAssociationEntryDown NOTIFICATION-TYPE
  OBJECTS      {
    forcesAssociationRunningProtocolVersion
  }
  STATUS      current
  DESCRIPTION
    "This notification is generated as soon
     as an association leaves the UP state.
     Note that these notifications are not
     throttled as the CE itself should
     throttle the setup of associations."
 ::= { forcesMibNotifications 2 }

forcesAssociationEntryUpStats NOTIFICATION-TYPE
  OBJECTS      {
    forcesAssociationRunningProtocolVersion,
    forcesAssociationTimeUp
  }
  STATUS      current
  DESCRIPTION
    "This notification is generated as soon
     as an association enters the UP state.
     Note that these notifications are not
     throttled as the CE itself should
     throttle the setup of associations."
 ::= { forcesMibNotifications 3 }
```

forcesAssociationEntryDownStats NOTIFICATION-TYPE

```
OBJECTS      {
    forcesAssociationRunningProtocolVersion,
    forcesAssociationTimeUp,
    forcesAssociationTimeDown,
    forcesAssociationHBMsgSent,
    forcesAssociationHBMsgReceived,
    forcesAssociationOperMsgSent,
    forcesAssociationOperMsgReceived,
    forcesAssociationCounterDiscontinuityTime
}
```

STATUS current

DESCRIPTION

"This notification is generated as soon as an association leaves the UP state. Note that these notifications are not throttled as the CE itself should throttle the setup of associations."

::= { forcesMibNotifications 4 }

-- Objects

forcesLatestProtocolVersionSupported OBJECT-TYPE

SYNTAX ForcesProtocolVersion

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The ForCES protocol version supported by the CE. The current protocol version is 1. Note that the CE must also allow interaction with FEs supporting earlier versions."

::= { forcesMibObjects 1 }

forcesAssociations OBJECT IDENTIFIER ::= { forcesMibObjects 2 }

forcesAssociationTable OBJECT-TYPE

SYNTAX SEQUENCE OF ForcesAssociationEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The (conceptual) table of associations."

::= { forcesAssociations 1 }

```
forcesAssociationEntry OBJECT-TYPE
    SYNTAX ForcesAssociationEntry
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "A (conceptual) entry for one association."
    INDEX { forcesAssociationCEID, forcesAssociationFEID }
    ::= { forcesAssociationTable 1 }

ForcesAssociationEntry ::= SEQUENCE {
    forcesAssociationCEID          ForcesID,
    forcesAssociationFEID          ForcesID,

    forcesAssociationRunningProtocolVersion
                                ForcesProtocolVersion,

    forcesAssociationTimeUp        TimeStamp,
    forcesAssociationTimeDown      TimeStamp,

    forcesAssociationHBMsgSent     ZeroBasedCounter32,
    forcesAssociationHBMsgReceived ZeroBasedCounter32,
    forcesAssociationOperMsgSent   ZeroBasedCounter32,
    forcesAssociationOperMsgReceived ZeroBasedCounter32,
    forcesAssociationCounterDiscontinuityTime TimeStamp
}

forcesAssociationCEID OBJECT-TYPE
    SYNTAX ForcesID
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "The ForCES ID of the CE."
    ::= { forcesAssociationEntry 1 }

forcesAssociationFEID OBJECT-TYPE
    SYNTAX ForcesID
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "The ForCES ID of the FE."
    ::= { forcesAssociationEntry 2 }
```



```
forcesAssociationRunningProtocolVersion OBJECT-TYPE
    SYNTAX      ForcesProtocolVersion
    MAX-ACCESS   read-only
    STATUS       current
    DESCRIPTION
        "The current ForCES protocol version used in
        this association.
        The current protocol version is 1."
    ::= { forcesAssociationEntry 3 }

forcesAssociationTimeUp OBJECT-TYPE
    SYNTAX TimeStamp
    MAX-ACCESS   read-only
    STATUS       current
    DESCRIPTION
        "The value of sysUpTime at the time this
        association entered the UP state.
        If this association started prior to the last
        initialization of the network subsystem, then
        this object contains a zero value.
        This object allows to uniquely identify
        associations with the same CE and FE IDs."
    ::= { forcesAssociationEntry 4 }

forcesAssociationTimeDown OBJECT-TYPE
    SYNTAX TimeStamp
    MAX-ACCESS   accessible-for-notify
    STATUS       current
    DESCRIPTION
        "The value of sysUpTime at the time this
        association left the UP state."
    ::= { forcesAssociationEntry 5 }

forcesAssociationHBMsgSent OBJECT-TYPE
    SYNTAX ZeroBasedCounter32
    MAX-ACCESS   read-only
    STATUS       current
    DESCRIPTION
        "A counter of how many Heartbeat messages have
        been sent by the CE on this association
        since the association entered the UP state.
        Discontinuities in the value of this counter
        can occur at reinitialization of the management
        system, and at other times as indicated by the
        value of forcesAssociationCounterDiscontinuityTime."
    ::= { forcesAssociationEntry 6 }
```

```
forcesAssociationHBMsgReceived OBJECT-TYPE
    SYNTAX ZeroBasedCounter32
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "A counter of how many Heartbeat messages
        have been received by the CE on this association
        since the association entered the UP state.
        Discontinuities in the value of this counter
        can occur at reinitialization of the management
        system, and at other times as indicated by the
        value of forcesAssociationCounterDiscontinuityTime."
    ::= { forcesAssociationEntry 7 }

forcesAssociationOperMsgSent OBJECT-TYPE
    SYNTAX ZeroBasedCounter32
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "A counter of how many messages other than
        Heartbeat (i.e., Config and Query)
        have been sent by the CE on this association
        since the association entered the UP state.
        Discontinuities in the value of this counter
        can occur at reinitialization of the management
        system, and at other times as indicated by the
        value of forcesAssociationCounterDiscontinuityTime."
    ::= { forcesAssociationEntry 8 }

forcesAssociationOperMsgReceived OBJECT-TYPE
    SYNTAX ZeroBasedCounter32
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "A counter of how many messages other than
        Heartbeat (i.e., Config response, Query response,
        event notification, and packet redirect)
        have been received by the CE on this association
        since the association entered the UP state.
        Discontinuities in the value of this counter
        can occur at reinitialization of the management
        system, and at other times as indicated by the
        value of forcesAssociationCounterDiscontinuityTime."
    ::= { forcesAssociationEntry 9 }
```

```
forcesAssociationCounterDiscontinuityTime OBJECT-TYPE
    SYNTAX TimeStamp
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "The value of sysUpTime on the most recent occasion
        at which any one or more of this association's
        counters suffered a discontinuity. The relevant
        counters are the specific instances associated with
        this association of any ZeroBasedCounter32 object
        contained in the forcesAssociationTable. If no
        such discontinuities have occurred since the last
        reinitialization of the local management subsystem,
        then this object contains a zero value."
    ::= { forcesAssociationEntry 10 }

-- Conformance

forcesMibCompliances OBJECT IDENTIFIER
    ::= { forcesMibConformance 1 }
forcesMibGroups OBJECT IDENTIFIER
    ::= { forcesMibConformance 2 }

-- Compliance statements

forcesMibCompliance MODULE-COMPLIANCE
    STATUS current
    DESCRIPTION
        "The compliance statement for routers running
        ForCES and implementing the ForCES MIB."
    MODULE -- this module
        MANDATORY-GROUPS { forcesMibGroup, forcesNotificationGroup }

        GROUP forcesNotificationStatsGroup
        DESCRIPTION
            "Implementation of this group is recommended."

        GROUP forcesStatsGroup
        DESCRIPTION
            "Implementation of this group is recommended."

    ::= { forcesMibCompliances 1 }
```

-- Units of conformance

```
forcesNotificationGroup NOTIFICATION-GROUP
    NOTIFICATIONS { forcesAssociationEntryUp,
                    forcesAssociationEntryDown
                  }
    STATUS current
    DESCRIPTION
        "A collection of notifications for signaling
         important ForCES events."
    ::= { forcesMibGroups 1 }

forcesMibGroup OBJECT-GROUP
    OBJECTS { forcesLatestProtocolVersionSupported,
              forcesAssociationRunningProtocolVersion
            }
    STATUS current
    DESCRIPTION
        "A collection of objects to support management
         of ForCES routers."
    ::= { forcesMibGroups 2 }

forcesNotificationStatsGroup NOTIFICATION-GROUP
    NOTIFICATIONS { forcesAssociationEntryUpStats,
                    forcesAssociationEntryDownStats
                  }
    STATUS current
    DESCRIPTION
        "A collection of optional notifications for
         signaling important ForCES events including
         statistics."
    ::= { forcesMibGroups 3 }
```

```
forcesStatsGroup OBJECT-GROUP
    OBJECTS { forcesAssociationTimeUp,
               forcesAssociationTimeDown,
               forcesAssociationHBMsgSent,
               forcesAssociationHBMsgReceived,
               forcesAssociationOperMsgSent,
               forcesAssociationOperMsgReceived,
               forcesAssociationCounterDiscontinuityTime
             }
    STATUS current
    DESCRIPTION
        "A collection of optional objects to provide
        extra information about the associations.
        There is no protocol reason to keep such
        information, but these objects can be very
        useful in debugging connectivity problems."
    ::= { forcesMibGroups 4}
```

END

## 6. Associations Kept in the MIB

Associations enter the UP state as soon as the CE has sent to the FE an Association Setup Response message containing a successful Association Setup Result. Only associations that are UP are reflected in this MIB module.

Associations are removed from the MIB module as soon as they leave the UP state, i.e., if the CE has not received any message (Heartbeat or other protocol message) from the FE within a given time period or if an Association Teardown message has been sent by the CE.

Statistics counters are initialized to zero when the association is created. If the same association goes down and comes back up, the counters will reset and the discontinuity can be discovered by checking the discontinuity timestamp. In addition, the time-up timestamp in the association allows to distinguish new associations from past ones with the same index. Note that the optional down notification contains the statistics with the final values of the statistics counters.

## 7. Support for Multiple CEs and FEs

An NE consists of one or more FEs and one or more CEs. Where there is a single CE, that CE will have knowledge of all the associations in the NE and so can provide the information necessary to support the managed objects defined in this MIB module. Where there is more than one CE, information about the associations may be distributed among the CEs. Whether each CE implements the managed objects for the associations of which it is aware or whether the CEs cooperate to present the appearance of a single set of managed objects for all the associations in the NE is outside the scope of this document.

## 8. Security Considerations

There are no management objects defined in this MIB module that have a MAX-ACCESS clause of read-write and/or read-create. So, if this MIB module is implemented correctly, then there is no risk that an intruder can alter or create any management objects of this MIB module via direct SNMP SET operations.

Some of the readable objects in this MIB module (i.e., objects with a MAX-ACCESS other than not-accessible) may be considered sensitive or vulnerable in some network environments. It is thus important to control even GET and/or NOTIFY access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP. These are the tables and objects and their sensitivity/vulnerability:

- o Objects in the forcesMibGroup are protocol versions. They are neither sensitive nor vulnerable.
- o Objects in the forcesStatsGroup are statistics. They are neither sensitive nor vulnerable.

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.

## 9. IANA Considerations

The MIB module in this document uses the following IANA-assigned OBJECT IDENTIFIER values recorded in the SMI Numbers registry:

Descriptor	OBJECT IDENTIFIER value
-----	-----
forcesMIB	{ mib-2 187 }

## 10. References

### 10.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.
- [RFC2578] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, April 1999.
- [RFC2579] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "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.
- [RFC5810] Doria, A., Ed., Hadi Salim, J., Ed., Haas, R., Ed., Khosravi, H., Ed., Wang, W., Ed., Dong, L., Gopal, R., and J. Halpern, "Forwarding and Control Element Separation (ForCES) Protocol Specification", RFC 5810, March 2010.

## 10.2. Informative References

### [FORCES-APP]

Crouch, A., Khosravi, H., Doria, A., Wang, X., and K. Ogawa, "ForCES Applicability Statement", Work in Progress, February 2010.

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

[RFC3654] Khosravi, H. and T. Anderson, "Requirements for Separation of IP Control and Forwarding", RFC 3654, November 2003.

[RFC3746] Yang, L., Dantu, R., Anderson, T., and R. Gopal, "Forwarding and Control Element Separation (ForCES) Framework", RFC 3746, April 2004.



## Appendix A. Acknowledgments

The author gratefully acknowledges the contributions of Spencer Dawkins, Jinrong Fenggen, John Flick, Xiaoyi Guo, Joel Halpern, Tom Petch, Jamal Hadi Salim, and Bert Wijnen.

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