Internet Engineering Task Force
Internet-Draft
Intended status: Standards Track
Expires: January 9, 2011

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July 8, 2010

Definition of Managed Objects for the Neighborhood Discovery Protocol draft-ietf-manet-nhdp-mib-04

Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes objects for configuring parameters of the Neighborhood Discovery Protocol (NHDP) process on a router. The MIB defined in this memo, denoted NHDP-MIB, also reports state, performance information and notifications. This additional state and performance information is useful to troubleshoot problems and performance issues during neighbor discovery.

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1. 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 describes objects for configuring parameters of the Neighborhood Discovery Protocol [NHDP] process on a router. The MIB defined in this memo, denoted NHDP-MIB, also reports state, performance information and notifications. This additional state and performance information is useful to troubleshoot problems and performance issues during neighbor discovery.

2. 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 [RFC2578], [RFC2579] and [RFC2580].

3. Conventions

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

4. Overview

[NHDP] allows a router in a Mobile Ad Hoc Network (MANET) to discover and track topological information of routers up to two hops away by virtue of exchanging HELLO messages. This information is useful for routers running various routing and multicast flooding protocols developed within the IETF MANET Working Group.

4.1. Terms

The following definitions apply throughout this document:

- Configuration Objects - switches, tables, objects which are initialized to default settings or set through the management interface defined by this MIB.

- State Objects - automatically generated values which define the current operating state of the NHDP protocol process in the router.

- Performance Objects - automatically generated values which help an administrator or automated tool to assess the performance of the NHDP protocol process on the router and the overall discovery performance within the MANET.

- Notification Objects - define triggers and associated notification messages allowing for asynchronous tracking of pre-defined events on the managed router.

5. Structure of the MIB Module

This section presents the structure of the NHDP-MIB module. The MIB is arranged into the following structure:

- nhdpObjects - defining objects within this MIB. The objects are arranged into the following groups:

  * Configuration Group - defining objects related to the configuration of the NHDP instance on the router.

  * State Group - defining objects which reflect the current state of the NHDP instance running on the router.

  * Performance Group - defining objects which are useful to a management station when characterizing the performance of NHDP on the router and in the MANET.

- nhdpNotifications - objects defining NHDP-MIB notifications.

- nhdpConformance - defining the minimal and maximal conformance requirements for implementations of this MIB.

5.1. The Configuration Group

The NHDP router is configured with a set of controls. The authoritative list of configuration controls within the NHDP-MIB are found within the MIB module itself. Generally, an attempt was made in developing the NHDP-MIB module to support all configuration objects defined in [NHDP]. For all of the configuration parameters, the same constraints and default values of these parameters as defined in [NHDP] are followed.

5.2. The State Group

The State Group reports current state information of a router running [NHDP]. The NHDP-MIB State Group tables were designed to contain the complete set of state information defined within the information bases in [NHDP].

Two constructs, i.e., TEXTUAL CONVENTIONs, are defined in support of the tables in the State Group. These are NeighborIfIndex and NeighborRouterId. These are locally (to the NHDP router) defined, unique identifiers. They are used to define indexes to the appropriate State Group tables and to correlate table entries to interface address, interfaces and routers within the MANET. NeighborIfIndex is a unique identifier of discovered NHDP interfaces on all routers within the MANET. NeighborRouterId is a unique identifier of discovered NHDP routers within the MANET.

5.3. The Performance Group

The Performance Group reports values relevant to system performance. This section lists objects for NHDP performance monitoring, some of which explicitly appear in the NHDP-MIB and others which are obtainable through a combination of base objects from this MIB and reports available through the REPORT-MIB [REPORT]. Throughout this section, those objects will be pointed out that are intended as base objects, which will be explicitly defined within this MIB, and those objects which are derived through a combination of the base objects and capabilities afforded by the REPORT-MIB.

The objects described in the following can be useful for determining certain properties of the NHDP instance. Notably unstable neighbors or 2-hop neighbors and frequent changes of sets can have a negative influence on the performance of NHDP. The following objects allow management applications to acquire information related to the stability and performance of NHDP:

The following objects return statistics related to HELLO messages:

- Total number of sent HELLO messages on an interface

  This is a Base Object.

  Object name: nhdpIfHelloMessageXmits

  Object type: Counter32

- Total number of received HELLO messages on an interface

  This is a Base Object.

  Object name: nhdpIfHelloMessageRecvd

  Object type: Counter32

- Total number of sent periodic HELLO messages on an interface

  This is a Base Object.

  Object name: nhdpIfHelloMessagePeriodicXmits

  Object type: Counter32

- Total number of sent triggered HELLO messages on an interface

  This is a Base Object.

  Object name: nhdpIfHelloMessageTriggeredXmits

  Object type: Counter32

- Acquire history of HELLO message scheduling instances for a given time duration on an interface

  It is desirable to develop the history of the exact timestamps of each HELLO message that has been sent as well as the type of the message (triggered or periodical). The list of events starts at the given point of time t0 and ends at the given time t1.

  This is a Derived Object to be pulled from the REPORT-MIB. It is derived from, e.g., the nhdpIfHelloMessagePeriodicXmits Base Object from the NHDP-MIB along with the capabilities derived from the reportHistoryGroup from the REPORT-MIB.

  Object type: SEQUENCE OF (TimeStamp, nhdpMessageType)

- Histogram of the intervals between HELLO messages on an interface

  It is desirable to track the values (in a 2-dimensional array) that represent a histogram of intervals between HELLO messages, separated by periodic and triggered HELLOs. The histogram displays the distribution of intervals between two consecutive HELLOs of the same type (triggered or periodical) using a given bin size. It includes all HELLOs that have been sent after the

given time t0 and before the given time t1.

This is a Derived Object to be pulled from the REPORT-MIB. It can be derived from, e.g., the nhdpIfHelloMessagePeriodicXmits Base Object from the NHDP-MIB along with the capabilities derived from the reportHistoryGroup from the REPORT-MIB. The network management application could convert this information into the desired histogram.

Object type: SEQUENCE OF (nhdpMessageType, TimeTicks, Unsigned32)

- Changes of the frequency of the message scheduling on an interface

  This object will divide the given time interval from t0 to t1 into a given number of equal parts. It then creates a histogram for each part and calculates the distances (e.g. using the Bhattacharyya distance) between each two adjacent histograms in time. A higher value between two histograms means more difference between the histograms. For instance, this is representative of an event that suddenly sends many triggered HELLO messages, whereas before only very few such triggered messages have been transmitted.

  This is a Derived Object to be pulled from the REPORT-MIB, as previously discussed, albeit this is a bit more complex with respect to the management application.

  Object type: SEQUENCE OF (nhdpMessageType, TimeStamp, Float32)

- Average number of sent HELLO messages per second between the given time t0 and t1 on an interface

  This is a Derived Object to be pulled from the reportSampledGroup from the REPORT-MIB. It is derived from, e.g., the nhdpIfHelloMessageXmits Base Object.

  Object type: Float32

- Average number of received HELLO messages per second on an interface between the given time t0 and t1

  This is a Derived Object to be pulled from the REPORT-MIB. See the previous discussion.

Object type: Float32

- Total accumulated size in octets of sent HELLO messages on an interface

  This is a Base Object.

  Object name: nhdpIfHelloMessageXmitAccumulatedSize

  Object type: Counter32

- Total accumulated size in octets of received HELLO messages on an interface

  This is a Base Object.

  Object name: nhdpIfHelloMessageRecvdAccumulatedSize

  Object type: Counter32

- Average size in octets of sent HELLO messages between the given time t0 and t1 on an interface.

  This is a Derived Object to be pulled from the reportSampledGroup from the REPORT-MIB. It is derived from, e.g., the nhdpIfHelloMessageRecvdAccumulatedSize Base Object from this NHDP-MIB.

  Object type: Float32

- Average size in octets of received HELLO messages between the given time t0 and t1 on an interface

  This is a Derived Object to be pulled from the REPORT-MIB. See previous discussion.

  Object type: Float32

- Total accumulated number of advertised symmetric neighbors in HELLOs on that interface.

  This is a Base Object.

  Object name: nhdpIfHelloMessageXmitAccumulatedSymmetricNeighborCount

Object type: Counter32

- Total accumulated number of advertised heard neighbors in HELLOs on that interface

  This is a Base Object.

  Object name: nhdpIfHelloMessageXmitAccumulatedHeardNeighborCount

  Object type: Counter32

- Total accumulated number of advertised lost neighbors in HELLOs on that interface

  This is a Base Object.

  Object name: nhdpIfHelloMessageXmitAccumulatedLostNeighborCount

  Object type: Counter32

- Number of expected packets from a given neighbor based on the packet sequence number on an interface

  This is a Base Object.

  Object name: nhdpDiscIfExpectedPackets

  Object type: Counter32

- Success rate of received packets (number of received packets divided by number of expected packets based on the packet sequence number).

  This is a Derived Object to be pulled from this NHDP-MIB. It is derived from, e.g., the nhdpDiscIfRecvdPackets and the nhdpDiscIfExpectedPackets Base Objects defined in this MIB. This metric is then computed by the network management application.

  Object type: Float32

The following objects inspect the frequency of all Neighbor Set changes:

- Number of Neighbor Set changes

This object counts each Neighbor Set change. A change occurs whenever a new Neighbor Tuple has been added, a Neighbor Tuple has been removed or any entry of a Neighbor Tuple has been modified.

This is a Base Object.

Object name: nhdpNibNeighborSetChanges

Object type: Counter32

- Acquire history of Neighbor Set changes

  This object returns the history of the exact timestamps of each time the Neighbor Set has been changed.

  This is a Derived Object to be pulled from the reportHistoryGroup of the REPORT-MIB. It is derived from the previously discussed Base Object.

  Object type: SEQUENCE OF TimeStamp

- Histogram of the intervals between Neighbor Set changes

  Returns the values (in a 2-dimensional array) that represent a histogram of intervals between Neighbor Set changes.

  This is a Derived Object to be pulled from the reportHistoryGroup from the REPORT-MIB. It is derived from the previously discussed Base Object. The network management application would develop the histograms based upon lists obtained from the REPORT-MIB.

  Object type: SEQUENCE OF (TimeTicks, Unsigned32)

- Changes of the frequency of the Neighbor Set changes

  This object will divide the given time interval from t0 to t1 into a given number of equal parts. It then creates a histogram for each part and calculates the distances (e.g. using the Bhattacharyya distance) between each two adjacent histograms in time. A higher value between two histograms means more difference between the histograms.

  This is a Derived Object to be pulled from the reportHistoryGroup from the REPORT-MIB. It is derived from the previously discussed Base Object. The network management application could then compute the desired metrics.

Object type: SEQUENCE OF (TimeStamp, Float32)

The next objects examine the uptime of a given neighbor:

- Number of changes of a Neighbor Tuple

  Returns the number of changes to the given Neighbor Tuple.

  This is a Base Object.

  Object name: nhdpDiscNeighborNibNeighborSetChanges

  Object type: Counter32

- Neighbor uptime

  Returns the number of milliseconds since the Neighbor Tuple corresponding to the given neighbor exists.

  This is a Base Object.

  Object name: nhdpDiscNeighborNibNeighborSetUpTime

  Object type: Unsigned32

- Acquire history of change of onlink status of a given neighbor

  This object returns the history of the exact timestamps of each time the neighbor becomes onlink or offlink. A neighbor is said to become "onlink" if a new Neighbor Tuple is created that corresponds to the given neighbor. It becomes "offlink" if such a tuple has been deleted.

  This is a Derived Object to be pulled from the reportHistoryGroup of the REPORT-MIB. It is derived from, e.g., the nhdpDiscNeighborNibNeighborSetChanges Base Object defined in this MIB.

  Object type: SEQUENCE OF TimeStamp

- Histogram of the intervals between a change of the onlink status of a given neighbor

  Returns the values that represent a histogram of intervals between a change of the onlink status of a given neighbor. The histogram includes all changes that have been made after the given time t0 and before the given time t1.

This is a Derived Object to be pulled from the reportHistoryGroup of the REPORT-MIB. It is derived from, e.g. the nhdpDiscNeighborNibNeighborSetChanges Base Object defined in this MIB. This object sits in the nhdpDiscNeighborSetPerfTable which is indexed by the nhdpDiscNeighborSetRouterId.

Object type: SEQUENCE OF (TimeTicks, Unsigned32)

The following objects examine the stability of a neighbor. A neighbor is said to be unstable if it "flaps" frequently between several links. It is said to be stable if the set of Link Tuples that correspond to the given neighbor is stationary.

- o Count the changes of the interface over which a given neighbor can be reached.

  This object counts each time the neighbor changes the interface over which it is reachable. That means that the corresponding Link Tuple of the given link moves from the Link Set of one interface to another interface.

  This is a Base Object.

  Object name: nhdpDiscNeighborNibNeighborSetReachableLinkChanges

  Object type: Counter32

- o Acquire history of changes of the interface over which a given neighbor can be reached.

  This object returns the history of the exact timestamps of each time the neighbor changes the interface over which it is reachable. That means that the corresponding Link Tuple of the given link moves from the Link Set of one interface to another interface.

  This is a Derived Object to be pulled from the reportHistoryGroup of the REPORT-MIB. It is derived from, e.g., the nhdpDiscNeighborNibNeighborSetReachableLinkChanges Base Object. The network management could develop the desired histogram based upon the information retrieved from the REPORT-MIB.

  Object type: SEQUENCE OF (TimeStamp)

- Histogram of the intervals between a change of the interface over which a given neighbor is reachable

  Returns the values that represent a histogram of intervals between a change of the interface over which a given neighbor is reachable after the given time t0 and before the given time t1.

  This is a Derived Object to be pulled from the reportHistoryGroup from the REPORT-MIB. It is derived from the previously discussed Base Object, nhdpDiscNeighborNibNeighborSetChanges counter. The network management application would develop the histograms based upon lists obtained from the REPORT-MIB.

  Object type: SEQUENCE OF (TimeTicks, Unsigned32)

The following objects inspect the stability of a given 2-hop neighbor:

- Count the changes of the N2_neighbor_iface_addr_list of a given 2-hop neighbor

  This object returns the count of the times the 2-hop neighbor changes its N2_neighbor_iface_addr_list, i.e. the neighbor over which it is reachable.

  This is a Base Object.

  Object name: nhdpIib2HopSetPerfChanges

  Object type: Counter32

- Acquire history of changes of the N2_neighbor_iface_addr_list of a given 2-hop neighbor

  This object returns the history of the exact timestamps of each time the 2-hop neighbor changes its N2_neighbor_iface_addr_list, i.e. the neighbor over which it is reachable.

  This is a Derived Object to be pulled from the reportHistoryGroup of the REPORT-MIB. It is derived from the previously discussed Base Object, nhdpIib2HopSetPerfChanges counter.

Object type: SEQUENCE OF (TimeStamp)

- Histogram of the intervals between a change of a 2-hop neighbor's N2_neighbor_iface_addr_list

  Returns the values that represent a histogram of intervals between a change of the 2-hop neighbor's N2_neighbor_iface_addr_list after the given time t0 and before the given time t1.

  This is a Derived Object to be pulled from the reportHistoryGroup from the REPORT-MIB. It is derived from the previously discussed Base Object, nhdpIib2HopSetPerfChanges counter. The network management application would develop the histograms based upon lists obtained from the REPORT-MIB.

  Object type: SEQUENCE OF (TimeTicks, Unsigned32)

The next objects examine the uptime of a given 2-hop neighbor:

- 2-hop Neighbor uptime

  Returns the number of milliseconds since the 2-Hop Tuple corresponding to the given 2-hop neighbor IP address exists.

  This is a Base Object.

  Object name: nhdpIib2HopSetPerfUpTime

  Object type: Unsigned32

- Acquire history of change of onlink status of a given 2-hop neighbor

  This object returns the history of the exact timestamps of each time the 2-hop neighbor becomes onlink or offlink. A 2-hop neighbor is said to become "onlink" if a new 2-hop Tuple is created that corresponds to the given 2-hop neighbor. It becomes "offlink" if such a tuple has been deleted.

  This is a Derived Object to be pulled from the reportHistoryGroup of the REPORT-MIB. It is derived from the previously discussed Base Object, nhdpIib2HopSetPerfChanges counter.

Object type: SEQUENCE OF (TimeStamp)

- Histogram of the intervals between a change of the onlink status of a given 2-hop neighbor

  Returns the values that represent a histogram of intervals between a change of the onlink status of a given 2-hop neighbor. The histogram includes all changes that have been made after the given time t0 and before the given time t1.

  This is a Derived Object to be pulled from the reportHistoryGroup from the REPORT-MIB. It is derived from the previously discussed Base Object, nhdpIib2HopSetPerfChanges counter. The network management application would develop the histograms based upon lists obtained from the REPORT-MIB.

  Object type: SEQUENCE OF (TimeTicks, Unsigned32)

5.4. Notifications

This section describes the use of notifications, and mechanisms to enhance the ability to manage NHDP networks.

5.4.1. Introduction

Notifications can be emitted by an NHDP router as a reaction a to specific event. This allows a network manager to efficiently determine the source of problems or significant changes of configuration or topology, instead of polling a possibly large number of NHDP routers.

5.4.2. Notification Generation

When an exception event occurs, the application notifies the local agent, which sends a notification to the appropriate SNMP management stations. The message includes the notification type and may include a list of notification-specific variables. Section 7 contains, amongst others, the notification definitions, which includes the variable lists. At least one IP address of the NHDP router that originates the notification is included in the variable list so that the network manager may determine the source of the notification.

5.4.3. Limiting Frequency of Notifications

To limit the frequency of notifications, the following additional mechanisms are suggested, similar to those in [RFC4750]:

5.4.3.1. Ignoring Initial Activity

The majority of critical events occur when NHDP is enabled on a router, at which time the symmetric neighbors and two-hop neighbors of the NHDP router are discovered. During this initial period, a potential flood of notifications is unnecessary since the events are expected. To avoid unnecessary notifications, a router should not originate expected notifications until a certain time interval has elapsed, which is to be predefined by the network manager.

5.4.3.2. Throttling Traps

The mechanism for throttling the notifications is the same as in [RFC4750] (i.e. the amount of transmitted notifications per time is bounded).

Appropriate values for the window time and upper bound are to be selected by the network manager and depend on the deployment of the MANET.

5.4.3.3. One Notification per Event

Similar to the according mechanism in [RFC4750], only one notification is sent per event.

6. Relationship to Other MIB Modules

This section specifies the relationship of the MIB modules contained in this document to other standards, particularly to standards containing other MIB modules. Definitions imported from other MIB modules and other MIB modules that SHOULD be implemented in conjunction with the MIB module contained within this document are identified in this section.

6.1. Relationship to the SNMPv2-MIB

The 'system' group in the SNMPv2-MIB [RFC3418] is defined as being mandatory for all systems, and the objects apply to the entity as a whole. The 'system' group provides identification of the management entity and certain other system-wide data. The NHDP-MIB does not duplicate those objects.

6.2. Relationship to Routing Protocol MIBs relying on the NHDP-MIB

[NHDP] allows routing protocols to rely on the neighborhood information that is discovered by means of HELLO message exchange. In order to allow for troubleshoot, fault isolate, and manage such routing protocols through a routing protocol MIB, it may be desired

to align the State Group tables of the NHDP-MIB and the routing protocol MIB. This is accomplished through the definition of two TEXTUAL-CONVENTIONS in the NHDP-MIB: the NeighborInterfaceId and the NeighborRouterId. These object types are used to develop indexes into common NHDP-MIB and routing protocol State Group tables. These objects are locally significant but should be locally common to the NHDP-MIB and the routing protocol MIB implemented on a common networked router. This will allow for improved cross referencing of information across the two MIBs.

6.3. Relationship to the REPORT-MIB

This document describes several Performance Management metrics for the management of NHDP network routers. However, not all of these metrics are explicitly defined solely within the context of this NHDP-MIB. Some of these metrics are obtained through joint interaction between this MIB and the REPORT-MIB [REPORT]. This NHDP-MIB defines the minimum necessary objects (often of type COUNTER) which form the underlying basis for more sophisticated Performance Management reporting available in conjunction with the REPORT-MIB. See Section 5.3 for a discussion of the performance metrics for NHDP management.

6.4. MIB modules required for IMPORTS

The following NHDP-MIB module IMPORTS objects from SNMPv2-SMI [RFC2578], SNMPv2-TC [RFC2579], SNMPv2-CONF [RFC2580], IF-MIB [RFC2863], INET-ADDRESS-MIB [RFC4001], and SMIng [RFC3781].

7. Definitions

This section contains the MIB module defined by the specification.

```
NHDP-MIB DEFINITIONS ::= BEGIN

IMPORTS

    Float32
                FROM SMIng  --[RFC3781]

    MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
    Counter32, Integer32, Unsigned32, mib-2
                FROM SNMPv2-SMI  --[RFC2578]

    TEXTUAL-CONVENTION, StorageType, TimeStamp,
    TruthValue, RowStatus
                FROM SNMPv2-TC  --[RFC2579]
```

```
    MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
                FROM SNMPv2-CONF  --[STD58]

    InetAddressType, InetAddress,
    InetAddressPrefixLength
                FROM INET-ADDRESS-MIB  --[RFC4001]

    InterfaceIndexOrZero
                FROM IF-MIB  --[RFC2863]
    ;

nhdpMIB MODULE-IDENTITY
       LAST-UPDATED "201007071000Z" -- July 07,2010
       ORGANIZATION "IETF MANET working group"
       CONTACT-INFO
       "WG E-Mail: manet@ietf.org

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                   USA
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                   http://www.ianchak.com/"
```

```
       DESCRIPTION
           "This NHDP-MIB module is applicable to routers
            implementing the Neighborhood Discovery Protocol
            defined in [RFC XXXX].

            Copyright (C) The IETF Trust (2009). This version
            of this MIB module is part of RFC xxxx; see the RFC
            itself for full legal notices."

       -- revision
       REVISION    "201007071000Z"   -- July 07, 2010
       DESCRIPTION
         "The seventh version of this MIB module,
          published as draft-ietf-manet-nhdp-mib-04.txt.
          Cleaned up and condensed the textual material
          in the earlier sections of this draft.  Checked
          consistency with NHDP draft, i.e.,
          draft-ietf-manet-nhdp-12.txt."
       REVISION    "201003081000Z"   -- March 08, 2010
       DESCRIPTION
         "The sixth version of this MIB module,
          published as draft-ietf-manet-nhdp-mib-03.txt.
          Added the local nhdpIfIndex to the
          nhdpIibLinkSetTable."
       REVISION    "200911091000Z"   -- November 09, 2009
       DESCRIPTION
         "The fifth version of this MIB module,
          published as draft-ietf-manet-nhdp-mib-02.txt.
          Cleaned up a few things and updated to newest
          revision of NHDP draft."
       REVISION    "200910211000Z"   -- October 21, 2009
       DESCRIPTION
         "The fourth version of this MIB module,
          published as draft-ietf-manet-nhdp-mib-01.txt.
          Added objects pertaining to the performance
          group."
       REVISION    "200905031500Z"   -- May 3, 2009
       DESCRIPTION
         "The third version of this MIB module,
          published as draft-ietf-manet-nhdp-mib-00.txt.
          No major revisions to this draft.  Mainly rev'd
          as a new working group document.  But also cleaned
          syntax errors, typos and other issues discovered
          with 'smilint'."
       REVISION    "200902151500Z"   -- February 15, 2009
       DESCRIPTION
         "The second version of this MIB module,
          published as draft-cole-manet-nhdp-mib-01.txt.  Major
```

```
          update adding objects for configuration and state."
       REVISION    "200804251500Z"   -- April 25, 2008
       DESCRIPTION
         "The original version of this MIB module,
          published as draft-cole-manet-nhdp-mib-00.txt."
       -- RFC-Editor assigns XXXX
       ::= { mib-2 998 }   -- to be assigned by IANA

--
-- Top-Level Components of this MIB
--
nhdpNotifications OBJECT IDENTIFIER ::= { nhdpMIB 0 }
nhdpObjects       OBJECT IDENTIFIER ::= { nhdpMIB 1 }
nhdpConformance   OBJECT IDENTIFIER ::= { nhdpMIB 2 }


--
-- Textual Conventions
--

NeighborIfIndex ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS       current
    DESCRIPTION
        "A locally arbitrary unique identifier associated with an
        NHDP neighbor interface.

        All objects of type NeighborIfIndex are assigned by the agent
        out of a common number space. In other words, NeighborIfIndex
        values assigned to entries in one table must not overlap with
        NeighborIfIndex values assigned to entries in another
        table.

        The NeighborIfIndex defines a discovered interface of a 1-hop
        or 2-hop neighbor of the local router.  The agent identifies a
        unique neighbor interface through the receipt of an address
        list advertised through an NHDP HELLO message.

        The value for each discovered neighbor interface must remain
        constant at least from one re-initialization of the entity's
        network management system to the next re-initialization, except
        that if an application is deleted and re-created.

        The specific value is meaningful only within a given SNMP
        entity. An NeighborIfIndex value must not be re-used until the
        next agent restart."
    SYNTAX       Unsigned32 (1..2147483647)
```

```
NeighborRouterId ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS       current
    DESCRIPTION
        "A locally arbitrary unique identifier associated with an
        NHDP discovered peer router.

        All objects of type NeighborRouterId are assigned by the agent
        out of a common number space.

        The NeighborRouterId defines a discovered NHDP peer of
        the local router. The agent identifies a
        unique neighbor interface through the receipt of an address
        list advertised through an NHDP HELLO message.

        The value for each discovered neighbor ID must remain
        constant at least from one re-initialization of the entity's
        network management system to the next re-initialization, except
        that if an application is deleted and re-created.

        The specific value is meaningful only within a given SNMP
        entity. An NeighborRouterId value must not be re-used until the
        next agent restart."
    SYNTAX       Unsigned32 (1..2147483647)



--
-- nhdpObjects
--

--    1) Configuration Objects Group
--    2) State Objects Group
--    3) Performance Objects Group



--
-- nhdpConfigurationObjGrp
--

-- Contains the NHDP objects which configure specific options
-- which determine the overall performance and operation of the
-- discovery protocol.


nhdpConfigurationObjGrp OBJECT IDENTIFIER ::= { nhdpObjects 1 }
```

```
   nhdpInterfaceTable  OBJECT-TYPE
      SYNTAX      SEQUENCE OF NhdpInterfaceEntry
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "nhdpInterfaceTable describes the
          configuration of the interfaces of this NHDP router.
          The ifIndex is from the interfaces group
          defined in the Interfaces Group MIB.

          nhdpIfStatus provides the functionality
          expected by the NHDP in the Local Interface Base (LIB)
          Local Interface Set Table.  Hence, the Local Interface
          Set Table will not be defined below.

          The objects in this table are persistent and when
          written the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "RFC 2863 - The Interfaces Group MIB, McCloghrie,
          K., and F. Kastenholtz, June 2000."
   ::= { nhdpConfigurationObjGrp 1 }

   nhdpInterfaceEntry OBJECT-TYPE
      SYNTAX      NhdpInterfaceEntry
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "nhdpInterfaceEntry describes one NHDP
          local interface configuration as indexed by
          its ifIndex as defined in the Standard MIB II
          Interface Table (RFC2863)."
      INDEX { nhdpIfIndex }
   ::= { nhdpInterfaceTable 1 }

   NhdpInterfaceEntry ::=
      SEQUENCE {
         nhdpIfIndex
            InterfaceIndexOrZero,
         nhdpIfStatus
            TruthValue,
         nhdpHelloInterval
            Unsigned32,
         nhdpHelloMinInterval
            Unsigned32,
         nhdpRefreshInterval
            Unsigned32,
         nhdpLHoldTime
```

```
            Unsigned32,
         nhdpHHoldTime
            Unsigned32,
         nhdpHystAcceptQuality
            Float32,
         nhdpHystRejectQuality
            Float32,
         nhdpInitialQuality
            Float32,
         nhdpInitialPending
            TruthValue,
         nhdpHpMaxJitter
            Unsigned32,
         nhdpHtMaxJitter
            Unsigned32,
         nhdpIfRowStatus
            RowStatus
         }

   nhdpIfIndex  OBJECT-TYPE
      SYNTAX      InterfaceIndexOrZero
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The ifIndex for this interface."
      ::= { nhdpInterfaceEntry 1 }

   nhdpIfStatus  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhpdIfStatus indicates whether this interface is
         a MANET interface. A value of true(1) indicates
         that the interface is a MANET interface.  A value of
         false(2) indicates that the interface is not a MANET
         interface. This corresponds to the I_manet parameter
         in the Local Interface Set, which is omitted in this MIB
         due to the redundancy with the nhdpInterfaceTable."
      DEFVAL { 2 }
   ::= { nhdpInterfaceEntry 2 }


   --
   -- Interface Parameters - Message Intervals
   --

   nhdpHelloInterval  OBJECT-TYPE
```

```
      SYNTAX      Unsigned32
      UNITS       "milliseconds"
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhpdHelloInterval corresponds to
         HELLO_INTERVAL of NHDP.

         The following constraint applies to this
         parameter:
             nhpdHelloInterval > = nhdpHelloMinInterval"
      REFERENCE
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      DEFVAL { 2000 }
   ::= { nhdpInterfaceEntry 3 }


   nhdpHelloMinInterval  OBJECT-TYPE
      SYNTAX      Unsigned32
      UNITS       "milliseconds"
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhpdHelloMinInterval corresponds to
         HELLO_MIN_INTERVAL of NHDP."
      REFERENCE
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      DEFVAL { 500 }
   ::= { nhdpInterfaceEntry 4 }


   nhdpRefreshInterval  OBJECT-TYPE
      SYNTAX      Unsigned32
      UNITS       "milliseconds"
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhpdRefreshInterval corresponds to
         REFRESH_INTERVAL of NHDP.

         The following constraint applies to this
         parameter:
             nhdpRefreshInterval > = nhdpHelloInterval"
      REFERENCE
```

```
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      DEFVAL { 2000 }
   ::= { nhdpInterfaceEntry 5 }

   --
   -- Interface Parameters - Information Validity times
   --

   nhdpLHoldTime  OBJECT-TYPE
      SYNTAX      Unsigned32
      UNITS       "milliseconds"
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhdpLHoldTime corresponds to
         L_HOLD_TIME of NHDP."
      REFERENCE
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      DEFVAL { 6000 }
   ::= { nhdpInterfaceEntry 6 }

   nhdpHHoldTime  OBJECT-TYPE
      SYNTAX      Unsigned32
      UNITS       "milliseconds"
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhdpHHoldTime corresponds to
         H_HOLD_TIME of NHDP."
      REFERENCE
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      DEFVAL { 6000 }
   ::= { nhdpInterfaceEntry 7 }

   --
   -- Interface Parameters - Link Quality
   -- (is optional and settings define operation)
   --

   nhdpHystAcceptQuality  OBJECT-TYPE
      SYNTAX      Float32
      MAX-ACCESS  read-write
```

```
      STATUS      current
      DESCRIPTION
         "nhdpHystAcceptQuality corresponds to
         HYST_ACCEPT of NHDP.

          The following constraint applies to this
          parameter:
              0 < = nhdpHystRejectQuality
                < = nhdpHystAcceptQuality < = 1.0"
      REFERENCE
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      -- DEFVAL { 1.0 }
   ::= { nhdpInterfaceEntry 8 }

   nhdpHystRejectQuality  OBJECT-TYPE
      SYNTAX      Float32
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhdpHystRejectQuality corresponds to
         HYST_REJECT of NHDP.

          The following constraint applies to this
          parameter:
              0 < = nhdpHystRejectQuality
                < = nhdpHystAcceptQuality < = 1.0"
      REFERENCE
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      -- DEFVAL { 0.0 }
   ::= { nhdpInterfaceEntry 9 }

   nhdpInitialQuality  OBJECT-TYPE
      SYNTAX      Float32
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhdpInitialQuality corresponds to
         INITIAL_QUALITY of NHDP.

          The following constraint applies to this
          parameter:
              0 < = nhdpInitialQuality < = 1.0"
      REFERENCE
         "The NHDP draft.
```

```
            Section 5 on Protocol Parameters and
            Constraints."
      -- DEFVAL { 1.0 }
   ::= { nhdpInterfaceEntry 10 }


   nhdpInitialPending  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpInitialPending corresponds to
         INITIAL_PENDING of NHDP."
      REFERENCE
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      DEFVAL { 2 }   -- i.e. false
   ::= { nhdpInterfaceEntry 11 }

   --
   -- Interface Parameters - Jitter
   --
   nhdpHpMaxJitter  OBJECT-TYPE
      SYNTAX      Unsigned32
      UNITS       "milliseconds"
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhdpHpMaxJitter corresponds to
         HP_MAXJITTER of NHDP."
      REFERENCE
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      DEFVAL { 500 }
   ::= { nhdpInterfaceEntry 12 }


   nhdpHtMaxJitter  OBJECT-TYPE
      SYNTAX      Unsigned32
      UNITS       "milliseconds"
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhdpHtMaxJitter corresponds to
         HT_MAXJITTER of NHDP."
```

```
      REFERENCE
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      DEFVAL { 500 }
   ::= { nhdpInterfaceEntry 13 }

   nhdpIfRowStatus  OBJECT-TYPE
      SYNTAX      RowStatus
      MAX-ACCESS  read-create
      STATUS      current
      DESCRIPTION
         "This object permits management of the table
         by facilitating actions such as row creation,
         construction, and destruction. The value of
         this object has no effect on whether other
         objects in this conceptual row can be
         modified."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpInterfaceEntry 14 }


   --
   -- Router Parameters - Information Validity Time
   --
   nhdpNHoldTime  OBJECT-TYPE
      SYNTAX      Unsigned32
      UNITS       "milliseconds"
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhdpNHoldTime corresponds to
         N_HOLD_TIME of NHDP.

          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      DEFVAL { 6000 }
   ::= { nhdpConfigurationObjGrp 2 }


   nhdpIHoldTime  OBJECT-TYPE
      SYNTAX      Unsigned32
```

```
      UNITS       "milliseconds"
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhdpIHoldTime corresponds to
         I_HOLD_TIME of NHDP.

          This object is persistent and when written
          the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "The NHDP draft.
          Section 5 on Protocol Parameters and
          Constraints."
      DEFVAL { 6000 }
   ::= { nhdpConfigurationObjGrp 3 }




--
-- nhdpStateObjGrp
--

-- Contains information describing the current state of the NHDP
-- process.

nhdpStateObjGrp    OBJECT IDENTIFIER ::= { nhdpObjects 2 }

   -- Two new constructs have been defined in this MIB for
   -- indexing into the following
   -- tables and indexing into other tables in other MIBs.
   -- The NeighborIfIndex defines a unique (to the local router)
   -- index referencing a discovered interface on another
   -- router within the MANET. The NeighborRouterId defines a
   -- unique (to the local router) index referencing a discovered
   -- router within the MANET.



   -- Note: This table is indexed by an IpAddr associated with
   -- NeighborIfIndex.  Multiple addresses can be associated
   -- with a given NeighborIfIndex.  Each NeighborIfIndex is
   -- associated with a NeighborRouterId.  Throughout this MIB,
   -- the NeighborIfIndex and the NeighborRouterId are used
   -- to define the set of IpAddrs related to the interface
   -- in discussion.
```

```
   nhdpDiscIfSetTable OBJECT-TYPE
      SYNTAX       SEQUENCE OF NhdpDiscIfSetEntry
       MAX-ACCESS   not-accessible
       STATUS       current
       DESCRIPTION
           "A router's set of discovered interfaces on
            neighboring routers."
       REFERENCE
          "The NHDP draft."
    ::= { nhdpStateObjGrp 1 }


    nhdpDiscIfSetEntry  OBJECT-TYPE
       SYNTAX      NhdpDiscIfSetEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "The entries include the nhdpDiscRouterId of
           the discovered router, the nhdpDiscIfIndex
           of the discovered interface and the
           current set of addresses associated
           with this neighbor interface.  The
           nhdpDiscIfIndex has to uniquely identify
           the remote interface address sets.  It
           does not need to be unique across the MANET.
           It must be unique within this router."
       REFERENCE
          "This NHDP-MIB draft."
       INDEX { nhdpDiscIfSetIpAddr }
    ::= { nhdpDiscIfSetTable 1 }

    NhdpDiscIfSetEntry ::=
       SEQUENCE {
          nhdpDiscIfSetRouterId
            NeighborRouterId,
          nhdpDiscIfSetIndex
            NeighborIfIndex,
          nhdpDiscIfSetIpAddrType
            InetAddressType,
          nhdpDiscIfSetIpAddr
            InetAddress,
          nhdpDiscIfSetIpAddrPrefixLen
            InetAddressPrefixLength
        }

   nhdpDiscIfSetRouterId  OBJECT-TYPE
      SYNTAX      NeighborRouterId
      MAX-ACCESS  read-only
```

```
      STATUS      current
      DESCRIPTION
         "The NHDP router ID (locally created)
          of a neigboring router.  Used for cross
          indexing into other NHDP tables and other
          MIBs."
      REFERENCE
         "This NHDP-MIB draft."
   ::= { nhdpDiscIfSetEntry 1 }

   nhdpDiscIfSetIndex  OBJECT-TYPE
      SYNTAX      NeighborIfIndex
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The NHDP interface index (locally created)
          of a neigbor's interface.  Used for cross
          indexing into other NHDP tables and other
          MIBs."
      REFERENCE
         "This NHDP-MIB draft."
   ::= { nhdpDiscIfSetEntry 2 }

   nhdpDiscIfSetIpAddrType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The type of the nhdpDiscIfSetIpAddr
          in the InetAddress MIB [RFC 4001]."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpDiscIfSetEntry 3 }

   nhdpDiscIfSetIpAddr  OBJECT-TYPE
      SYNTAX      InetAddress
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The nhdpDiscIfSetIpAddr is a
          recently used address of a neighbor
          of this router."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpDiscIfSetEntry 4 }

   nhdpDiscIfSetIpAddrPrefixLen  OBJECT-TYPE
      SYNTAX      InetAddressPrefixLength
```

```
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "Indicates the number of leading one bits that form the
          mask to be logical-ANDed with the destination address
          before being compared to the value in the
          nhdpDiscIfSetAddr field.  If the resulting
          address block is contained in a block in this
          table, then a match should be returned."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpDiscIfSetEntry 5 }



   -- An NHDP router's Local Information Base (LIB)

      -- Note: Local IF Set Table is not specified in this
      --       MIB because the table would be redundant with
      --       information in nhdpInterfaceTable.



      -- Removed Interface Addr Set Table
      -- Entry (foreach Addr): (IfAddrRemoved,
      --                        ExpirationTime)

    nhdpLibRemovedIfAddrSetTable OBJECT-TYPE
       SYNTAX       SEQUENCE OF NhdpLibRemovedIfAddrSetEntry
       MAX-ACCESS   not-accessible
       STATUS       current
       DESCRIPTION
          "A router's Removed Interface Address Set records
          network addresses which were recently used as local
          interface network addresses.  If a router's interface
          network addresses are immutable then the Removed
          Interface Address Set is always empty and MAY be omitted.
          It consists of Removed Interface Address Tuples, one
          per network address."
       REFERENCE
          "The NHDP draft."
    ::= { nhdpStateObjGrp 2 }

    nhdpLibRemovedIfAddrSetEntry  OBJECT-TYPE
       SYNTAX      NhdpLibRemovedIfAddrSetEntry
       MAX-ACCESS  not-accessible
       STATUS      current
```

```
       DESCRIPTION
          "A router's Removed Interface Address Set consists
          of Removed Interface Address Tuples, one per network
          address:

          (IR_local_iface_addr, IR_time)

          The association between these addrs and
          the router's Interface is found in the
          Standard MIB II's IP address table
          (RFC1213)."
       REFERENCE
          "The NHDP draft."
       INDEX { nhdpLibRemovedIfAddrSetIpAddr }
    ::= { nhdpLibRemovedIfAddrSetTable 1 }

    NhdpLibRemovedIfAddrSetEntry ::=
       SEQUENCE {
          nhdpLibRemovedIfAddrSetIpAddrType
            InetAddressType,
          nhdpLibRemovedIfAddrSetIpAddr
            InetAddress,
          nhdpLibRemovedIfAddrSetIpAddrPrefixLen
            InetAddressPrefixLength,
          nhdpLibRemovedIfAddrSetIfIndex
            InterfaceIndexOrZero,
          nhdpLibRemovedIfAddrSetIrTime
            TimeStamp
        }

   nhdpLibRemovedIfAddrSetIpAddrType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The type of the nhdpLibRemovedIfAddrSetIpAddr
          in the InetAddress MIB [RFC 4001]."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpLibRemovedIfAddrSetEntry 1 }

   nhdpLibRemovedIfAddrSetIpAddr  OBJECT-TYPE
      SYNTAX      InetAddress
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "nhdpLibRemovedIfAddrSetAddr is a
          recently used address of an interface of
```

```
          this router."
       REFERENCE
          "The NHDP draft."
    ::= { nhdpLibRemovedIfAddrSetEntry 2 }

    nhdpLibRemovedIfAddrSetIpAddrPrefixLen  OBJECT-TYPE
       SYNTAX      InetAddressPrefixLength
       MAX-ACCESS  read-only
       STATUS      current
       DESCRIPTION
          "Indicates the number of leading one bits that form the
           mask to be logical-ANDed with the address
           to determine the network address to which
           this interface is attached."
       REFERENCE
          "The NHDP draft."
    ::= { nhdpLibRemovedIfAddrSetEntry 3 }


      nhdpLibRemovedIfAddrSetIfIndex  OBJECT-TYPE
         SYNTAX      InterfaceIndexOrZero
         MAX-ACCESS  read-only
         STATUS      current
         DESCRIPTION
            "Specifies the local IfIndex from which this
             IP address was recently removed."
         REFERENCE
            "The NHDP draft."
      ::= { nhdpLibRemovedIfAddrSetEntry 4 }

      nhdpLibRemovedIfAddrSetIrTime  OBJECT-TYPE
         SYNTAX      TimeStamp
         MAX-ACCESS  read-only
         STATUS      current
         DESCRIPTION
            "Specifies when this Tuple expires and MUST be removed
             from this table."
         REFERENCE
            "The NHDP draft."
      ::= { nhdpLibRemovedIfAddrSetEntry 5 }




    -- Interface Information Base (IIB)

    --
```

```
   -- NHDP Interface Information Base (IIB)
   --

   --     IIB Link Set
   --         Entry (foreach 1-H neighbor): (NeighborIfAddrList,
   --                                        HeardTime,
   --                                        SymTime,
   --                                        Quality,
   --                                        Pending,
   --                                        Lost,
   --                                        ExpireTime)

   nhdpIibLinkSetTable OBJECT-TYPE
      SYNTAX       SEQUENCE OF NhdpIibLinkSetEntry
      MAX-ACCESS   not-accessible
      STATUS       current
      DESCRIPTION
          "A Link Set of an interface records links from
           other routers which are, or recently
           were, 1-hop neighbors."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpStateObjGrp 3 }

    nhdpIibLinkSetEntry  OBJECT-TYPE
       SYNTAX      NhdpIibLinkSetEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "A Link Set consists of Link Tuples, each
           representing a single link indexed by the
           local and remote interface pair:

           (L_neighbor_iface_addr_list, L_HEARD_time,
            L_SYM_time, L_quality, L_pending,
            L_lost, L_time).

            Note that L_quality is not included in the
            entries below, because updates may be
            required too frequently."
       REFERENCE
          "This NHDP-MIB draft."
       INDEX { nhdpIfIndex,
               nhdpIibLinkSet1HopIfIndex }
    ::= { nhdpIibLinkSetTable 1 }

    NhdpIibLinkSetEntry ::=
       SEQUENCE {
```

```
          nhdpIibLinkSet1HopIfIndex
            NeighborIfIndex,
          nhdpIibLinkSetIfIndex
            InterfaceIndexOrZero,
          nhdpIibLinkSetLHeardTime
            TimeStamp,
          nhdpIibLinkSetLSymTime
            TimeStamp,
          nhdpIibLinkSetLPending
            TruthValue,
          nhdpIibLinkSetLLost
            TruthValue,
          nhdpIibLinkSetLTime
            TimeStamp
        }

   nhdpIibLinkSet1HopIfIndex  OBJECT-TYPE
      SYNTAX      NeighborIfIndex
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSet1HopIfIndex is
          the value of the NeighborIfIndex (from
          nhdpDiscIfSetTable). This
          object is repeated here to support
          table walks to view the set of neighbors
          of this router."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIibLinkSetEntry 1 }

   nhdpIibLinkSetIfIndex  OBJECT-TYPE
      SYNTAX      InterfaceIndexOrZero
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetIfIndex is
          is the local router's interface
          index associated with the symmetric
          link to this entries neighbor
          interface.

          The set of IP addresses associated with
          this neighbor's interface is found in
          nhdpDiscIfSetTable."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIibLinkSetEntry 2 }
```

```
   nhdpIibLinkSetLHeardTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLHeardTime corresponds
         to L_HEARD_time of NHDP."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIibLinkSetEntry 3 }

   nhdpIibLinkSetLSymTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLSymTime corresponds
         to L_SYM_time of NHDP."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIibLinkSetEntry 4 }

   nhdpIibLinkSetLPending  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLPending corresponds
         to L_pending of NHDP"
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIibLinkSetEntry 5 }

   nhdpIibLinkSetLLost  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLLost corresponds
         to L_lost of NHDP"
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIibLinkSetEntry 6 }

   nhdpIibLinkSetLTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
```

```
      DESCRIPTION
         "nhdpIibLinkSetLTime specifies
          when this Tuple expires and MUST
          be removed."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIibLinkSetEntry 7 }




  --
  --     IIB 2-Hop Set
  --         Entry (foreach IF on a 2-H neighbor):
  --                                (1NeighIfAddrList,
  --                                 2NeighIfAddr,
  --                                 ExpireTime)
  --
    nhdpIib2HopSetTable OBJECT-TYPE
       SYNTAX       SEQUENCE OF NhdpIib2HopSetEntry
       MAX-ACCESS   not-accessible
       STATUS       current
       DESCRIPTION
           "A 2-Hop Set of an interface records network
           addresses of symmetric 2-hop neighbors, and
           the symmetric links to symmetric 1-hop neighbors
           through which these symmetric 2-hop neighbors
           can be reached.  It consists of 2-Hop Tuples,
           each representing a single network address of
           a symmetric 2-hop neighbor, and a single MANET
           interface of a symmetric 1-hop neighbor.

           (N2_neighbor_iface_addr_list,
            N2_2hop_addr, N2_time)."
       REFERENCE
          "The NHDP draft."
    ::= { nhdpStateObjGrp 4 }

    nhdpIib2HopSetEntry  OBJECT-TYPE
       SYNTAX      NhdpIib2HopSetEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "The entries include the 2-hop neighbor addresses,
           which act as the table index, and associated
           1-hop symmetric link address set, designated
           through nhdpDiscIfIndex, and an expiration time."
```

```
       REFERENCE
          "This NHDP-MIB draft."
       INDEX { nhdpIib2HopSetIpAddress }
    ::= { nhdpIib2HopSetTable 1 }

    NhdpIib2HopSetEntry ::=
       SEQUENCE {
          nhdpIib2HopSetIpAddressType
            InetAddressType,
          nhdpIib2HopSetIpAddress
            InetAddress,
          nhdpIib2HopSet1HopIfIndex
            NeighborIfIndex,
          nhdpIib2HopSetN2Time
            TimeStamp
         }


   nhdpIib2HopSetIpAddressType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The type of the nhdpIib2HopSetIpAddress
          in the InetAddress MIB [RFC 4001]."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIib2HopSetEntry 1 }

   nhdpIib2HopSetIpAddress  OBJECT-TYPE
      SYNTAX      InetAddress
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIib2HopSetIpAddr corresponds
         to N2_2hop_addr of NHDP."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIib2HopSetEntry 2 }

   nhdpIib2HopSet1HopIfIndex  OBJECT-TYPE
      SYNTAX      NeighborIfIndex
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIib2HopSet1HopIfIndex is
          NeighborIfIndex of the one hop
          neighbor which communicated the ipAddress
```

```
          of the 2-hop neighbor in this row entry."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIib2HopSetEntry 3 }

   nhdpIib2HopSetN2Time  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIib2HopSetN2Time specifies
          when this column entry expires and
          MUST be removed."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIib2HopSetEntry 4 }




   --
   -- Neighbor Information Base (NIB)
   --
   -- Each router maintains a Neighbor Information Base
   -- that records information about addresses of
   -- current and recently symmetric 1-hop neighbors.


   --     NIB Neighbor Set
   --         Entry (foreach 1-H Neighbor):
   --              (AllIfAddrListOfIhNeighbor,
   --               SymmetricIndicator)
   --     The NIB Neighbor Set Table is small because
   --     most of the corresponding information is found
   --     in the nhdpDiscoveredIfTable above.
   --
   nhdpNibNeighborSetTable OBJECT-TYPE
      SYNTAX       SEQUENCE OF NhdpNibNeighborSetEntry
      MAX-ACCESS   not-accessible
      STATUS       current
      DESCRIPTION
          "A router's Neighbor Set records all network
          addresses of each 1-hop neighbor."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpStateObjGrp 5 }

   nhdpNibNeighborSetEntry  OBJECT-TYPE
```

```
      SYNTAX      NhdpNibNeighborSetEntry
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
          "A router's Neighbor Set consists
           of Neighbor Tuples, each representing
           a single 1-hop neighbor:

           (N_neighbor_addr_list,
            N_symmetric)"
      REFERENCE
         "This NHDP-MIB draft."
      INDEX { nhdpNibNeighborSetRouterId }
   ::= { nhdpNibNeighborSetTable 1 }

    NhdpNibNeighborSetEntry ::=
       SEQUENCE {
          nhdpNibNeighborSetRouterId
            NeighborRouterId,
          nhdpNibNeighborSetNSymmetric
            TruthValue
        }

   nhdpNibNeighborSetRouterId  OBJECT-TYPE
      SYNTAX      NeighborRouterId
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "nhdpNibNeighborSetRouterId is
          the NeighborRouterId of a one hop
          neighbor to this router.  It must also
          exist in nhdpDiscIfSetTable,
          allowing the manager to determine
          the set of IP addresses associated
          with NeighborRouterId in this row."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpNibNeighborSetEntry 1 }

   nhdpNibNeighborSetNSymmetric  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpNibNeighborNSymmetric corresponds
         to N_symmetric of NHDP."
      REFERENCE
         "The NHDP draft."
```

```
   ::= { nhdpNibNeighborSetEntry 2 }



  --     Lost Neighbor Set
  --         Entry ( foreach IF foreach 1-H Neighbor): (IfAddr,
  --                                                    ExpireTime)
  --
    nhdpNibLostNeighborSetTable OBJECT-TYPE
       SYNTAX       SEQUENCE OF NhdpNibLostNeighborSetEntry
       MAX-ACCESS   not-accessible
       STATUS       current
       DESCRIPTION
           "A router's Lost Neighbor Set records network
           addresses of routers which recently were
           symmetric 1-hop neighbors, but which are now
           advertised as lost."
       REFERENCE
          "The NHDP draft."
    ::= { nhdpStateObjGrp 6 }

    nhdpNibLostNeighborSetEntry  OBJECT-TYPE
       SYNTAX      NhdpNibLostNeighborSetEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "A router's Lost Neighbor Set consists of
          Lost Neighbor Tuples, each representing a
          single such network address:

          (NL_neighbor_addr, NL_time)"
       REFERENCE
          "This NHDP-MIB draft."
       INDEX { nhdpNibLostNeighborSetRouterId }
    ::= { nhdpNibLostNeighborSetTable 1 }

    NhdpNibLostNeighborSetEntry ::=
       SEQUENCE {
          nhdpNibLostNeighborSetRouterId
            NeighborRouterId,
          nhdpNibLostNeighborSetNLTime
            TimeStamp
        }

   nhdpNibLostNeighborSetRouterId  OBJECT-TYPE
      SYNTAX      NeighborRouterId
      MAX-ACCESS  not-accessible
      STATUS      current
```

```
      DESCRIPTION
         "nhdpNibLostNeighborSetRouterId is
          the NeighborRouterId of a one hop
          neighbor to this router which was
          recently lost.  It must also
          exist in nhdpDiscIfSetTable,
          allowing the manager to determine
          the set of IP addresses associated
          with NeighborRouterId in this row."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpNibLostNeighborSetEntry 1 }

   nhdpNibLostNeighborSetNLTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpNibLostNeighborSetNLTime
          specifies when this Tuple expires
          and MUST be removed."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpNibLostNeighborSetEntry 2 }



--
-- nhdpPerformanceObjGrp
--

-- Contains objects which help to characterize the performance of
-- the NHDP process, typically counters.
--
nhdpPerformanceObjGrp OBJECT IDENTIFIER ::= { nhdpObjects 3 }

  --
  -- Objects per local interface
  --

  nhdpInterfacePerfTable  OBJECT-TYPE
      SYNTAX      SEQUENCE OF NhdpInterfacePerfEntry
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "This table summarizes performance objects that are
          measured per local NHDP interface."
      REFERENCE
```

```
         "The NHDP draft."
   ::= { nhdpPerformanceObjGrp 1 }

   nhdpInterfacePerfEntry OBJECT-TYPE
      SYNTAX      NhdpInterfacePerfEntry
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "A single entry contains performance counters for
          a local NHDP interface."
      INDEX { nhdpIfIndex }
   ::= { nhdpInterfacePerfTable 1 }

   NhdpInterfacePerfEntry ::=
      SEQUENCE {
         nhdpIfPerfIndex
            InterfaceIndexOrZero,
         nhdpIfHelloMessageXmits
            Counter32,
         nhdpIfHelloMessageRecvd
            Counter32,
         nhdpIfHelloMessageXmitAccumulatedSize
            Counter32,
         nhdpIfHelloMessageRecvdAccumulatedSize
            Counter32,
         nhdpIfHelloMessageTriggeredXmits
            Counter32,
         nhdpIfHelloMessagePeriodicXmits
            Counter32,
         nhdpIfHelloMessageXmitAccumulatedSymmetricNeighborCount
            Counter32,
         nhdpIfHelloMessageXmitAccumulatedHeardNeighborCount
            Counter32,
         nhdpIfHelloMessageXmitAccumulatedLostNeighborCount
            Counter32
         }

   nhdpIfPerfIndex  OBJECT-TYPE
      SYNTAX      InterfaceIndexOrZero
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The ID of an interface.  Used for cross
          indexing into other NHDP tables and other
          MIBs."
   ::= { nhdpInterfacePerfEntry 1 }

   nhdpIfHelloMessageXmits  OBJECT-TYPE
```

```
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter is incremented each time a HELLO
         message has been transmitted on that interface."
   ::= { nhdpInterfacePerfEntry 2 }

   nhdpIfHelloMessageRecvd  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter is incremented each time a
         HELLO message has been received on that interface."
   ::= { nhdpInterfacePerfEntry 3 }

   nhdpIfHelloMessageXmitAccumulatedSize  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter is incremented by the number of octets in
         a HELLO message each time a
         HELLO message has been sent."
   ::= { nhdpInterfacePerfEntry 4 }

   nhdpIfHelloMessageRecvdAccumulatedSize  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter is incremented by the number of octets in
         a HELLO message each time a
         HELLO message has been received."
   ::= { nhdpInterfacePerfEntry 5 }

   nhdpIfHelloMessageTriggeredXmits  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter is incremented each time a triggered
         HELLO message has been sent."
   ::= { nhdpInterfacePerfEntry 6 }

   nhdpIfHelloMessagePeriodicXmits  OBJECT-TYPE
      SYNTAX      Counter32
```

```
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter is incremented each time a periodic
         HELLO message has been sent."
   ::= { nhdpInterfacePerfEntry 7 }

   nhdpIfHelloMessageXmitAccumulatedSymmetricNeighborCount  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter is incremented by the number of advertised
         symmetric neighbors in a HELLO each time a HELLO
         message has been sent."
   ::= { nhdpInterfacePerfEntry 8 }

   nhdpIfHelloMessageXmitAccumulatedHeardNeighborCount  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter is incremented by the number of advertised
         heard neighbors in a HELLO each time a HELLO
         message has been sent."
   ::= { nhdpInterfacePerfEntry 9 }

   nhdpIfHelloMessageXmitAccumulatedLostNeighborCount  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "A counter is incremented by the number of advertised
         lost neighbors in a HELLO each time a HELLO
         message has been sent."
   ::= { nhdpInterfacePerfEntry 10 }



  --
  -- Objects per discovered neighbor interface
  --
  nhdpDiscIfSetPerfTable OBJECT-TYPE
       SYNTAX       SEQUENCE OF NhdpDiscIfSetPerfEntry
       MAX-ACCESS   not-accessible
       STATUS       current
       DESCRIPTION
          "A router's set of performance properties for
```

```
          each discovered interface of a neighbor."
       REFERENCE
          "The NHDP draft."
   ::= { nhdpPerformanceObjGrp 2 }


   nhdpDiscIfSetPerfEntry  OBJECT-TYPE
       SYNTAX      NhdpDiscIfSetPerfEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "There is an entry for each discovered
          interface of a neighbor."
       REFERENCE
          "This NHDP-MIB draft."
       INDEX { nhdpDiscIfSetPerfIndex }
   ::= { nhdpDiscIfSetPerfTable 1 }

    NhdpDiscIfSetPerfEntry ::=
       SEQUENCE {
          nhdpDiscIfSetPerfIndex
            NeighborIfIndex,
          nhdpDiscIfRecvdPackets
            Counter32,
          nhdpDiscIfExpectedPackets
            Counter32
         }

   nhdpDiscIfSetPerfIndex  OBJECT-TYPE
      SYNTAX      NeighborIfIndex
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The NHDP interface ID (locally created)
          of a neigboring router.  Used for cross
          indexing into other NHDP tables and other
          MIBs."
      REFERENCE
         "This NHDP-MIB draft."
   ::= { nhdpDiscIfSetPerfEntry 1 }

   nhdpDiscIfRecvdPackets  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This counter increments each
         time this router receives a packet from that interface
```

```
         of the neighbor."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpDiscIfSetPerfEntry 2 }

   nhdpDiscIfExpectedPackets  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This counter increments by the number
          of missed packets from this neighbor based
          on the packet sequence number each time this
          router receives a packet from that interface
          of the neighbor."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpDiscIfSetPerfEntry 3 }



   --
   -- Objects concerning the neighbor set
   --
   nhdpNibNeighborSetChanges  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This counter increments each time the Neighbor Set changes.
         A change occurs whenever a new Neighbor Tuple has been
         added, a Neighbor Tuple has been removed or any entry of
         a Neighbor Tuple has been modified."
   ::= { nhdpPerformanceObjGrp 3 }



   --
   -- Objects per discovered neighbor
   --
   nhdpDiscNeighborSetPerfTable OBJECT-TYPE
      SYNTAX       SEQUENCE OF NhdpDiscNeighborSetPerfEntry
       MAX-ACCESS   not-accessible
       STATUS       current
       DESCRIPTION
          "A router's set of discovered neighbors and
           their properties."
       REFERENCE
```

```
          "The NHDP draft."
   ::= { nhdpPerformanceObjGrp 4 }

   nhdpDiscNeighborSetPerfEntry  OBJECT-TYPE
       SYNTAX      NhdpDiscNeighborSetPerfEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "The entries include the nhdpDiscRouterId of
           the discovered router, as well as performance
           objects related to changes of the Neighbor
           Set."
       REFERENCE
          "This NHDP-MIB draft."
       INDEX { nhdpDiscNeighborSetRouterId }
   ::= { nhdpDiscNeighborSetPerfTable 1 }

    NhdpDiscNeighborSetPerfEntry ::=
       SEQUENCE {
          nhdpDiscNeighborSetRouterId
            NeighborRouterId,
          nhdpDiscNeighborNibNeighborSetChanges
            Counter32,
          nhdpDiscNeighborNibNeighborSetUpTime
            Unsigned32,
          nhdpDiscNeighborNibNeighborSetReachableLinkChanges
            Counter32
         }

   nhdpDiscNeighborSetRouterId  OBJECT-TYPE
      SYNTAX      NeighborRouterId
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The NHDP router ID (locally created)
          of a neigboring router.  Used for cross
          indexing into other NHDP tables and other
          MIBs."
      REFERENCE
         "This NHDP-MIB draft."
   ::= { nhdpDiscNeighborSetPerfEntry 1 }

   nhdpDiscNeighborNibNeighborSetChanges  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This counter increments each time the neighbor becomes
```

```
          onlink or offlink.  A neighbor is said to become
          'onlink' if a new nhdpNibNeighborSetEntry is created
          for a particular nhdpNibNeighborSetRouterId. It becomes
          'offlink' if the entry for that neighbor has been deleted."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpDiscNeighborSetPerfEntry 2 }


   nhdpDiscNeighborNibNeighborSetUpTime  OBJECT-TYPE
      SYNTAX      Unsigned32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This object returns the time in milliseconds since
         the neighbor becomes onlink or offlink.  A neighbor is
         said to become 'onlink' if a new nhdpNibNeighborSetEntry
         is created for a particular nhdpNibNeighborSetRouterId.
         It becomes 'offlink' if the entry for that neighbor
         has been deleted.

         Positive values indicate that the neighbor is currently
         'onlink' and indicates the duration of the current 'onlink'
         period.  Negative values indicate that the neighbor is
         currently 'offlink' and the magnitude indicates the
         duration of the current 'offlink' period."
      REFERENCE
         "This NHDP-MIB draft."
   ::= { nhdpDiscNeighborSetPerfEntry 3 }

   nhdpDiscNeighborNibNeighborSetReachableLinkChanges  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This counter increments each
         time the neighbor changes the interface over which it is
         reachable.  That means that the corresponding Link Tuple of the
         given link moves from the Link Set of one interface to another
         interface."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpDiscNeighborSetPerfEntry 4 }




   --
```

```
   -- Objects per discovered 2-hop neighbor
   --
      nhdpIib2HopSetPerfTable OBJECT-TYPE
       SYNTAX       SEQUENCE OF NhdpIib2HopSetPerfEntry
       MAX-ACCESS   not-accessible
       STATUS       current
       DESCRIPTION
           "This table contains performance objects per
           discovered 2-hop neighbor."
       REFERENCE
          "The NHDP draft."
    ::= { nhdpPerformanceObjGrp 5 }

    nhdpIib2HopSetPerfEntry  OBJECT-TYPE
       SYNTAX      NhdpIib2HopSetPerfEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "The entries contain performance objects per
           discovered 2-hop neighbor."
       REFERENCE
          "This NHDP-MIB draft."
       INDEX { nhdpIib2HopSetIpAddress }
    ::= { nhdpIib2HopSetPerfTable 1 }

    NhdpIib2HopSetPerfEntry ::=
       SEQUENCE {
          nhdpIib2HopSetPerfIpAddress
            InetAddress,
          nhdpIib2HopSetPerfChanges
            Counter32,
          nhdpIib2HopSetPerfUpTime
            Unsigned32
        }

   nhdpIib2HopSetPerfIpAddress  OBJECT-TYPE
      SYNTAX      InetAddress
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The nhdpIib2HopSetIpAddr is an
          address of an interface of a symmetric
          2-hop neighbor which has a symmetric
          link (using any MANET interface) to
          the indicated symmetric 1-hop neighbor."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIib2HopSetPerfEntry 1 }
```

```
   nhdpIib2HopSetPerfChanges  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This counter increments each
         time this 2-hop neighbor changes its
         N2_neighbor_iface_addr_list in the
         nhdpIib2HopSetTable."
      REFERENCE
         "The NHDP draft."
   ::= { nhdpIib2HopSetPerfEntry 2 }


   nhdpIib2HopSetPerfUpTime  OBJECT-TYPE
      SYNTAX      Unsigned32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This object returns the time in milliseconds since
         the 2-Hop Tuple
         corresponding to the given 2-hop neighbor IP address exists
         in the nhdpIib2HopSetTable."
      REFERENCE
         "This NHDP-MIB draft."
   ::= { nhdpIib2HopSetPerfEntry 3 }




--
-- nhdpNotifications
--

nhdpNotificationsControl OBJECT IDENTIFIER ::= { nhdpNotifications 1 }
nhdpNotificationsObjects OBJECT IDENTIFIER ::= { nhdpNotifications 2 }
nhdpNotificationsStates  OBJECT IDENTIFIER ::= { nhdpNotifications 3 }


   -- nhdpNotificationsControl

   nhdpSetNotification OBJECT-TYPE
          SYNTAX       OCTET STRING (SIZE(4))
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A 4-octet string serving as a bit map for
```

```
            the notification events defined by the NHDP
            notifications. This object is used to enable
            and disable specific NHDP notifications where
            a 1 in the bit field represents enabled. The
            right-most bit (leastsignificant) represents
            notification 0.

            This object is persistent and when written
            the entity SHOULD save the change to
            non-volatile storage.
            "
          ::= { nhdpNotificationsControl 1 }

   nhdpPacketSrc OBJECT-TYPE
          SYNTAX       InetAddress
          MAX-ACCESS   read-only
          STATUS       current
          DESCRIPTION
             "The IP address of an inbound packet that
             cannot be identified by a neighbor instance. When
             the last value of a notification using this object is
             needed, but no notifications of that type have been sent,
             this value pertaining to this object should
             be returned as 0.0.0.0 or :: respectively."
          ::= { nhdpNotificationsControl 2 }


   -- nhdpNotificationsObjects


   nhdpNbrStateChange NOTIFICATION-TYPE
          OBJECTS { nhdpDiscIfSetRouterId, -- The originator of
                                           --     the notification.
                    nhdpNbrState           -- The new state
                  }
          STATUS       current
          DESCRIPTION
             "nhdpNbrStateChange is a notification sent when a
             significant number of neighbors change their status
             (i.e. down, asymmetric, or symmetric) in a short
             time. The network administrator should select
             appropriate values for 'significant number of
             neighbors' and 'short time'."
          ::= { nhdpNotificationsObjects 1 }

    nhdp2hopNbrStateChange NOTIFICATION-TYPE
          OBJECTS { nhdpIib2HopSetIpAddress, -- The originator
                                             -- of the notification
```

```
            nhdp2hopNbrState  -- The new state
            }
         STATUS       current
         DESCRIPTION
            "nhdp2hopNbrStateChange is a notification sent
            when a significant number of 2-hop neighbors
            change their status (i.e. up or down) in a short
            time. The network administrator should select
            appropriate values for 'significant number of
            neighbors' and 'short time'."
         ::= { nhdpNotificationsObjects 2 }

   nhdpIfRxBadPacket NOTIFICATION-TYPE
         OBJECTS { nhdpDiscIfSetRouterId, -- The originator of
                                          -- the notification
            nhdpDiscIfSetIndex,  -- The interface on which the
                                 -- packet has been received
            nhdpPacketSrc  -- The source IP address of the packet
            }
         STATUS       current
         DESCRIPTION
            "nhdpIfRxBadPacket is a notification sent when a
            significant number of incoming packets have not
            been succesfully parsed in a short time. The
            etwork administrator should select appropriate
            values for 'significant number of neighbors'
            and 'short time'."
         ::= { nhdpNotificationsObjects 3 }


   nhdpIfStateChange NOTIFICATION-TYPE
         OBJECTS { nhdpIfIndex, -- The local interface
            nhdpIfState   -- The new state
            }
         STATUS       current
         DESCRIPTION
            "nhdpIfStateChange is a notification sent when
            the status of an interface of this router has
            changed (i.e. an IP address has been added or
            removed to the interface, or the interface has
            changed its status from up to down or vice versa)."
         ::= { nhdpNotificationsObjects 4 }



    -- nhdpNotificationStates
```

```
    nhdpNbrState OBJECT-TYPE
       SYNTAX       INTEGER {
                       down (0),
                       asymmetric (1),
                       symmetric(2)
                       }
       MAX-ACCESS   read-only
       STATUS       current
       DESCRIPTION
          "NHDP neighbor states."
       DEFVAL { down }
       ::= { nhdpNotificationsStates 1 }

   nhdp2hopNbrState OBJECT-TYPE
       SYNTAX       INTEGER {
                       down (0),
                       up (1)
                       }
       MAX-ACCESS   read-only
       STATUS       current
       DESCRIPTION
          "NHDP 2hop neighbor states."
       DEFVAL { down }
       ::= { nhdpNotificationsStates 2 }

   nhdpIfState OBJECT-TYPE
       SYNTAX       INTEGER {
                       down (0),
                       up (1),
                       addresschange(2) -- If a new address has been
                                        -- added or an address has
                                        -- been removed
                       }
       MAX-ACCESS   read-only
       STATUS       current
       DESCRIPTION
          "NHDP interface states."
       DEFVAL { down }
       ::= { nhdpNotificationsStates 3 }




--
-- nhdpConformance information
--

nhdpCompliances       OBJECT IDENTIFIER ::= { nhdpConformance 1 }
```

```
nhdpMIBGroups         OBJECT IDENTIFIER ::= { nhdpConformance 2 }


-- Compliance Statements
nhdpBasicCompliance MODULE-COMPLIANCE
  STATUS current
  DESCRIPTION
    "The basic implementation requirements for
     managed network entities that implement
     NHDP."
  MODULE -- this module

  MANDATORY-GROUPS { nhdpConfigurationGroup }


  ::= { nhdpCompliances 1 }

nhdpFullCompliance MODULE-COMPLIANCE
  STATUS current
  DESCRIPTION
    "The full implementation requirements for
     managed network entities that implement
     NHDP."
  MODULE -- this module

  MANDATORY-GROUPS { nhdpConfigurationGroup,
                     nhdpStateGroup,
                     nhdpNotificationGroup,
                     nhdpPerformanceGroup }

  ::= { nhdpCompliances 2 }


--
-- Units of Conformance
--

  nhdpConfigurationGroup OBJECT-GROUP
     OBJECTS {
               nhdpIfStatus,
               nhdpHelloInterval,
               nhdpHelloMinInterval,
               nhdpRefreshInterval,
               nhdpLHoldTime,
               nhdpHHoldTime,
               nhdpHystAcceptQuality,
               nhdpHystRejectQuality,
               nhdpInitialQuality,
```

```
              nhdpInitialPending,
              nhdpHpMaxJitter,
              nhdpHtMaxJitter,
              nhdpNHoldTime,
              nhdpIHoldTime,
              nhdpIfRowStatus
             }
     STATUS  current
     DESCRIPTION
        "Set of NHDP configuration objects implemented
         in this module."
   ::= { nhdpMIBGroups 2 }

  nhdpStateGroup OBJECT-GROUP
     OBJECTS {
              nhdpDiscIfSetRouterId,
              nhdpDiscIfSetIndex,
              nhdpDiscIfSetIpAddrType,
              nhdpDiscIfSetIpAddrPrefixLen,
              nhdpLibRemovedIfAddrSetIpAddrType,
              nhdpLibRemovedIfAddrSetIpAddrPrefixLen,
              nhdpLibRemovedIfAddrSetIfIndex,
              nhdpLibRemovedIfAddrSetIrTime,
              nhdpIibLinkSetIfIndex,
              nhdpIibLinkSetLHeardTime,
              nhdpIibLinkSetLSymTime,
              nhdpIibLinkSetLPending,
              nhdpIibLinkSetLLost,
              nhdpIibLinkSetLTime,
              nhdpIib2HopSetIpAddressType,
              nhdpIib2HopSet1HopIfIndex,
              nhdpIib2HopSetN2Time,
              nhdpNibNeighborSetNSymmetric,
              nhdpNibLostNeighborSetNLTime
             }
     STATUS  current
     DESCRIPTION
        "Set of NHDP state objects implemented
         in this module."
   ::= { nhdpMIBGroups 3 }

  nhdpPerformanceGroup OBJECT-GROUP
     OBJECTS {
              nhdpIfHelloMessageXmits,
              nhdpIfHelloMessageRecvd,
              nhdpIfHelloMessageXmitAccumulatedSize,
              nhdpIfHelloMessageRecvdAccumulatedSize,
              nhdpIfHelloMessageTriggeredXmits,
```

```
              nhdpIfHelloMessagePeriodicXmits,
              nhdpIfHelloMessageXmitAccumulatedSymmetricNeighborCount,
              nhdpIfHelloMessageXmitAccumulatedHeardNeighborCount,
              nhdpIfHelloMessageXmitAccumulatedLostNeighborCount,
              nhdpDiscIfRecvdPackets,
              nhdpDiscIfExpectedPackets,
              nhdpNibNeighborSetChanges,
              nhdpDiscNeighborNibNeighborSetChanges,
              nhdpDiscNeighborNibNeighborSetUpTime,
              nhdpDiscNeighborNibNeighborSetReachableLinkChanges,
              nhdpIib2HopSetPerfChanges,
              nhdpIib2HopSetPerfUpTime
            }
      STATUS  current
      DESCRIPTION
         "Set of NHDP performance objects implemented
          in this module."
   ::= { nhdpMIBGroups 4 }

  nhdpNotificationGroup NOTIFICATION-GROUP
     NOTIFICATIONS {
             nhdpNbrStateChange,
             nhdp2hopNbrStateChange,
             nhdpIfRxBadPacket,
             nhdpIfStateChange
             }
      STATUS  current
      DESCRIPTION
         "Set of NHDP notification objects implemented
          in this module."
   ::= { nhdpMIBGroups 5 }


END
```

8. Security Considerations

This MIB defines objects for the configuration, monitoring and notification of the Neighborhood Discovery Protocol [NHDP]. NHDP allows routers to acquire topological information up to two hops away by virtue of exchanging HELLO messages. The information acquired by NHDP may be used by routing protocols. The neighborhood information, exchanged between routers using NHDP, serves these routing protocols as a baseline for calculating paths to all destinations in the MANET, relay set selection for network-wide transmissions etc.

There are a number of management objects defined in this MIB module with 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. These are the tables and objects and their sensitivity/vulnerability:

- nhdpIfStatus - this writable object turns on or off the NHDP process for the specified interface. If disabled, higher level protocol functions, e.g., routing, would fail causing network-wide disruptions.

- nhdpHelloInterval, nhdpHelloMinInterval, and nhdpRefreshInterval - these writable objects control the rate at which HELLO messages are sent on a wireless interface. If set at too high a rate, this could represent a form of DOS attack by overloading interface resources.

- nhdpHystAcceptQuality, nhdpHystRejectQuality, nhdpInitialQuality, nhdpInitialPending - these writable objects affect the perceived quality of the HNDP links and hence the overall stability of the network. If improperly set, these settings could result in network-wide disruptions.

- nhdpInterfaceTable - this table contains writable objects that affect the overall performance and stability of the NHDP process. Failure of the NHDP process would result in network-wide failure. Particularly sensitive objects from this table are discussed in the previous list items. This is the only table in the NHDP-MIB with writable objects.

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:

- nhdpDiscIfSetTable - The contains information on discovered neighbors,specifically their IP address in the nhdpDiscIfSetIpAddr object. This information provides an adversary broad information on the members of the MANET, located within this single table. This information can be use to expedite attacks on the other members of the MANET without having to go through a laborious discovery process on their own. This object is the index into the table, and has a MAX-ACCESS of 'not-accessible'. However, this information can be exposed using SNMP operations.

MANET technology is often deployed to support communications of emergency services or military tactical applications. In these applications, it is imperative to maintain the proper operation of the communications network and to protect sensitive information related to its operation. Therefore, when implementing these capabilities, the full use of SNMPv3 cryptographic mechanisms for authentication and privacy is RECOMMENDED.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPSec), 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

This memo does not include any request to IANA.

10. Contributors

This MIB document uses the template authored by D. Harrington which is based on contributions from the MIB Doctors, especially Juergen Schoenwaelder, Dave Perkins, C.M.Heard and Randy Presuhn.

11. References

11.1. Normative References

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[NHDP] Clausen, T., Dearlove, C., and J. Dean, "Mobile Ad Hoc Network (MANET) Neighborhood Discovery Protocol (NHDP)", draft-ietf-manet-nhdp-12 (work in progress), March 2010.

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

11.2. Informative References

[REPORT] Cole, R., Macker, J., and A. Morton, "Definition of Managed Objects for Performance Reporting", draft-ietf-manet-report-mib-00 (work in progress), July 2010.

[RFC4750] Joyal, D., Galecki, P., Giacalone, S., Coltun, R., and F. Baker, "OSPF Version 2 Management Information Base", RFC 4750, December 2006.

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

[RFC3781] Strauss, F. and J. Schoenwaelder, "Next Generation Structure of Management Information (SMIng) Mappings to the Simple Network Management Protocol (SNMP)", RFC 3781, May 2004.

Appendix A. Change Log

Here we list the changes made to the various drafts of this MIB.

We list here the changes made on the draft-ietf-manet-nhdp-mib-03

draft to generate draft-ietf-manet-nhdp-mib-04.

1. Cleaned up and condensed text in the front material to this draft. Specifically, shortened the Configuration and State Group sections, defering to the MIB as definitive. Left the Performance Group discussion primarily intact due to its discussion of base and derived performance objects and statistics and their value to management and operations of NHDP.

2. Added information identifying objects requiring non-volatile storage within the DESCRIPTION clause of the objects within the NHDP-MIB.

3. Updated to to NHDP draft version 12.

4. Changed type of several objects in the MIB (for timers, and floating point values).

5. Removed link-quality object for performance reasons.

6. Fixed many small editorial issues.

7. Removed references to SMF- and OLSRv2-MIB.

We list here the changes made on the draft-ietf-manet-nhdp-mib-02 draft to generate the draft-ietf-manet-nhdp-mib-03 draft.

1. Cleaned up text in the Performance Group section defining the base versus the derived (from the REPORT-MIB) objects.

2. Added the local nhdpIfIndex to the nhdpIibLinkSetTable. A duplex of interface indecies is required to define a wireless link.

3. Added text to the Security Considerations section.

4. Added notifications.

We list here the changes made on the draft-ietf-manet-nhdp-mib-01 draft to generate the draft-ietf-manet-nhdp-mib-02 draft.

1. Cleaned up several things (e.g. moved N_HOLD_TIME from interface parameter to router paramter)

2. Updated to NHDP draft version 11

We list here the changes made on the draft-ietf-manet-nhdp-mib-00 draft to generate the draft-ietf-manet-nhdp-mib-01 draft.

1. Made and extensive addition in the area of performance monitoring. Added text in the front material, added a PerformanceGroup to the MIB and added the PerformanceGroup to the Conformance Sections.

We list here the changes made on the draft-cole-manet-nhdp-mib-01 draft to generate the draft-ietf-manet-nhdp-mib-00 draft.

1. Cleanup up numerous typos and add material to the Conformance section in order to pass the MIB checker, i.e., smilint.

We list here the changes made on the draft-cole-manet-nhdp-mib-00 draft to generate the draft-cole-manet-nhdp-mib-01 draft.

1. Defined the NeighborIfIndex and the NeighborRouterId textual conventions. These identify a remote neighbor IfIndex and a remote neighbor router and are used as indexes into NHDP state tables. These constructs were necessary in order to associate address lists with specific remote interfaces as required by the NHDP protocol specification.

2. Developed the nhdpInterfaceTable as part of the configuration group.

3. Developed the nhdpDiscIfSetTable as a means to associate address lists with remotely discovered neighbor interfaces.

4. Added tables defining the router's NHDP Local Information Base (LIB) as specified in the NHPD protocol specification.

5. Added tables defining the router's NHDP Interface information Base (IIB) as specified in the NHPD protocol specification.

6. Added tables defining the router's NHDP Neighbor Information Base (NIB) as specified in the NHPD protocol specification.

7. Aligned the NHDP-MIB and the OLSRv2-MIB configuration tables and indexing.

Appendix B. Open Issues

This section contains the set of open issues related to the development and design of the NHDP-MIB. This section will not be present in the final version of the MIB and will be removed once all the open issues have been resolved.

1. Assure that once can set Float32 values to variables. If so, is it possible to set upper and lower bounds (e.g. (0.0..1.0), similar to Unsigned32)?

2. Are DEFVALs required for NHDP parameters? How to specify Float32 DEFVAL?

3. Check out the definitions of the Notification Group and their relationship within the subtree of the NHDP-MIB. Should we specify thresholds for neighbor change Notifications? How do we specify these?

4. Need to check out the structure of the Notification Group and also its location within the NHDP-MIB (should be the zeroth group).

5. How to handle dynamic parameters within NHDP? Should we expose setting, min and max values?

6. Incorporate parameter relationship conditions into their DESCRIPTION clauses.

7. Also, specify specific SNMP response to the snmp set request, i.e., 'generic error', 'bad value', etc.

8. Clean up all of the 'Note:' statements within the body of the MIB.

9. Work on the relationship to other MIBs, IF-MIB, REPORT-MIB.

10. Cleanup all the [TODOs] from the MIB template.

Appendix C.

```
   ************************************************************
   * Note to the RFC Editor (to be removed prior to publication) *
   *                                                          *
   * 1) The reference to RFCXXXX within the DESCRIPTION clauses  *
   * of the MIB module point to this draft and are to be      *
   * assigned by the RFC Editor.                              *
   *                                                          *
   * 2) The reference to RFCXXX2 throughout this document point  *
   * to the current draft-ietf-manet-nhdp-mib-xx.txt.  This   *
   * need to be replaced with the XXX RFC number.             *
   *                                                          *
   ************************************************************
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