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Definition of Managed Objects for the Neighborhood Discovery Protocol draft-ietf-manet-nhdp-mib-08

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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This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on January 9, 2012.

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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 [RFC6130] 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

[RFC6130] 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:

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

- 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.

5. Structure of the MIB Module

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

- nhdpNotifications - objects defining NHDP-MIB notifications.

- 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.

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

5.1. Notifications

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

5.1.1. Introduction

Notifications can be emitted by an NHDP router as a reaction to a 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.

5.1.2. 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 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.

5.1.3. Limiting Frequency of Notifications

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

5.1.3.1. 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.

5.1.3.2. 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.

5.1.3.3. One Notification per Event

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

5.2. 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 [RFC6130]. For all of the configuration

parameters, the same constraints and default values of these parameters as defined in [RFC6130] are followed.

5.3. The State Group

The State Group reports current state information of a router running [RFC6130]. The NHDP-MIB State Group tables were designed to contain the complete set of state information defined within the information bases specified in Section 6, Section 7 and Section 8 in [RFC6130].

Two constructs, i.e., TEXTUAL CONVENTIONs, are defined in support of the tables in the State Group. The NHDP protocol stores and indexes information through sets of (dynamically defined) addresses. Within SMIv2 it is not possible to index tables with variably defined address sets. Hence, these TEXTUAL CONVENTIONS are defined to provide a local mapping between NHDP managed address sets and SMIv2 table indexing. These constructs are the NeighborIfIndex and NeighborRouterIndex. These are locally (to the NHDP router) defined, unique identifiers of virutal neighbors and neighbor interfaces. Due to the nature of the NHDP protocol, the local router may have identified distinct address sets but is not able to associate these as a single interface. Hence, two or more NeighborIfIndexes pointing to multiple distinct address sets may in fact be related to a common neighbor interface. This ambiguity may also hold with respect to the assignment of the NeighborRouterIndex. The local MIB agent is responsible for managing, aggregating and retiring the defined indexes, and in updating MIB tables using these indexes as the local router learns more about its neighbors' topology. These constructs are used to define indexes to the appropriate State Group tables and to correlate table entries to address sets, virtual interfaces and virtual routers within the MANET.

5.4. The Performance Group

The Performance Group reports values relevant to system performance. This section lists objects for NHDP performance monitoring, some of which are explicitly defined 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 are explicitly defined within this MIB and those objects which are derived through a combination of the base objects and capabilities offered by the REPORT-MIB.

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.

- 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. The histogram would display the distribution of intervals between two consecutive HELLOs 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.

- 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 there have been only very few such triggered messages.

  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.

- 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.

- 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.

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

This is a Base Object.

Object name: nhdpIfHelloMessageXmitAccumulatedSize

Object type: Counter64

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

  This is a Base Object.

  Object name: nhdpIfHelloMessageRecvdAccumulatedSize

  Object type: Counter64

- 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.

- 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.

- 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.

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.

- 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.

- 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.

The next objects examine the uptime of a given neighbor (as listed in the Neighbor Set):

- 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 hundredths of a second since the Neighbor Tuple corresponding to the given neighbor exists.

  This is a Base Object.

  Object name: nhdpDiscNeighborNibNeighborSetUpTime

  Object type: TimeTicks

- Acquire history of change of the "nbrup" status of a given neighbor

  This object returns the history of the exact timestamps of each time the neighbor (as listed in the Neighbor Set) becomes "nbrup" or "nbrdown". A neighbor is said to become "nbrup" if a new Neighbor Tuple is created that corresponds to the given neighbor. It becomes "nbrdown" if such a Neighbor Tuple has been deleted. The existance of a Lost Neighbor Tuple for that previous neighbor does not mean that the neighbor is still "nbrup".

  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.

- Histogram of the intervals between a change of the "nbrup" status of a given neighbor

  Returns the values that represent a histogram of intervals between a change of the "nbrup" 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 nhdpDiscRouterIndex.

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.

- Count the changes of the interface(s) over which a given neighbor (as listed in the Neighbor Set) can be reached

  This object counts each time the neighbor changes the interface(s) over which it is reachable. That means that there is a change in the set of corresponding Link Tuples of that Neighbor Tuple, i.e. a corresponding Link Tuple is added or removed from the set of all corresponding Link Tuples.

  This is a Base Object.

  Object name: nhdpDiscNeighborNibNeighborSetReachableLinkChanges

  Object type: Counter32

- Acquire history of changes of the interface(s) 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(s) over which it is reachable. That means that there is a change in the set of corresponding Link Tuples of for that Neighbor Tuple, i.e. a corresponding Link Tuple is added or removed from the set of all corresponding Link Tuples.

  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.

- Histogram of the intervals between a change of the interface(s) 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.

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

- Count the changes of the union of all N2_neighbor_iface_addr_list of 2-hop Tuples with an N2_2hop_addr equal to one of the given 2-hop neighbor's addresses

  This object returns the count of the times the 2-hop neighbor changes the neighbor(s) 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 the neighbor(s) 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.

- 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 neighbor(s) over which the 2-hop 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, nhdpIib2HopSetPerfChanges counter. The network management application would develop the histograms based upon lists obtained from the REPORT-MIB.

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

- 2-hop Neighbor uptime

Returns the number of hundredths of a second since the any 2-Hop Tuple with a N2_2hop_addr of the given 2-hop neighbor IP address was registered.

This is a Base Object.

Object name: nhdpIib2HopSetPerfUpTime

Object type: TimeTicks

- o Acquire history of change of "nbrup" status of a given 2-hop neighbor

  This object returns the history of the exact timestamps of each time the 2-hop neighbor becomes "nbrup" or "nbrdown". A 2-hop neighbor is said to become "nbrup" when the first 2-hop Tuple with N2_2hop_addr of the given 2-hop neighbor is created. It becomes "nbrdown" when the last 2-hop Tuple with N2_2hop_addr of the given 2-hop neighbor 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.

- o Histogram of the intervals between a change of the "nbrup" status of a given 2-hop neighbor

  Returns the values that represent a histogram of intervals between a change of the "nbrup" 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.

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

[RFC6130] allows routing protocols to rely on the neighborhood information that is discovered by means of HELLO message exchange. In order to allow for troubleshooting, fault isolation, and management of 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 NeighborIfIndex and the NeighborRouterIndex. 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 5.4 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 [FLOATTC].

7. Definitions

This section contains the MIB module defined by the specification.

```
NHDP-MIB DEFINITIONS ::= BEGIN
```

```
-- This MIB module defines objects for the management of the
-- NHDP [RFC6130] - The Neighborhood Discovery Protocol,
-- Clausen, T., Dearlove, C. and J. Dean, January 2011.

IMPORTS

    MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
    Counter32, Counter64, Integer32, Unsigned32, mib-2,
                TimeTicks
                FROM SNMPv2-SMI  --[RFC2578]

    TEXTUAL-CONVENTION, TruthValue, TimeStamp,
                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]

    Float32TC
                FROM FLOAT-TC-MIB  --[RFCXXXX]
    ;

nhdpMIB MODULE-IDENTITY
       LAST-UPDATED "201107081000Z" -- July 8, 2011
       ORGANIZATION "IETF MANET working group"
       CONTACT-INFO
       "WG E-Mail: manet@ietf.org

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```
      DESCRIPTION
          "This NHDP-MIB module is applicable to routers
           implementing the Neighborhood Discovery Protocol
           defined in [RFC6130].

           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 "201107081000Z" -- July 8, 2011
      DESCRIPTION
           "The eleventh version of this MIB module,
            published as draft-ietf-manet-nhdp-mib-08.txt.
            Clarified the use of the NeighborIfIndex and
            the NeighborRouterIndex.  Also, cleaned up
            the indexing of tables in the StateObjGroup.
           "
      REVISION "201101031000Z" -- January 3, 2011
      DESCRIPTION
           "The tenth version of this MIB module,
            published as draft-ietf-manet-nhdp-mib-07.txt.
            Added Float32TC from FLOAT-TC-MIB using this
            for representing the link quality parameters.
            Added a threshold (number) and window (time
            interval) within the nhdpNotificationsControl
            for the nhdpNbrStateChange, nhdp2HopNbrStateChange
            and nhdpIfRxBadPacket notifications.
           "
```

```
      REVISION "201011111000Z" -- November 11, 2010
      DESCRIPTION
           "The ninth version of this MIB module,
           published as draft-ietf-manet-nhdp-mib-06.txt.
           Corrected editorial issues, fixed some small
           bugs in the MIB."
      REVISION "201011081000Z" -- November 08, 2010
      DESCRIPTION
           "The eight version of this MIB module,
           published as draft-ietf-manet-nhdp-mib-05.txt.
           Cleaned up defaults and interdependence's
           between objects."
      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 a
        discovered NHDP neighbor virtual interface.
        Due to the nature of the NHDP protocol, it may not be
        possible for the local router to determine all 2-hop neighbor
        addresses associated with a single interface.  Further,
        the local router may not know if two distinct address sets
        belong to the same interface on a 2-hop neighbor or to
        two different interfaces.  As the local router gains more
        knowledge of its neighbors, its local view may change and
        this table will be updated to reflect the local router's current
        understanding associating address sets to neighbor interfaces.
        The local router identifies virtual neighbor interface through
        the receipt of address lists advertised through an
        NHDP HELLO message.

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

        The value for each discovered virtual neighbor
        interface must remain constant at least from
        one re-initialization of the entity's network management
        agent to the next re-initialization, except that
```

```
        if an application is deleted and re-created.  If the
        local router gains information associating two virtual
        interfaces on a neighbor as a common interface,
        then the agent must aggregate the two address sets to
        a single index choosen from the set of aggregated indexes,
        it must update all tables in this
        MIB which are indexed by indexes
        of type NeighborIfIndex.  It can then reuse freed
        index values following the next agent restart.

        The specific value is meaningful only within a given SNMP
        entity."
    SYNTAX       Unsigned32 (1..2147483647)


NeighborRouterIndex ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS       current
    DESCRIPTION
        "A locally arbitrary unique identifier associated with an
        NHDP discovered virtual peer router.  Given the nature of the
        NHDP protocol, the local router may have identified multiple
        virtual routers which in fact are one and the same.  As the
        local router's knowledge of its neighbors' topology
        increases, the local router will be able to associate
        multiple virtual router indexes into a single virtual
        router index chosen from the set of aggregated indexes,
        it must update all tables in this MIB indexed by these
        indexes, and it can reuse the freed indexes following the
        next agent re-initialization.

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

        The NeighborRouterIndex defines a discovered NHDP peer
        virtual router of the local router.
        The value for each discovered virtual neighbor index must remain
        constant at least from one re-initialization of the entity's
        network management agent 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 NeighborRouterIndex 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.

          The objects in this table are persistent and when
          written the entity SHOULD save the change to
          non-volatile storage."
      REFERENCE
         "[RFC2863] - 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
            Float32TC,
         nhdpHystRejectQuality
            Float32TC,
         nhdpInitialQuality
            Float32TC,
         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.
         "
      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
         "Section 5 on Protocol Parameters and
          Constraints of [RFC6130]."
      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
         "Section 5 on Protocol Parameters and
          Constraints of [RFC6130]."
      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
         "Section 5 on Protocol Parameters and
          Constraints of [RFC6130]."
      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
         "Section 5 on Protocol Parameters and
          Constraints of [RFC6130]."
      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.

         This object is persistent and when written
         the entity SHOULD save the change to
         non-volatile storage."
```

```
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of [RFC6130]."
      DEFVAL { 6000 }
   ::= { nhdpInterfaceEntry 7 }

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

   nhdpHystAcceptQuality  OBJECT-TYPE
      SYNTAX      Float32TC
      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
         "Section 5 on Protocol Parameters and
          Constraints of [RFC6130]."
      -- DEFVAL { 1.0 }
   ::= { nhdpInterfaceEntry 8 }

   nhdpHystRejectQuality  OBJECT-TYPE
      SYNTAX      Float32TC
      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
         "Section 5 on Protocol Parameters and
          Constraints of [RFC6130]."
      -- DEFVAL { 0.0 }
   ::= { nhdpInterfaceEntry 9 }

   nhdpInitialQuality  OBJECT-TYPE
```

```
      SYNTAX      Float32TC
      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
         "Section 5 on Protocol Parameters and
          Constraints of [RFC6130]."
      -- DEFVAL { 1.0 }
   ::= { nhdpInterfaceEntry 10 }



   nhdpInitialPending  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpInitialPending corresponds to
         INITIAL_PENDING of NHDP.

         The following constraints apply to this parameter:

         If INITIAL_QUALITY >= HYST_ACCEPT,
         then INITIAL_PENDING := false.

         If INITIAL_QUALITY < HYST_REJECT,
         then INITIAL_PENDING := true."
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of [RFC6130]."
      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.

         For constraints on this object, refer
         to Section 5.4 of RFC5148."
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of [RFC6130]."
      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
         "Section 5 on Protocol Parameters and
          Constraints of [RFC6130]."
      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
         "[RFC6130]."
   ::= { 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
         "[RFC6130].
          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
         "[RFC6130].
          Section 5 on Protocol Parameters and
          Constraints."
      DEFVAL { 6000 }
   ::= { nhdpConfigurationObjGrp 3 }


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

    -- Local Interface Set Table
    -- Entry (foreach local interface): (IfNetAddrs, Is_manet)

    nhdpLibLocalIfSetTable OBJECT-TYPE
       SYNTAX       SEQUENCE OF NhdpLibLocalIfSetEntry
       MAX-ACCESS   not-accessible
       STATUS       current
       DESCRIPTION
          "A router's Local Interface Set records all
```

```
            network addresses which are defined as local
            interface network addresses.  The local interface
            is defined by the nhdpLibLocalIfSetIfIndex.

            It consists of Local Interface Address Tuples
            per network interface and their prefix lenghts (in
            order to determine the network addresses related to
            the interface) and an indication of whether the
            interface is a MANET interface or not.

            Further guidance on the addition or removal of
            local addresses and network addresses is found
            in Section 9 of [RFC6130]."
         REFERENCE
            "[RFC6130]."
      ::= { nhdpConfigurationObjGrp 4 }

      nhdpLibLocalIfSetEntry  OBJECT-TYPE
         SYNTAX      NhdpLibLocalIfSetEntry
         MAX-ACCESS  not-accessible
         STATUS      current
         DESCRIPTION
            "A router's Local Interface Set consists
             of Configured Interface Address Tuples foreach network
             interface, and an indication of whether the interface
             is a MANET interface or not.

             (IR_local_iface_addr, IR_time)
            "
         REFERENCE
            "[RFC6130]."
         INDEX { nhdpIfIndex }
      ::= { nhdpLibLocalIfSetTable 1 }

      NhdpLibLocalIfSetEntry ::=
         SEQUENCE {
            nhdpLibLocalIfSetIpAddrType
              InetAddressType,
            nhdpLibLocalIfSetIpAddr
              InetAddress,
            nhdpLibLocalIfSetIpAddrPrefixLen
              InetAddressPrefixLength,
            nhdpLibLocalIfSetIsManet
              TruthValue
          }

     nhdpLibLocalIfSetIpAddrType  OBJECT-TYPE
        SYNTAX      InetAddressType
```

```
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "The type of the nhdpLibLocalIfSetIpAddr
          in the InetAddress MIB [RFC 4001]."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpLibLocalIfSetEntry 1 }

   nhdpLibLocalIfSetIpAddr  OBJECT-TYPE
      SYNTAX      InetAddress
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhdpLibLocalIfSetAddr is an
          address of an interface of
          this router."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpLibLocalIfSetEntry 2 }

   nhdpLibLocalIfSetIpAddrPrefixLen  OBJECT-TYPE
      SYNTAX      InetAddressPrefixLength
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "Indicates the number of leading one bits that form the
          mask to be logical-ANDed with the address
          used as the table index to determine
          the row match from this table and
          to determine the network address to which
          this interface is attached.  A row match is
          true if the address used as an index falls within
          the network interface address range."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpLibLocalIfSetEntry 3 }

     nhdpLibLocalIfSetIsManet  OBJECT-TYPE
        SYNTAX      TruthValue
        MAX-ACCESS  read-only
        STATUS      current
        DESCRIPTION
           "Specifies whether this interface is
            a MANET interface or not."
        REFERENCE
           "[RFC6130]."
     ::= { nhdpLibLocalIfSetEntry 4 }
```

```
    -- Removed Interface Addr Set Table
    -- Entry (foreach removed network 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
          "[RFC6130]."
    ::= { nhdpConfigurationObjGrp 5 }

    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
          "[RFC6130]."
       INDEX { nhdpLibRemovedIfAddrSetIpAddrType,
               nhdpLibRemovedIfAddrSetIpAddr }
    ::= { nhdpLibRemovedIfAddrSetTable 1 }

    NhdpLibRemovedIfAddrSetEntry ::=
       SEQUENCE {
          nhdpLibRemovedIfAddrSetIpAddrType
            InetAddressType,
          nhdpLibRemovedIfAddrSetIpAddr
            InetAddress,
          nhdpLibRemovedIfAddrSetIpAddrPrefixLen
```

```
            InetAddressPrefixLength,
          nhdpLibRemovedIfAddrSetIfIndex
            InterfaceIndexOrZero,
          nhdpLibRemovedIfAddrSetIrTime
            TimeStamp
        }

   nhdpLibRemovedIfAddrSetIpAddrType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The type of the nhdpLibRemovedIfAddrSetIpAddr
          in the InetAddress MIB [RFC 4001]."
      REFERENCE
         "[RFC6130]."
   ::= { 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
         "[RFC6130]."
   ::= { 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
         "[RFC6130]."
   ::= { 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
           "[RFC6130]."
     ::= { 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
           "[RFC6130]."
     ::= { nhdpLibRemovedIfAddrSetEntry 5 }




--
-- nhdpStateObjGrp
--

-- Contains information describing the current state of the NHDP
-- process on this device.

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.
   -- This was necessary because the NHDP protocol manages and
   -- indexes based upon dynamic address tuples, while SMI requires
   -- statically defined indexes for accessing its table rows.
   -- The NeighborIfIndex defines a unique (to the local router)
   -- index referencing a discovered virtual interface on another
   -- router within the MANET. The NeighborRouterIndex defines a
   -- unique (to the local router) index referencing a discovered
   -- virtual router within the MANET.
   --
   -- Due to the nature of the NHDP protocol,
   -- different indexes may be related to common neighbor
   -- interfaces or common neighbor routers, but the information
   -- obtained through NHDP has not allowed the local router
   -- to relate these virtual objects (i.e., interfaces or routers)
   -- at this point in time.  As more topology information
```

```
   -- is gathered by the local router, it may associate
   -- virtual interfaces or routers and collapse these
   -- indexes appropriately.

   -- Multiple addresses can be associated with a
   -- given NeighborIfIndex.  Each NeighborIfIndex is
   -- associated with a NeighborRouterIndex.  Throughout
   -- the nhdpStateObjGroup, the
   -- NeighborIfIndex and the NeighborRouterIndex are used
   -- to define the set of IpAddrs related to a virtual interface
   -- or virtual router under discussion.

   nhdpUpTime OBJECT-TYPE
       SYNTAX TimeTicks
        MAX-ACCESS read-only
        STATUS current
        DESCRIPTION
             "The number of hundredths of a second since the
             current NHDP process was initialized."
        REFERENCE
          "[RFC6130]."
    ::= { nhdpStateObjGrp 1 }


   nhdpInterfaceStateTable  OBJECT-TYPE
      SYNTAX      SEQUENCE OF NhdpInterfaceStateEntry
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "nhdpInterfaceStateTable lists state information
          related to specific interfaces of this NHDP router.
          The ifIndex is from the interfaces group
          defined in the Interfaces Group MIB.

          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."
   ::= { nhdpStateObjGrp 2 }

   nhdpInterfaceStateEntry OBJECT-TYPE
      SYNTAX      NhdpInterfaceStateEntry
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "nhdpInterfaceStateEntry describes one NHDP
```

```
          local interface state as indexed by
          its ifIndex as defined in the Standard MIB II
          Interface Table (RFC2863)."
      INDEX { nhdpIfIndex }
   ::= { nhdpInterfaceStateTable 1 }

   NhdpInterfaceStateEntry ::=
      SEQUENCE {
         nhdpIfStateUpTime
            TimeTicks
         }

   nhdpIfStateUpTime  OBJECT-TYPE
      SYNTAX      TimeTicks
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
             "The number of hundredths of a second since the
             current NHDP process was initialized."
   ::= { nhdpInterfaceStateEntry 1 }


   --
   -- Interface Parameters - Message Intervals
   --

   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
          "[RFC6130]."
    ::= { nhdpStateObjGrp 3 }


    nhdpDiscIfSetEntry  OBJECT-TYPE
       SYNTAX      NhdpDiscIfSetEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "The entries include the nhdpDiscRouterIndex of
           the discovered router, the nhdpDiscIfIndex
           of the discovered interface and the
           current set of addresses associated
           with this neighbor interface.  The
```

```
            nhdpDiscIfIndex uniquely identifies
            the remote interface address sets
            through this table.  It does not need
            to be unique across the MANET, but must
            be locally unique within this router."
        REFERENCE
           "[RFC6130]."
        INDEX { nhdpDiscIfSetIpAddrType,
                nhdpDiscIfSetIpAddr }
    ::= { nhdpDiscIfSetTable 1 }

    NhdpDiscIfSetEntry ::=
       SEQUENCE {
          nhdpDiscRouterIndex
            NeighborRouterIndex,
          nhdpDiscIfIndex
            NeighborIfIndex,
          nhdpDiscIfSetIpAddrType
            InetAddressType,
          nhdpDiscIfSetIpAddr
            InetAddress,
          nhdpDiscIfSetIpAddrPrefixLen
            InetAddressPrefixLength
        }

   nhdpDiscRouterIndex  OBJECT-TYPE
      SYNTAX      NeighborRouterIndex
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The NHDP router ID (locally created)
          of a neighboring router.  Used for cross
          indexing into other NHDP tables and other
          MIBs."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpDiscIfSetEntry 1 }

   nhdpDiscIfIndex  OBJECT-TYPE
      SYNTAX      NeighborIfIndex
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The NHDP interface index (locally created)
          of a neighbor's interface.  Used for cross
          indexing into other NHDP tables and other
          MIBs."
      REFERENCE
```

```
         "[RFC6130]."
   ::= { nhdpDiscIfSetEntry 2 }

   nhdpDiscIfSetIpAddrType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The type of the nhdpDiscIfSetIpAddr
          in the InetAddress MIB [RFC 4001]."
      REFERENCE
         "[RFC6130]."
   ::= { 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
         "[RFC6130]."
   ::= { 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 nhdpDiscIfSetIpAddr before
          being compared to the value of the
          address used to index this table.
          If the resulting address block contains the
          address used to index this table,
          then a match should be returned."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpDiscIfSetEntry 5 }


   -- Interface Information Base (IIB)

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

```
   --

   --     IIB Link Set
   --         Entry (foreach discovered discovered link to a
   --                         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 all links
           from other routers which are, or recently
           were, 1-hop neighbors."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpStateObjGrp 4 }

    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
          "[RFC6130]."
       INDEX { nhdpIfIndex,
               nhdpDiscIfIndex }
    ::= { nhdpIibLinkSetTable 1 }

    NhdpIibLinkSetEntry ::=
       SEQUENCE {
```

```
          nhdpIibLinkSetLHeardTime
            TimeStamp,
          nhdpIibLinkSetLSymTime
            TimeStamp,
          nhdpIibLinkSetLPending
            TruthValue,
          nhdpIibLinkSetLLost
            TruthValue,
          nhdpIibLinkSetLTime
            TimeStamp
        }

   nhdpIibLinkSetLHeardTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLHeardTime corresponds
         to L_HEARD_time of NHDP."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpIibLinkSetEntry 1 }

   nhdpIibLinkSetLSymTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLSymTime corresponds
         to L_SYM_time of NHDP."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpIibLinkSetEntry 2 }

   nhdpIibLinkSetLPending  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLPending corresponds
         to L_pending of NHDP"
      REFERENCE
         "[RFC6130]."
   ::= { nhdpIibLinkSetEntry 3 }

   nhdpIibLinkSetLLost  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
```

```
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLLost corresponds
         to L_lost of NHDP"
      REFERENCE
         "[RFC6130]."
   ::= { nhdpIibLinkSetEntry 4 }

   nhdpIibLinkSetLTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLTime specifies
          when this Tuple expires and MUST
          be removed."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpIibLinkSetEntry 5 }


  --
  --     IIB 2-Hop Set
  --         Entry (foreach discovered 2-H neighbor
  --                network address): (1HopNeighIfAddrList,
  --                                   2HopNeighNetworkAddr,
  --                                   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
          "[RFC6130]."
    ::= { nhdpStateObjGrp 5 }
```

```
    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
          "[RFC6130]."
       INDEX { nhdpIib2HopSetIpAddressType,
               nhdpIib2HopSetIpAddress }
    ::= { nhdpIib2HopSetTable 1 }

    NhdpIib2HopSetEntry ::=
       SEQUENCE {
          nhdpIib2HopSetIpAddressType
            InetAddressType,
          nhdpIib2HopSetIpAddress
            InetAddress,
          nhdpIib2HopSetIpAddrPrefixLen
            InetAddressPrefixLength,
          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
         "[RFC6130]."
   ::= { nhdpIib2HopSetEntry 1 }

   nhdpIib2HopSetIpAddress  OBJECT-TYPE
      SYNTAX      InetAddress
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIib2HopSetIpAddr corresponds
         to N2_2hop_addr of NHDP."
      REFERENCE
```

```
          "[RFC6130]."
      ::= { nhdpIib2HopSetEntry 2 }

      nhdpIib2HopSetIpAddrPrefixLen  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
             used as the table index to determine
             the row match from this table and
             to determine the network address to which
             this interface is attached.  A row match is
             true if the address used as an index falls within
             the network interface address range."
         REFERENCE
            "[RFC6130]."
      ::= { nhdpIib2HopSetEntry 3 }

      nhdpIib2HopSet1HopIfIndex  OBJECT-TYPE
         SYNTAX      NeighborIfIndex
         MAX-ACCESS  read-only
         STATUS      current
         DESCRIPTION
            "nhdpIib2HopSet1HopIfIndex is
             nhdpDiscIfIndex of the one hop
             neighbor which communicated the ipAddress
             of the 2-hop neighbor in this row entry."
         REFERENCE
            "[RFC6130]."
      ::= { nhdpIib2HopSetEntry 4 }

      nhdpIib2HopSetN2Time  OBJECT-TYPE
         SYNTAX      TimeStamp
         MAX-ACCESS  read-only
         STATUS      current
         DESCRIPTION
            "nhdpIib2HopSetN2Time specifies
             when this column entry expires and
             MUST be removed."
         REFERENCE
            "[RFC6130]."
      ::= { nhdpIib2HopSetEntry 5 }


      --
      -- 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 discovered 1-Hop neighbor:
   --                N_neighbor_addr_list, N_symmetric)
   --     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
         "[RFC6130]."
   ::= { nhdpStateObjGrp 6 }

   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)

           Neighbor tuples are removed from the
           neighbor set only when the
           corresponding link tuples expire from
           the Link Set table."
      REFERENCE
         "[RFC6130]."
      INDEX { nhdpDiscRouterIndex }
   ::= { nhdpNibNeighborSetTable 1 }

    NhdpNibNeighborSetEntry ::=
       SEQUENCE {
          nhdpNibNeighborSetNSymmetric
```

```
            TruthValue
          }

   nhdpNibNeighborSetNSymmetric  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpNibNeighborNSymmetric corresponds
         to N_symmetric of NHDP."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpNibNeighborSetEntry 1 }



  --     Lost Neighbor Set
  --         Entry ( foreach recently lost
  --                  1-hop neighbor router):
  --                           (NL_neighbor_addrs, NL_time)
  --
    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
          "[RFC6130]."
    ::= { nhdpStateObjGrp 7 }

    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
          "[RFC6130]."
       INDEX { nhdpDiscRouterIndex }
    ::= { nhdpNibLostNeighborSetTable 1 }
```

```
    NhdpNibLostNeighborSetEntry ::=
       SEQUENCE {
          nhdpNibLostNeighborSetNLTime
            TimeStamp
         }

   nhdpNibLostNeighborSetNLTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpNibLostNeighborSetNLTime
          specifies when this Tuple expires
          and MUST be removed."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpNibLostNeighborSetEntry 1 }



--
-- 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
         "[RFC6130]."
   ::= { 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 {
         nhdpIfHelloMessageXmits
            Counter32,
         nhdpIfHelloMessageRecvd
            Counter32,
         nhdpIfHelloMessageXmitAccumulatedSize
            Counter64,
         nhdpIfHelloMessageRecvdAccumulatedSize
            Counter64,
         nhdpIfHelloMessageTriggeredXmits
            Counter32,
         nhdpIfHelloMessagePeriodicXmits
            Counter32,
         nhdpIfHelloMessageXmitAccumulatedSymmetricNeighborCount
            Counter32,
         nhdpIfHelloMessageXmitAccumulatedHeardNeighborCount
            Counter32,
         nhdpIfHelloMessageXmitAccumulatedLostNeighborCount
            Counter32
         }

   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 1 }

   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 2 }

   nhdpIfHelloMessageXmitAccumulatedSize  OBJECT-TYPE
      SYNTAX      Counter64
```

```
      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 3 }

   nhdpIfHelloMessageRecvdAccumulatedSize  OBJECT-TYPE
      SYNTAX      Counter64
      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 4 }

   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 5 }

   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 6 }

   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 7 }

   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 8 }

   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 9 }



  --
  -- 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
          "[RFC6130]."
   ::= { 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
          "[RFC6130]."
       INDEX { nhdpDiscIfIndex }
   ::= { nhdpDiscIfSetPerfTable 1 }

    NhdpDiscIfSetPerfEntry ::=
```

```
       SEQUENCE {
          nhdpDiscIfRecvdPackets
            Counter32,
          nhdpDiscIfExpectedPackets
            Counter32
        }

   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
         "[RFC6130]."
   ::= { nhdpDiscIfSetPerfEntry 1 }

   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
         "[RFC6130]."
   ::= { nhdpDiscIfSetPerfEntry 2 }



   --
   -- 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
          "[RFC6130]."
   ::= { nhdpPerformanceObjGrp 4 }

   nhdpDiscNeighborSetPerfEntry  OBJECT-TYPE
       SYNTAX      NhdpDiscNeighborSetPerfEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "The entries include the nhdpDiscRouterIndex of
           the discovered router, as well as performance
           objects related to changes of the Neighbor
           Set."
       REFERENCE
          "[RFC6130]."
       INDEX { nhdpDiscRouterIndex }
   ::= { nhdpDiscNeighborSetPerfTable 1 }

    NhdpDiscNeighborSetPerfEntry ::=
       SEQUENCE {
          nhdpDiscNeighborNibNeighborSetChanges
            Counter32,
          nhdpDiscNeighborNibNeighborSetUpTime
            TimeTicks,
          nhdpDiscNeighborNibNeighborSetReachableLinkChanges
            Counter32
         }

   nhdpDiscNeighborNibNeighborSetChanges  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This object returns the number of changes
         to the given Neighbor Tuple."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpDiscNeighborSetPerfEntry 1 }
```

```
   nhdpDiscNeighborNibNeighborSetUpTime  OBJECT-TYPE
      SYNTAX      TimeTicks
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This object returns the time in hundredths of a second since
         the neighbor becomes 'nbrup'.  A neighbor is
         said to become 'nbrup' if a new nhdpNibNeighborSetEntry
         is created for a particular nhdpNibNeighborSetRouterIndex.
         It becomes 'nbrdown' if the entry for that neighbor
         has been deleted."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpDiscNeighborSetPerfEntry 2 }

   nhdpDiscNeighborNibNeighborSetReachableLinkChanges  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This object counts each time the neighbor changes the
         interface(s) over which it is reachable. That means that
         here is a change in the set of corresponding Link Tuples
         of that Neighbor Tuple, i.e. a corresponding Link Tuple
         is added or removed from the set of all corresponding
         Link Tuples."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpDiscNeighborSetPerfEntry 3 }




   --
   -- 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
          "[RFC6130]."
    ::= { 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
         "[RFC6130]."
      INDEX { nhdpDiscRouterIndex }
   ::= { nhdpIib2HopSetPerfTable 1 }

   NhdpIib2HopSetPerfEntry ::=
      SEQUENCE {
         nhdpIib2HopSetPerfChanges
           Counter32,
         nhdpIib2HopSetPerfUpTime
           TimeTicks
       }

   nhdpIib2HopSetPerfChanges  OBJECT-TYPE
      SYNTAX      Counter32
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This object counts the changes of the union of all
         N2_neighbor_iface_addr_list of 2-hop Tuples with an
         N2_2hop_addr equal to one of the given 2-hop
         neighbor's addresses."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpIib2HopSetPerfEntry 1 }


   nhdpIib2HopSetPerfUpTime  OBJECT-TYPE
      SYNTAX      TimeTicks
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This object returns the time in hundredths of
         a second when the 2-Hop Tuple
         corresponding to the given 2-hop neighbor IP address
         was registered in the nhdpIib2HopSetTable."
      REFERENCE
         "[RFC6130]."
   ::= { nhdpIib2HopSetPerfEntry 2 }
```

```
--
-- 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 (least significant) represents
             notification 0.

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

   nhdpNbrStateChangeThreshold OBJECT-TYPE
          SYNTAX       Integer32 (0..255)
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A threshold value for the
              nhdpNbrStateChange object.  If the
              number of occurences exceeds this threshold
              within the previous nhdpNbrStateChangeWindow,
              then the nhdpNbrStateChange notification
              is to be sent.
             "
           ::= { nhdpNotificationsControl 2 }

   nhdpNbrStateChangeWindow OBJECT-TYPE
          SYNTAX       TimeTicks
          MAX-ACCESS   read-write
          STATUS       current
```

```
          DESCRIPTION
             "A time window for the
              nhdpNbrStateChange object.  If the
              number of occurences exceeds the
              nhdpNbrStateChangeThreshold
              within the previous nhdpNbrStateChangeWindow,
              then the nhdpNbrStateChange notification
              is to be sent.

              This object represents the time in hundredths
              of a second.
             "
           ::= { nhdpNotificationsControl 3 }

   nhdp2HopNbrStateChangeThreshold OBJECT-TYPE
          SYNTAX       Integer32 (0..255)
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A threshold value for the
              nhdp2HopNbrStateChange object.  If the
              number of occurences exceeds this threshold
              within the previous nhdp2HopNbrStateChangeWindow,
              then the nhdp2HopNbrStateChange notification
              is to be sent.
             "
           ::= { nhdpNotificationsControl 4 }

   nhdp2HopNbrStateChangeWindow OBJECT-TYPE
          SYNTAX       TimeTicks
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A time window for the
              nhdp2HopNbrStateChange object.  If the
              number of occurences exceeds the
              nhdp2HopNbrStateChangeThreshold
              within the previous nhdp2HopNbrStateChangeWindow,
              then the nhdp2HopNbrStateChange notification
              is to be sent.

              This object represents the time in hundredths
              of a second.
             "
           ::= { nhdpNotificationsControl 5 }

   nhdpIfRxBadPacketThreshold OBJECT-TYPE
          SYNTAX       Integer32 (0..255)
```

```
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A threshold value for the
              nhdpIfRxBadPacket object.  If the
              number of occurences exceeds this threshold
              within the previous nhdpIfRxBadPacketWindow,
              then the nhdpIfRxBadPacket notification
              is to be sent.
             "
           ::= { nhdpNotificationsControl 6 }

   nhdpIfRxBadPacketWindow OBJECT-TYPE
          SYNTAX       TimeTicks
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A time window for the
              nhdpIfRxBadPacket object.  If the
              number of occurences exceeds the
              nhdpIfRxBadPacketThreshold
              within the previous nhdpIfRxBadPacketWindow,
              then the nhdpIfRxBadPacket notification
              is to be sent.

              This object represents the time in hundredths
              of a second.
             "
           ::= { nhdpNotificationsControl 7 }


   -- nhdpNotificationsObjects

   nhdpNbrStateChange NOTIFICATION-TYPE
          OBJECTS { nhdpIfIndex,  -- 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 { nhdpIfIndex,      -- 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 { nhdpDiscRouterIndex, -- The originator of
                                         -- the notification
                    nhdpIfIndex,         -- The interface on which the
                                         -- packet has been received
                    nhdpPacketSrcType,   -- The type of the source IP
                                         -- address of the packet
                    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 successfully parsed in a short time. The
             network 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 }

  nhdpPacketSrcType OBJECT-TYPE
            SYNTAX InetAddressType
            MAX-ACCESS read-only
            STATUS current
            DESCRIPTION
            "The IP address type of the
```

```
            address of an inbound packet that
            cannot be identified by a neighbor instance."
            ::= { nhdpNotificationsStates 4 }

   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."
          ::= { nhdpNotificationsStates 5 }




--
-- 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,
                     nhdpPerformanceGroup,
                     nhdpNotificationObjectGroup,
                     nhdpNotificationGroup,
                     nhdpPerformanceGroup }

  ::= { nhdpCompliances 2 }


--
-- Units of Conformance
--

  nhdpConfigurationGroup OBJECT-GROUP
     OBJECTS {
              nhdpIfIndex,
              nhdpIfStatus,
              nhdpHelloInterval,
              nhdpHelloMinInterval,
              nhdpRefreshInterval,
              nhdpLHoldTime,
              nhdpHHoldTime,
              nhdpHystAcceptQuality,
              nhdpHystRejectQuality,
              nhdpInitialQuality,
              nhdpInitialPending,
              nhdpHpMaxJitter,
              nhdpHtMaxJitter,
              nhdpNHoldTime,
              nhdpIHoldTime,
              nhdpIfRowStatus,
              nhdpLibLocalIfSetIpAddrType,
              nhdpLibLocalIfSetIpAddr,
              nhdpLibLocalIfSetIpAddrPrefixLen,
              nhdpLibLocalIfSetIsManet,
              nhdpLibRemovedIfAddrSetIpAddrPrefixLen,
              nhdpLibRemovedIfAddrSetIfIndex,
              nhdpLibRemovedIfAddrSetIrTime
             }
      STATUS  current
      DESCRIPTION
         "Set of NHDP configuration objects implemented
          in this module."
   ::= { nhdpMIBGroups 2 }
```

```
  nhdpStateGroup OBJECT-GROUP
     OBJECTS {
              nhdpUpTime,
              nhdpIfStateUpTime,
              nhdpDiscRouterIndex,
              nhdpDiscIfIndex,
              nhdpDiscIfSetIpAddrPrefixLen,
              nhdpIibLinkSetLHeardTime,
              nhdpIibLinkSetLSymTime,
              nhdpIibLinkSetLPending,
              nhdpIibLinkSetLLost,
              nhdpIibLinkSetLTime,
              nhdpIib2HopSetIpAddressType,
              nhdpIib2HopSetIpAddress,
              nhdpIib2HopSetIpAddrPrefixLen,
              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 }

    nhdpNotificationObjectGroup OBJECT-GROUP
      OBJECTS {
            nhdpSetNotification,
            nhdpNbrStateChangeThreshold,
            nhdpNbrStateChangeWindow,
            nhdp2HopNbrStateChangeThreshold,
            nhdp2HopNbrStateChangeWindow,
            nhdpIfRxBadPacketThreshold,
            nhdpIfRxBadPacketWindow,
            nhdpIfState,
            nhdpNbrState,
            nhdp2HopNbrState,
            nhdpPacketSrcType,
            nhdpPacketSrc
      }
      STATUS current
      DESCRIPTION
      "Set of NHDP notification objects implemented
      in this module."
   ::= { nhdpMIBGroups 5 }



  nhdpNotificationGroup NOTIFICATION-GROUP
     NOTIFICATIONS {
             nhdpNbrStateChange,
             nhdp2HopNbrStateChange,
             nhdpIfRxBadPacket,
             nhdpIfStateChange
             }
      STATUS  current
      DESCRIPTION
         "Set of NHDP notifications implemented
          in this module."
   ::= { nhdpMIBGroups 6 }


END
```

8. Security Considerations

This MIB defines objects for the configuration, monitoring and notification of the Neighborhood Discovery Protocol [RFC6130]. 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 NHDP 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

Editor's Note (to be removed prior to publication): the IANA is requested to assign a value for "XXXX" under the 'mib-2' subtree and to record the assignment in the SMI Numbers registry. When the assignment has been made, the RFC Editor is asked to replace "XXXX" (here and in the MIB module) with the assigned value and to remove this note. Note well: prior to official assignment by the IANA, a draft document MUST use placeholders (such as "XXXX" above) rather than actual numbers. See RFC4181 Section 4.5 for an example of how this is done in a draft MIB module.

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. Acknowledgements

The authors wish to thank Justin Dean of the MANET WG for his detailed review and insightful comments to this document.

12. References

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12.2. Informative References

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Appendix A.

```
*****************************************************************
* 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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