

Network Working Group
Request for Comments: 2238
Category: Standards Track

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November 1997

Definitions of Managed Objects for HPR using SMIPv2

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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Table of Contents

1.	Status of this Memo	1
2.	Introduction	1
3.	The SNMP Network Management Framework	2
4.	Overview	2
4.1	HPR MIB structure	3
5.	Definitions	5
6.	Acknowledgments	33
7.	References	33
8.	Security Considerations	33
9.	Authors' Addresses	34
10.	Full Copyright Statement	35

2. Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it defines objects for monitoring and controlling network devices with HPR (High Performance Routing) capabilities. This memo identifies managed objects for the HPR protocol.

3. The SNMP Network Management Framework

The SNMP Network Management Framework consists of several components. For the purpose of this specification, the applicable components of the Framework are the SMI and related documents [1, 2, 3], which define the mechanisms used for describing and naming objects for the purpose of management.

The Framework permits new objects to be defined for the purpose of experimentation and evaluation.

4. Overview

This document identifies objects for monitoring the configuration and active characteristics of devices with HPR capabilities. HPR is an enhancement to the Advanced Peer-to-Peer Network (APPN) architecture that provides fast data routing and improved session reliability. APPN is one of the protocols that can use the HPR transport mechanism. See the SNANAU APPN MIB [4] for management of APPN and APPN use of the HPR transport.

The HPR terms and overall architecture [5] are available at <http://www.networking.ibm.com/app/aiwdoc/aiwsrsrc.htm>.

Automatic Network Routing (ANR) is a fast low-level routing technique. Each node assigns a unique (within that node) ANR label for each out-bound link as it is activated. The label size is defined by the ANR node, and nodes only need to know how to interpret their own labels. The ANR string is a group of ANR labels encoded in a header in front of the message being sent. At each hop the node strips off its own ANR label and forwards the message onto the link with that label. The last label in the string is the Network Connection Endpoint (NCE), which identifies the component within the destination node that is to receive the message.

Rapid Transport Protocol (RTP) is an end-to-end full duplex transport connection (pipe). It provides for high-speed transport of data using ANR. RTP is connection-oriented, and delivers data in correct order reliably. Error recovery is done efficiently with selective retransmission of data. An RTP path can be switched without disrupting the sessions using it. An RTP path switch may be done automatically if a link in the path fails and another RTP path is available, or on demand to attempt to restore the optimal path.

RTP performs flow/congestion control with the Adaptive Rate-Based (ARB) algorithm, described in [5]. ARB is done only at the endpoints of the RTP pipe, so intermediate hops are not involved.

ARB regulates the flow of data over an RTP connection by adaptively changing the sender's rate based on feedback on the receiver's rate. It is designed to prevent congestion rather than react to it.

In this document, we describe HPR managed objects.

Highlights of the management functions supported by the HPR MIB module include the following:

- o Identifying network connection endpoints (NCEs).
- o Identifying how incoming packets are routed based on ANR labels.
- o Monitoring the RTP connections between nodes.
- o Ability to trigger an RTP path switch. The MIB only supports a path switch with no specified path. Some implementations may have a product-specific option to specify a new path. The `hprOperatorPathSwitchSupport` object identifies this support.
- o Historical information about RTP path switch attempts.

This MIB module does not support:

- o Configuration of HPR nodes.
- o Protocol-specific uses of HPR (such as APPN).
- o Traps. The APPN MIB contains a trap for Alert conditions that may affect HPR resources. The value for the `affectedObject` object contained in the `alertTrap` is determined by the implementation. It may contain a `VariablePointer` from the HPR MIB. The APPN/HPR Alerts are defined in [6].

4.1. HPR MIB Structure

Although HPR is an extension to APPN, the HPR MIB relies very little upon the APPN MIB. The `appnNodeCounterDisconTime` object in the APPN MIB is used to detect discontinuities in HPR MIB counters. The `hprNodeCpName` object in this MIB has the same value as the `appnNodeCpName` object in the APPN MIB.

The HPR MIB module contains the following collections of objects:

- o `hprGlobal` - general HPR objects.
- o `hprAnrRouting` - objects related to the ANR routing table.

- o hprTransportUser - objects related to users of the HPR transport.
- o hprRtp - objects related to the HPR Transport Tower.

These are described below in more detail.

4.1.1. hprGlobal group

The hprGlobal group consists of general objects such as the APPN CP (control point) name of the HPR node and the level of support for operator-requested path switches.

4.1.2. hprAnrRouting group

The hprAnrRouting group consists objects to monitor and control the counting of ANR packets received and the following table:

The hprAnrRoutingTable correlates incoming ANR labels to the outbound transmission group (TG) or local NCE to which incoming packet will be forwarded. An entry defines the label type as identifying a local NCE or a TG, identifies the NCE or TG, and counts the number of packets received with the entry's ANR label.

4.1.3. hprTransportUser group

The hprTransportUser group consists of the following table:

The hprNceTable identifies network connection endpoints and their function types. The function type can be any combination of a CP, logical unit (LU), boundary function, and route setup.

4.1.4. hprRtp group

The hprRtp group consists of the following objects and tables:

1) hprRtpGlobe

These objects contain information about the number of RTP connection setups, and control of RTP counters.

2) hprRtpTable

This table contains one entry for each RTP connection. The information includes local and remote NCE IDs and TCIDs (transport connection identifiers), timers, send rates, and statistics. A path switch can be triggered by the hprRptPathSwitchTrigger object if the agent node supports it; however, a new path cannot be specified.

3) hprRtpStatusTable

This table contains statistics and historical information for RTP path switches attempts, including old and new ANR strings and Route Selection Control Vectors (RSCVs), why the path switch was initiated, and the result (successful or reason for failure).

5. Definitions

HPR-MIB DEFINITIONS ::= BEGIN

IMPORTS

DisplayString, DateAndTime, TimeStamp, TEXTUAL-CONVENTION
FROM SNMPv2-TC

Counter32, Gauge32, Unsigned32, TimeTicks,
OBJECT-TYPE, MODULE-IDENTITY
FROM SNMPv2-SMI

MODULE-COMPLIANCE, OBJECT-GROUP
FROM SNMPv2-CONF

snanauMIB
FROM SNA-NAU-MIB

SnaControlPointName
FROM APPN-MIB;

hprMIB MODULE-IDENTITY

LAST-UPDATED "970514000000Z"
ORGANIZATION "AIW APPN / HPR MIB SIG"
CONTACT-INFO

"

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"

DESCRIPTION

"This is the MIB module for objects used to manage network devices with HPR capabilities."

::= { snanauMIB 6 }

-- snanauMIB ::= { mib-2 34 }

-- *****

-- Textual Conventions

-- *****

-- SnaControlPointName is imported from the APPN MIB

HprNceTypes ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"A bit string identifying the set of functions provided by a network connection endpoint (NCE). The following values are defined:

bit 0: control point
 bit 1: logical unit
 bit 2: boundary function
 bit 3: route setup

"

SYNTAX BITS { controlPoint(0),
 logicalUnit(1),
 boundaryFunction(2),
 routeSetup(3) }

HprRtpCounter ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"An object providing statistics for an RTP connection. A Management Station can detect discontinuities in this counter by monitoring the correspondingly indexed hprRtpCounterDisconTime object."

SYNTAX Counter32

-- *****

hprObjects OBJECT IDENTIFIER ::= { hprMIB 1 }

-- *****

-- *****

```

hprGlobal          OBJECT IDENTIFIER ::= { hprObjects 1 }
-- *****
-- The hprGlobal group applies to both intermediate and end nodes.
-- *****

hprNodeCpName OBJECT-TYPE
    SYNTAX SnaControlPointName
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "Administratively assigned network name for the APPN node
        where this HPR implementation resides. If this object has
        the same value as the appnNodeCpName object in the APPN MIB,
        then the two objects are referring to the same APPN node."

    ::= { hprGlobal 1 }

hprOperatorPathSwitchSupport OBJECT-TYPE
    SYNTAX INTEGER {
        notSupported(1),
        switchTriggerSupported(2),
        switchToPathSupported(3)
    }
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "This object indicates an implementation's level of support
        for an operator-requested path switch.

        notSupported(1)          - the agent does not support
                                operator-requested path switches
        switchTriggerSupported(2) - the agent supports a 'switch
                                path now' command from an
                                operator, but not a command to
                                switch to a specified path
        switchToPathSupported(3) - the agent supports both a
                                'switch path now' command and a
                                command to switch to a specified
                                path. Note that the latter
                                command is not available via
                                this MIB; a system that supports
                                it must do so via other means,
                                such as a local operator
                                interface."

    ::= { hprGlobal 2 }

-- *****

```

```

hprAnrRouting          OBJECT IDENTIFIER ::= { hprObjects 2 }
-- *****

hprAnrsAssigned OBJECT-TYPE
    SYNTAX Counter32
    UNITS "ANR labels"
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "The count of ANR labels assigned by this node since it was
        last re-initialized.  A Management Station can detect
        discontinuities in this counter by monitoring the
        appnNodeCounterDisconTime object in the APPN MIB."

    ::= { hprAnrRouting 1 }

hprAnrCounterState OBJECT-TYPE
    SYNTAX INTEGER {
        notActive(1),
        active(2)
    }
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
        "This object is used for a network management station to turn
        on/off the counting of ANR packets in the hprAnrRoutingTable.
        The initial value of this object is an implementation choice.

        notActive(1) - the counter hprAnrPacketsReceived
                        returns no meaningful value
        active(2)    - the counter hprAnrPacketsReceived is
                        being incremented and is returning
                        meaningful values"

    ::= { hprAnrRouting 2 }

hprAnrCounterStateTime OBJECT-TYPE
    SYNTAX DateAndTime
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "The time when the hprAnrCounterState object last changed its
        value.  The initial value returned by this object is the time
        at which the APPN node instrumented with this MIB was last
        brought up."

    ::= { hprAnrRouting 3 }

```


hprAnrRoutingTable OBJECT-TYPE

SYNTAX SEQUENCE OF HprAnrRoutingEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The ANR Routing table provides a means of correlating an incoming ANR label (i.e., one assigned by this node) with the TG over which a packet containing the label will be forwarded. When the ANR label identifies a local NCE, the hprAnrOutTgDest and hprAnrOutTgNum objects have no meaning. The table also contains an object to count the number of packets received with a given ANR label."

::= { hprAnrRouting 4 }

hprAnrRoutingEntry OBJECT-TYPE

SYNTAX HprAnrRoutingEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The ANR label is used to index this table."

INDEX { hprAnrLabel }

::= { hprAnrRoutingTable 1 }

HprAnrRoutingEntry ::= SEQUENCE {

hprAnrLabel	OCTET STRING,
hprAnrType	INTEGER,
hprAnrOutTgDest	DisplayString,
hprAnrOutTgNum	INTEGER,
hprAnrPacketsReceived	Counter32,
hprAnrCounterDisconTime	TimeStamp

}**hprAnrLabel OBJECT-TYPE**

SYNTAX OCTET STRING (SIZE (1..8))

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The first ANR label in an incoming packet."

::= { hprAnrRoutingEntry 1 }

hprAnrType OBJECT-TYPE

SYNTAX INTEGER {

nce(1),
tg(2)

```

    }
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "An object indicating whether an ANR label assigned by this
    node identifies a local NCE or a TG on which outgoing packets
    are forwarded.

```

```

    nce(1)  - the ANR label identifies a local NCE.  In this
              case the hprAnrOutTgDest and hprAnrOutTgNum
              objects have no meaning.
    tg(2)   - the ANR label identifies a TG."

```

```
 ::= { hprAnrRoutingEntry 2 }

```

hprAnrOutTgDest OBJECT-TYPE

SYNTAX DisplayString (SIZE (0 | 3..17))

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Destination node for the TG over which packets with this ANR label are forwarded. This is the fully qualified name of an APPN network node or end node, formatted according to the SnaControlPointName textual convention. If the ANR label identifies a local NCE, then this object returns a zero-length string.

This object corresponds to the appnLocalTgDest object in the APPN MIB."

```
 ::= { hprAnrRoutingEntry 3 }

```

hprAnrOutTgNum OBJECT-TYPE

SYNTAX INTEGER (0..255)

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Number of the TG over which packets with this ANR label are forwarded. If the ANR label identifies a local NCE, then this object returns the value 0, since 0 is not a valid TG number for a TG that supports HPR.

This object corresponds to the appnLocalTgNum object in the APPN MIB."

```
 ::= { hprAnrRoutingEntry 4 }

```

hprAnrPacketsReceived OBJECT-TYPE

```

SYNTAX Counter32
UNITS "ANR packets"
MAX-ACCESS read-only
STATUS current
DESCRIPTION

```

"The count of packets received with this ANR label as their first label.

A Management Station can detect discontinuities in this counter by monitoring the hprAnrCounterDisconTime object in the same row."

```
 ::= { hprAnrRoutingEntry 5 }
```

```
hprAnrCounterDisconTime OBJECT-TYPE
```

```

SYNTAX TimeStamp
MAX-ACCESS read-only
STATUS current
DESCRIPTION

```

"The value of the sysUpTime object when the hprAnrPacketsReceived counter for this ANR label last experienced a discontinuity. This will be the more recent of two times: the time at which the ANR label was associated with either an outgoing TG or a local NCE, or the time at which the ANR counters were last turned on or off."

```
 ::= { hprAnrRoutingEntry 6 }
```

```

-- *****
hprTransportUser      OBJECT IDENTIFIER ::= { hprObjects 3 }
-- *****
-- Transport Service User (TU) Table: (RTP Connection Users)
--
-- There will be several users of the HPR transport and each HPR node
-- shall maintain a table of these users.
-- *****

```

```
hprNceTable OBJECT-TYPE
```

```

SYNTAX SEQUENCE OF HprNceEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION

```

"The Network Connection Endpoint (NCE) table."

```
 ::= { hprTransportUser 1 }
```

```
hprNceEntry OBJECT-TYPE
```

```

SYNTAX HprNceEntry

```

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The NCE ID is used to index this table."

INDEX { hprNceId }

::= { hprNceTable 1 }

HprNceEntry ::= SEQUENCE {

hprNceId OCTET STRING,

hprNceType HprNceTypes,

hprNceDefault HprNceTypes,

hprNceInstanceId OCTET STRING

}

hprNceId OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (1..8))

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The Network Connection Endpoint (NCE) ID. NCEs identify Control Points (Cp), Logical Units (Lu), HPR Boundary Functions (Bf) and Route Setup (Rs) Functions. A value for this object can be retrieved from any of the following objects in the APPN MIB:

- appnLsCpCpNceId
- appnLsRouteNceId
- appnLsBfNceId
- appnIsInRtpNceId
- appnIsRtpNceId

In each case this value identifies a row in this table containing information related to that in the APPN MIB."

::= { hprNceEntry 1 }

hprNceType OBJECT-TYPE

SYNTAX HprNceTypes

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"A bit string identifying the function types provided by this Network Connection Endpoint (NCE)."

::= { hprNceEntry 2 }

hprNceDefault OBJECT-TYPE

SYNTAX HprNceTypes

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"A bit string identifying the function types for which this Network Connection Endpoint (NCE) is the default NCE. While default NCEs are not explicitly defined in the architecture, some implementations provide them; for such implementations, it is useful to make this information available to a Management Station."

::= { hprNceEntry 3 }

hprNceInstanceId OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (4))

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The NCE instance identifier (NCEII) identifying the current instance of this NCE. An NCEII is used to denote different instances (IPLs) of an NCE component. Each time an NCE is activated (IPL'd), it acquires a different, unique NCEII."

::= { hprNceEntry 4 }

-- *****

hprRtp OBJECT IDENTIFIER ::= { hprObjects 4 }

-- *****

-- *****

--

-- The RTP group is implemented by all managed nodes supporting the
 -- HPR Transport Tower. The group contains several scalars (simple
 -- objects) and a table.

-- *****

-- *****

hprRtpGlobe OBJECT IDENTIFIER ::= { hprRtp 1}

-- *****

hprRtpGlobeConnSetups OBJECT-TYPE

SYNTAX Counter32

UNITS "RTP connection setups"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The count of RTP connection setups in which this node has participated, as either sender or receiver, since it was last re-initialized. Retries of a setup attempt do not cause the

counter to be incremented.

A Management Station can detect discontinuities in this counter by monitoring the appnNodeCounterDisconTime object in the APPN MIB."

```
::= { hprRtpGlobe 1 }
```

hprRtpGlobeCtrState OBJECT-TYPE

```
SYNTAX INTEGER {
    notActive(1),
    active(2)
}
```

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"This object allows a network management station to turn the counters in the hprRtpTable on and off. The initial value of this object is an implementation choice.

notActive(1) - the counters in the hprRtpTable are returning no meaningful values

active(2) - the counters in the hprRtpTable are being incremented and are returning meaningful values"

```
::= { hprRtpGlobe 2 }
```

hprRtpGlobeCtrStateTime OBJECT-TYPE

```
SYNTAX DateAndTime
```

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The time when the value of the hprRtpGlobeCtrState object last changed. The initial value returned by this object is the time at which the APPN node instrumented with this MIB was last brought up."

```
::= { hprRtpGlobe 3 }
```

```
-- *****
-- The RTP Connection Table
-- There may be many RTP connections on a node supporting the functions
-- specified in the RTP option set. Each node implementing this option
-- set shall maintain a table of these RTP connections.
-- *****
```

hprRtpTable OBJECT-TYPE

SYNTAX SEQUENCE OF HprRtpEntry
 MAX-ACCESS not-accessible
 STATUS current
 DESCRIPTION
 "The RTP Connection table"

::= { hprRtp 2 }

hprRtpEntry OBJECT-TYPE
 SYNTAX HprRtpEntry
 MAX-ACCESS not-accessible
 STATUS current
 DESCRIPTION
 "The local NCE ID and local TCID are used to index this
 table."

INDEX
 { hprRtpLocNceId,
 hprRtpLocTcid }

::= { hprRtpTable 1 }

HprRtpEntry ::= SEQUENCE {
 hprRtpLocNceId OCTET STRING, -- local nce id
 hprRtpLocTcid OCTET STRING, -- local tcid
 hprRtpRemCpName SnaControlPointName, -- remote cp name
 hprRtpRemNceId OCTET STRING, -- remote nce id
 hprRtpRemTcid OCTET STRING, -- remote tcid
 hprRtpPathSwitchTrigger INTEGER, -- trigger (read-write)
 hprRtpRscv OCTET STRING, -- rscv
 hprRtpTopic DisplayString, -- topic (cos)
 hprRtpState INTEGER, -- state
 hprRtpUpTime TimeTicks, -- up time

 hprRtpLivenessTimer Unsigned32, -- liveness timer
 hprRtpShortReqTimer Unsigned32, -- short request timer
 hprRtpPathSwTimer Unsigned32, -- path switch timer
 hprRtpLivenessTimeouts HprRtpCounter, -- liveness timeouts
 hprRtpShortReqTimeouts HprRtpCounter, -- short req timeouts

 hprRtpMaxSendRate Gauge32, -- maximum send rate
 hprRtpMinSendRate Gauge32, -- minimum send rate
 hprRtpCurSendRate Gauge32, -- current send rate

 hprRtpSmRdTripDelay Gauge32, -- smooth rnd trip
 delay

 hprRtpSendPackets HprRtpCounter, -- packets sent

hprRtpRecvPackets	HprRtpCounter,	-- packets received
hprRtpSendBytes	HprRtpCounter,	-- bytes sent
hprRtpRecvBytes	HprRtpCounter,	-- bytes received
hprRtpRetrPackets	HprRtpCounter,	-- pkts re-xmitted
hprRtpPacketsDiscarded	HprRtpCounter,	-- pkts discarded
hprRtpDetectGaps	HprRtpCounter,	-- gaps detected
hprRtpRateReqSends	HprRtpCounter,	-- rate req send
hprRtpOkErrPathSws	HprRtpCounter,	-- ok err path sws
hprRtpBadErrPathSws	HprRtpCounter,	-- bad err path sws
hprRtpOkOpPathSws	HprRtpCounter,	-- ok op path sws
hprRtpBadOpPathSws	HprRtpCounter,	-- bad op path sws
hprRtpCounterDisconTime	TimeStamp	-- discontinuity ind

}

hprRtpLocNceId OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (1..8))

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The local Network Connection Endpoint (NCE) ID of this RTP connection. NCEs identify CPs, LUs, Boundary Functions (BFs), and Route Setup (RS) components. A value for this object can be retrieved from any of the following objects in the APPN MIB:

- appnLsCpCpNceId
- appnLsRouteNceId
- appnLsBfNceId
- appnIsInRtpNceId
- appnIsRtpNceId

In each case this value identifies a row in this table containing information related to that in the APPN MIB."

::= { hprRtpEntry 1 }

hprRtpLocTcid OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (8))

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The local TCID of this RTP connection. A value for this object can be retrieved from either the appnIsInRtpTcid object or the appnIsRtpTcid object the APPN MIB; in each case this value identifies a row in this table containing information

related to that in the APPN MIB."

::= { hprRtpEntry 2 }

hprRtpRemCpName OBJECT-TYPE

SYNTAX SnaControlPointName

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Administratively assigned network name for the remote node of this RTP connection."

::= { hprRtpEntry 3 }

hprRtpRemNceId OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (1..8))

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The remote Network Connection Endpoint (NCE) of this RTP connection. NCEs identify CPs, LUs, Boundary Functions (BFs), and Route Setup (RS) components."

::= { hprRtpEntry 4 }

hprRtpRemTcid OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (8))

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The remote TCID of this RTP connection."

::= { hprRtpEntry 5 }

hprRtpPathSwitchTrigger OBJECT-TYPE

SYNTAX INTEGER {

ready(1),

switchPathNow(2)

}

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"Object by which a Management Station can trigger an operator-requested path switch, by setting the value to switchPathNow(2). Setting this object to switchPathNow(2) triggers a path switch even if its previous value was already switchPathNow(2)."

The value ready(1) is returned on GET operations until a SET has been processed; after that the value received on the most recent SET is returned.

This MIB module provides no support for an operator-requested switch to a specified path."

::= { hprRtpEntry 6 }

hprRtpRscv OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (0..255))

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The forward Route Selection Control Vector for this RTP connection. The format of this vector is described in SNA Formats.

The value returned in this object during a path switch is implementation-dependent: it may be the old path, the new path, a zero-length string, or some other valid RSCV string."

::= { hprRtpEntry 7 }

hprRtpTopic OBJECT-TYPE

SYNTAX DisplayString (SIZE(8))

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The topic for this RTP connection. This is used to indicate the Class of Service."

::= { hprRtpEntry 8 }

hprRtpState OBJECT-TYPE

SYNTAX INTEGER {

rtpListening(1),
rtpCalling(2),
rtpConnected(3),
rtpPathSwitching(4),
rtpDisconnecting(5),
other(99)

}

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The state of the RTP connection, from the perspective of the local RTP protocol machine:

rtpListening	- connection open; waiting for other end to call in
rtpCalling	- connection opened, attempting to call out, have not yet received any data from other end
rtpConnected	- connection is active; responded to a call-in or received other end's TCID from a call-out attempt
rtpPathSwitching	- the path switch timer is running; attempting to find a new path for this connection.
rtpDisconnecting	- no sessions are using this connection; in process of bringing it down
other	- the connection is not in any of the states listed above."

```
::= { hprRtpEntry 9 }
```

```
hprRtpUpTime OBJECT-TYPE
```

```
SYNTAX TimeTicks
```

```
UNITS "1/100ths of a second"
```

```
MAX-ACCESS read-only
```

```
STATUS current
```

```
DESCRIPTION
```

```
"The length of time the RTP connection has been up, measured
in 1/100ths of a second."
```

```
::= { hprRtpEntry 10 }
```

```
hprRtpLivenessTimer OBJECT-TYPE
```

```
SYNTAX Unsigned32
```

```
UNITS "1/100ths of a second"
```

```
MAX-ACCESS read-only
```

```
STATUS current
```

```
DESCRIPTION
```

```
"The value of the liveness (ALIVE) timer of this RTP
connection, in units of 1/100th of a second. When this timer
expires and no packet has arrived from the partner since it
was last set, packets with Status Request indicators will be
sent to see if the RTP connection is still alive."
```

```
::= { hprRtpEntry 11 }
```

```
hprRtpShortReqTimer OBJECT-TYPE
```

```
SYNTAX Unsigned32
```

```
UNITS "1/100ths of a second"
```

```
MAX-ACCESS read-only
```

```
STATUS current
```

DESCRIPTION

"The value of the RTP SHORT_REQ timer, in units of 1/100 of a second. This timer represents the maximum time that a sender waits for a reply from a receiver."

::= { hprRtpEntry 12 }

hprRtpPathSwTimer OBJECT-TYPE

SYNTAX Unsigned32

UNITS "1/100ths of a second"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The length of time that RTP should attempt a path switch for a connection, in units of 1/100th of a second."

::= { hprRtpEntry 13 }

hprRtpLivenessTimeouts OBJECT-TYPE

SYNTAX HprRtpCounter

UNITS "liveness timeouts"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The count of liveness timeouts for this RTP connection."

::= { hprRtpEntry 14 }

hprRtpShortReqTimeouts OBJECT-TYPE

SYNTAX HprRtpCounter

UNITS "short request timeouts"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The count of short request timeouts for this RTP connection."

::= { hprRtpEntry 15 }

hprRtpMaxSendRate OBJECT-TYPE

SYNTAX Gauge32

UNITS "bytes per second"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The high-water mark for this RTP connection's send rate, in units of bytes per second. This is the high-water mark for the entire life of the connection, not just the high-water mark for the connection's current path."

For more details on this and other parameters related to HPR, see the High Performance Routing Architecture Reference."

::= { hprRtpEntry 16 }

hprRtpMinSendRate OBJECT-TYPE

SYNTAX Gauge32

UNITS "bytes per second"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The low-water mark for this RTP connection's send rate, in units of bytes per second. This is the low-water mark for the entire life of the connection, not just the low-water mark for the connection's current path.

For more details on this and other parameters related to HPR, see the High Performance Routing Architecture Reference."

::= { hprRtpEntry 17 }

hprRtpCurSendRate OBJECT-TYPE

SYNTAX Gauge32

UNITS "bytes per second"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The current send rate for this RTP connection, in units of bytes per second.

For more details on this and other parameters related to HPR, see the High Performance Routing Architecture Reference."

::= { hprRtpEntry 18 }

hprRtpSmRdTripDelay OBJECT-TYPE

SYNTAX Gauge32

UNITS "1/1000ths of a second"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The smoothed round trip delay for this RTP connection, in units of 1/1000th of a second (ms).

For more details on this and other parameters related to HPR, see the High Performance Routing Architecture Reference."

::= { hprRtpEntry 19 }

hprRtpSendPackets OBJECT-TYPE

SYNTAX HprRtpCounter

UNITS "RTP packets"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The count of packets successfully sent on this RTP connection."

::= { hprRtpEntry 20 }

hprRtpRecvPackets OBJECT-TYPE

SYNTAX HprRtpCounter

UNITS "RTP packets"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The count of packets received on this RTP connection. The counter is incremented only once if duplicate copies of a packet are received."

::= { hprRtpEntry 21 }

hprRtpSendBytes OBJECT-TYPE

SYNTAX HprRtpCounter

UNITS "bytes"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The count of bytes sent on this RTP connection. Both RTP Transport Header (THDR) bytes and data bytes are included in this count."

::= { hprRtpEntry 22 }

hprRtpRecvBytes OBJECT-TYPE

SYNTAX HprRtpCounter

UNITS "bytes"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The count of bytes received on this RTP connection. Both RTP Transport Header (THDR) bytes and data bytes are included in this count."

::= { hprRtpEntry 23 }

hprRtpRetrPackets OBJECT-TYPE

```
SYNTAX HprRtpCounter
UNITS "RTP packets"
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "The count of packets retransmitted on this RTP connection."
```

```
::= { hprRtpEntry 24 }
```

hprRtpPacketsDiscarded OBJECT-TYPE

```
SYNTAX HprRtpCounter
UNITS "RTP packets"
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "The count of packets received on this RTP connection and then
    discarded. A packet may be discarded because it is determined
    to be a duplicate, or for other reasons."
```

```
::= { hprRtpEntry 25 }
```

hprRtpDetectGaps OBJECT-TYPE

```
SYNTAX HprRtpCounter
UNITS "gaps"
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "The count of gaps detected on this RTP connection."
```

```
::= { hprRtpEntry 26 }
```

hprRtpRateReqSends OBJECT-TYPE

```
SYNTAX HprRtpCounter
UNITS "rate requests"
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "The count of Rate Requests sent on this RTP connection."
```

```
::= { hprRtpEntry 27 }
```

hprRtpOkErrPathSws OBJECT-TYPE

```
SYNTAX HprRtpCounter
UNITS "path switch attempts"
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "The count of successful path switch attempts for this RTP
```

connection due to errors."

::= { hprRtpEntry 28 }

hprRtpBadErrPathSws OBJECT-TYPE

SYNTAX HprRtpCounter

UNITS "path switch attempts"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The count of unsuccessful path switches for this RTP connection due to errors."

::= { hprRtpEntry 29 }

hprRtpOkOpPathSws OBJECT-TYPE

SYNTAX HprRtpCounter

UNITS "path switches"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The count of successful path switches for this RTP connection due to operator requests."

::= { hprRtpEntry 30 }

hprRtpBadOpPathSws OBJECT-TYPE

SYNTAX HprRtpCounter

UNITS "path switches"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The count of unsuccessful path switches for this RTP connection due to operator requests. This counter is not incremented by an implementation that does not support operator-requested path switches, even if a Management Station requests such a path switch by setting the hprRtpPathSwitchTrigger object."

::= { hprRtpEntry 31 }

hprRtpCounterDisconTime OBJECT-TYPE

SYNTAX TimeStamp

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The value of the sysUpTime object when the counters for this RTP connection last experienced a discontinuity. This will be

the more recent of two times: the time at which the connection was established or the time at which the HPR counters were last turned on or off."

```
::= { hprRtpEntry 32 }
```

```
-- *****
-- The RTP Connection Status Table
-- This table contains statistics and historical information related to
-- both successful and unsuccessful RTP path switches. This
-- information can be important for both trend analysis and problem
-- determination.
--
-- Note the terminology here: when RTP is triggered to find a new path
-- for a connection, this initiates a 'path switch,' which will end up
-- being either successful or unsuccessful. During this path switch,
-- RTP will make one or more 'path switch attempts,' which are attempts
-- to find a new path for the connection and switch the connection to
-- it. This 'new' path may be the same path that the connection was
-- using before the path switch.
--
-- It is an implementation option how many entries to keep in this
-- table, and how long to retain any individual entry.
-- *****
```

```
hprRtpStatusTable OBJECT-TYPE
```

```
SYNTAX SEQUENCE OF HprRtpStatusEntry
```

```
MAX-ACCESS not-accessible
```

```
STATUS current
```

```
DESCRIPTION
```

"RTP Connection Status Table: This table contains historical information on RTP connections. An entry is created in this table when a path switch is completed, either successfully or unsuccessfully."

```
::= { hprRtp 3 }
```

```
hprRtpStatusEntry OBJECT-TYPE
```

```
SYNTAX HprRtpStatusEntry
```

```
MAX-ACCESS not-accessible
```

```
STATUS current
```

```
DESCRIPTION
```

"This table is indexed by local NCE ID, local TCID, and an integer hprRtpStatusIndex. Thus the primary grouping of table rows is by RTP connection, with the multiple entries for a given RTP connection ordered by time."

```
INDEX
```

```
{ hprRtpStatusLocNceId,
```

```

    hprRtpStatusLocTcid,
    hprRtpStatusIndex }

```

```
 ::= { hprRtpStatusTable 1 }
```

```

HprRtpStatusEntry ::= SEQUENCE {
    hprRtpStatusLocNceId      OCTET STRING, -- local nce id
    hprRtpStatusLocTcid      OCTET STRING, -- local tcid
    hprRtpStatusIndex        Unsigned32,    -- index
    hprRtpStatusStartTime    DateAndTime,   -- time stamp
    hprRtpStatusEndTime     DateAndTime,   -- time stamp
    hprRtpStatusRemCpName    SnaControlPointName, -- remote cp name
    hprRtpStatusRemNceId     OCTET STRING, -- remote nce id
    hprRtpStatusRemTcid      OCTET STRING, -- remote tcid
    hprRtpStatusNewRscv      OCTET STRING, -- new rscv
    hprRtpStatusOldRscv      OCTET STRING, -- old rscv
    hprRtpStatusCause        INTEGER,       -- cause
    hprRtpStatusLastAttemptResult INTEGER    -- result of last
                                     }

```

```

hprRtpStatusLocNceId OBJECT-TYPE
    SYNTAX OCTET STRING (SIZE (1..8))
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "The local Network Connection Endpoint (NCE) of this RTP
        connection. NCEs identify CPs, LUs, Boundary Functions (BFs),
        and Route Setup (RS) components."

```

```
 ::= { hprRtpStatusEntry 1 }
```

```

hprRtpStatusLocTcid OBJECT-TYPE
    SYNTAX OCTET STRING (SIZE (8))
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "The local TCID of this RTP connection."

```

```
 ::= { hprRtpStatusEntry 2 }
```

```

hprRtpStatusIndex OBJECT-TYPE
    SYNTAX Unsigned32 (1..4294967295)
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "Table index. This value begins at one and is incremented
        when a new entry is added to the table. It is an
        implementation choice whether to run a single counter for

```

all entries in the table, or to run a separate counter for the entries for each RTP connection. In the unlikely event of a wrap, it is assumed that Management Stations will have the ability to order table entries correctly."

::= { hprRtpStatusEntry 3 }

hprRtpStatusStartTime OBJECT-TYPE

SYNTAX DateAndTime

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The time when the path switch began."

::= { hprRtpStatusEntry 4 }

hprRtpStatusEndTime OBJECT-TYPE

SYNTAX DateAndTime

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The time when the path switch was ended, either successfully or unsuccessfully."

::= { hprRtpStatusEntry 5 }

hprRtpStatusRemCpName OBJECT-TYPE

SYNTAX SnaControlPointName

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Administratively assigned network name for the remote node of this RTP connection."

::= { hprRtpStatusEntry 6 }

hprRtpStatusRemNceId OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (1..8))

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The remote Network Connection Endpoint (NCE) of this RTP connection. NCEs identify CPs, LUs, Boundary Functions (BFs), and Route Setup (RS) components."

::= { hprRtpStatusEntry 7 }

hprRtpStatusRemTcid OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (8))
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The remote TCID of this RTP connection."

::= { hprRtpStatusEntry 8 }

hprRtpStatusNewRscv OBJECT-TYPE
SYNTAX OCTET STRING (SIZE (0..255))
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The new Route Selection Control Vector for this RTP connection. A zero-length string indicates that no value is available, perhaps because the implementation does not save RSCVs."

::= { hprRtpStatusEntry 9 }

hprRtpStatusOldRscv OBJECT-TYPE
SYNTAX OCTET STRING (SIZE (0..255))
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The old Route Selection Control Vector for this RTP connection. A zero-length string indicates that no value is available, perhaps because the implementation does not save RSCVs."

::= { hprRtpStatusEntry 10 }

hprRtpStatusCause OBJECT-TYPE
SYNTAX INTEGER {
 other(1),
 rtpConnFail(2),
 locLinkFail(3),
 remLinkFail(4),
 operRequest(5)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The reason for the path switch:

 other(1) - Reason other than those listed below,
 rtpConnFail(2) - RTP connection failure detected,
 locLinkFail(3) - Local link failure,

remLinkFail(4) - Remote link failure (learned from TDUs),
 operRequest(5) - Operator requested path switch. "

::= { hprRtpStatusEntry 11 }

hprRtpStatusLastAttemptResult OBJECT-TYPE

```
SYNTAX INTEGER { successful(1),
                  initiatorMoving(2),
                  directorySearchFailed(3),
                  rscvCalculationFailed(4),
                  negativeRouteSetupReply(5),
                  backoutRouteSetupReply(6),
                  timeoutDuringFirstAttempt(7),
                  otherUnsuccessful(8)
                }
```

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The result of the last completed path switch attempt. If the path switch is aborted in the middle of a path switch attempt because the path switch timer expires, the result of the previous path switch attempt is reported.

The values are defined as follows:

successful(1)	- The final path switch attempt was successful.
initiatorMoving(2)	- The final path switch attempt failed because the initiator is mobile, and there was no active link out of this node.
directorySearchFailed(3)	- The final path switch attempt failed because a directory search for the destination node's CP name failed.
rscvCalculationFailed(4)	- The final path switch attempt failed because an RSCV to the node containing the remote RTP endpoint could not be calculated.
negativeRouteSetupReply(5)	- The final path switch attempt failed because route setup failed for the new path.
backoutRouteSetupReply(6)	- The final path switch attempt failed because the

```

remote RTP endpoint refused
to continue the RTP
connection.
timeoutDuringFirstAttempt(7) - The path switch timer
expired during the first
path switch attempt.
otherUnsuccessful(8) - The final path switch
attempt failed for a reason
other than those listed
above."

 ::= { hprRtpStatusEntry 12 }

-- *****
-- Conformance information
-- *****

hprConformance          OBJECT IDENTIFIER ::= { hprMIB 2 }

hprCompliances          OBJECT IDENTIFIER ::= { hprConformance 1 }
hprGroups              OBJECT IDENTIFIER ::= { hprConformance 2 }

-- Compliance statements

hprCompliance MODULE-COMPLIANCE
    STATUS current
    DESCRIPTION
        "The compliance statement for the SNMPv2 entities that
        implement the HPR MIB."

    MODULE -- this module

-- Unconditionally mandatory groups
    MANDATORY-GROUPS {
        hprGlobalConfGroup,
        hprAnrRoutingConfGroup,
        hprTransportUserConfGroup
    }

-- Conditionally mandatory groups
    GROUP hprRtpConfGroup
    DESCRIPTION
        "The hprRtpConfGroup is mandatory for HPR implementations
        supporting the HPR transport tower."

 ::= { hprCompliances 1 }

```

-- Units of conformance

hprGlobalConfGroup OBJECT-GROUP

```
OBJECTS {
    hprNodeCpName,
    hprOperatorPathSwitchSupport
}
```

STATUS current

DESCRIPTION

"A collection of objects providing the instrumentation of HPR general information and capabilities."

::= { hprGroups 1 }

hprAnrRoutingConfGroup OBJECT-GROUP

```
OBJECTS {
    hprAnrsAssigned,
    hprAnrCounterState,
    hprAnrCounterStateTime,
    hprAnrType,
    hprAnrOutTgDest,
    hprAnrOutTgNum,
    hprAnrPacketsReceived,
    hprAnrCounterDisconTime
}
```

STATUS current

DESCRIPTION

"A collection of objects providing instrumentation for the node's ANR routing."

::= { hprGroups 2 }

hprTransportUserConfGroup OBJECT-GROUP

```
OBJECTS {
    hprNceType,
    hprNceDefault,
    hprNceInstanceId
}
```

STATUS current

DESCRIPTION

"A collection of objects providing information on the users of the HPR transport known to the node."

::= { hprGroups 3 }

hprRtpConfGroup OBJECT-GROUP

```
OBJECTS {
    hprRtpGlobeConnSetups,
    hprRtpGlobeCtrState,
}
```

```
hprRtpGlobeCtrStateTime,  
hprRtpRemCpName,  
hprRtpRemNceId,  
hprRtpRemTcid,  
hprRtpPathSwitchTrigger,  
hprRtpRscv,  
hprRtpTopic,  
hprRtpState,  
hprRtpUpTime,  
hprRtpLivenessTimer,  
hprRtpShortReqTimer,  
hprRtpPathSwTimer,  
hprRtpLivenessTimeouts,  
hprRtpShortReqTimeouts,  
  
hprRtpMaxSendRate,  
hprRtpMinSendRate,  
hprRtpCurSendRate,  
  
hprRtpSmRdTripDelay,  
  
hprRtpSendPackets,  
hprRtpRecvPackets,  
hprRtpSendBytes,  
hprRtpRecvBytes,  
  
hprRtpRetrPackets,  
hprRtpPacketsDiscarded,  
hprRtpDetectGaps,  
hprRtpRateReqSends,  
  
hprRtpOkErrPathSws,  
hprRtpBadErrPathSws,  
hprRtpOkOpPathSws,  
hprRtpBadOpPathSws,  
hprRtpCounterDisconTime,  
  
hprRtpStatusStartTime,  
hprRtpStatusEndTime,  
hprRtpStatusRemNceId,  
hprRtpStatusRemTcid,  
hprRtpStatusRemCpName,  
hprRtpStatusNewRscv,  
hprRtpStatusOldRscv,  
hprRtpStatusCause,  
hprRtpStatusLastAttemptResult  
  
}
```


STATUS current

DESCRIPTION

"A collection of objects providing the instrumentation for RTP connection end points."

::= { hprGroups 4 }

-- end of conformance statement

END

6. Acknowledgments

This MIB module is the product of the IETF SNA NAU MIB WG and the AIW APPN/HPR MIBs SIG. Thanks to Ray Bird, IBM Corporation; Jim Cobban, Nortel; and Laura Petrie, IBM Corporation, for their contributions and review.

7. References

- [1] Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, "Structure of Management Information for version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1902, January 1996.
- [2] Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, "Textual Conventions for Version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1903, January 1996.
- [3] Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, "Conformance Statements for Version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1904, January 1996.
- [4] Clouston, B., and B. Moore, "Definition of Managed Objects for APPN", RFC 2115, June 1997.
- [5] IBM, APPN High Performance Routing Architecture Reference, SV40-1018-00.
- [6] IBM, SNA/MS Formats, GC31-8302-00

8. Security Considerations

In most cases, MIBs are not themselves security risks; if SNMP security is operating as intended, the use of a MIB to view information about a system, or to change some parameter at the system, is a tool, not a threat.

None of the read-only objects in the HPR MIB reports a password, user data, or anything else that is particularly sensitive. Some enterprises view their network configuration itself, as well as information about network usage and performance, as corporate assets; such enterprises may wish to restrict SNMP access to most of the objects in the MIB.

One read-write object in the MIB can affect network operations:

- o `hprRtpPathSwitchTrigger`: Setting this object to 'switchPathNow' triggers an immediate path switch attempt. An HPR path switch does not itself disrupt the SNA sessions using the RTP connection undergoing the path switch. However, frequent path switches for many RTP connections can have an adverse impact on overall network performance.

It is recommended that SNMP access to this object be restricted.

Other read-write objects control the gathering of network management data; controlling access to these objects is less critical.

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