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Definition of Managed Objects for the Neighborhood Discovery Protocol draft-ietf-manet-nhdp-mib-13

Abstract

This document 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 module 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 November 7, 2012.

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1. Introduction

This document 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 module 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 module 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 module.

- 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 module is arranged into the following structure:

- nhdpNotifications - objects defining NHDP-MIB notifications.

- nhdpObjects - defining objects within this MIB module. 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 module.

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 first 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. It is RECOMMENDED that this time interval is at least 3 x 'nhdpHelloInterval', so that symmetric neighbors are discovered. The suppression window for notifications is started when the 'nhdpIfStatus' transitions from its default value of 'false' to 'true'

5.1.3.2. Throttling Notifications

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. If NHDP is deployed on a lossy, wireless medium, sending too many notifications in a short time interval may lead to collisions and dropped packets. In particular, in dense deployments of NHDP routers (i.e. where each router has many neighbors), a change of the local topology may trigger many notifications at the same time. [RFC4750] recommends "7 notifications with a window time of 10 seconds" as upper bound. As NHDP is expected to be deployed in more lossy channels than OSPF, it is RECOMMENDED to choose a lower threshold for the number of notifications per time than that.

Specifically it is RECOMMENDED to choose a threshold value for the objects reflecting the change be set to a value of '10' and have set the DEFAULT values for these objects within the Notifications Group to this value. Further, a time window for the change objects is defined within this MIB module. It is RECOMMENDED that if the number of occurrences exceeds the change threshold within the previous change window, then the notification is to be sent. Furthermore, it is RECOMMENDED that the value for this window be set to at least 5 times the 'nhdpHelloInterval'.

The following objects are used to define the thresholds and time windows for specific Notifications defined in the NHDP-MIB module: 'nhdpNbrStateChangeThreshold', 'nhdpNbrStateChangeWindow', 'nhdp2HopNbrStateChangeThreshold', 'nhdp2HopNbrStateChangeWindow', 'nhdpIfRxBadPacketThreshold', 'nhdpIfRxBadPacketWindow'.

5.1.3.3. One Notification per Event

Similar to the 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 module 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. Refer to [RFC5148] for guidance on setting jitter related parameters, e.g., nhdpMaxJitter.

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 of [RFC6130].

Two constructs, i.e., TEXTUAL CONVENTIONs, are defined to support of the tables in the State Group. The NHDP protocol stores and indexes information through sets of (dynamically defined) addresses, i.e., address sets. 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 virtual 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 neighbor interfaces and virtual neighbors within the MANET.

5.4. The Performance Group

The Performance Group reports values relevant to system performance. Unstable neighbors or 2-hop neighbors and frequent changes of sets can have a negative influence on the performance of NHDP. This MIB module defines several objects that can be polled in order to, e.g., calculate histories or monitor frequencies of changes. This may help the network admministrator to determine unusual topology changes or other changes that affect stability and reliability of the MANET. One such framework is specified in [REPORT-MIB].

5.5. Tables and Indexing

The NHDP-MIB module contains a number of tables which record data related to:

- the local NHDP router,
- a local NHDP interface on the NHDP router,
- other NHDP routers which are 1-hop removed from the local NHDP router,
- interfaces on other NHDP routers which are 1-hop removed from the local NHDP router, and
- other NHDP routers which are 2-hop removed from the local NHDP router.

The NHDP-MIB module's tables are indexed via the following constructs:

- nhdpIfIndex - which is the IfIndex of the local router on which NHDP is enabled.

- nhdpDiscIfIndex - a locally managed index representing a known interface on an NHDP neighboring router.

- nhdpDiscRouterIndex - a locally managed index representing an ID of a known neighboring NHDP router.

- nhdpIPAddressType and nhdpIpAddress pair - for tables containing address lists.

These tables and their indexing are:

- nhdpInterfaceTable - describes the configuration of the interfaces of this NHDP router. This table has 'INDEX { nhdpIfIndex }'.

- nhdpLibLocalIfSetTable - records all network addresses which are defined as local interface network addresses on this NHDP router. This table has 'INDEX { nhdpIfIndex }'.

- nhdpLibRemovedIfAddrSetTable - records network addresses which were recently used as local interface network addresses on this NHDP router but have been removed. This table has 'INDEX { nhdpLibRemovedIfAddrSetIpAddrType, nhdpLibRemovedIfAddrSetIpAddr }'.

- nhdpInterfaceStateTable - records state information related to specific interfaces of this NHDP deroutervice. This table has 'INDEX { nhdpIfIndex }'.

- nhdpDiscIfSetTable - include the nhdpDiscRouterIndex of the discovered router, the nhdpDiscIfIndex of the discovered interface and the current set of addresses associated with this neighbor interface. This table has 'INDEX { nhdpDiscIfSetIndex }'.

- nhdpIibLinkSetTable - foreach local interface, this table records all links belonging to other routers which are, or recently were, 1-hop neighbors to this NHDP router. This table has 'INDEX { nhdpIfIndex, nhdpDiscIfIndex }'.

- nhdpIib2HopSetTable - foreach local interface, this table records network addresses of symmetric 2-hop neighbors, and the symmetric links to symmetric 1-hop neighbors of this NHDP router through which these symmetric 2-hop neighbors can be reached. This table has 'INDEX { nhdpIfIndex, nhdpIib2HopSetIpAddressType, nhdpIib2HopSetIpAddress }'.

- nhdpNibNeighborSetTable - records all network addresses of each 1-hop neighbor to this NHDP router. This table has 'INDEX { nhdpDiscRouterIndex }'.

- nhdpNibLostNeighborSetTable - records network addresses of other NHDP routers which recently were symmetric 1-hop neighbors to this NHDP router, but which are now advertised as lost. This table has 'INDEX { nhdpDiscRouterIndex }'.

- nhdpInterfacePerfTable - records performance objects that are measured foreach local NHDP interface on this NHDP router. This table has 'INDEX { nhdpIfIndex }'.

- nhdpDiscIfSetPerfTable - records performance objects that are measured foreach discovered interface of a neighbor of this NHDP router. This table has 'INDEX { nhdpDiscIfIndex }'.

- nhdpDiscNeighborSetPerfTable - records performance objects that are measured for discovered neighbors of this NHDP router. This table has 'INDEX { nhdpDiscRouterIndex }'.

- nhdpIib2HopSetPerfTable - records performance objects that are measured for discovered 2-hop neighbors of this NHDP router. This table has 'INDEX { nhdpDiscRouterIndex }'.

6. Relationship to Other MIB Modules

This section specifies the relationship of the MIB module 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 module [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 module does not duplicate those objects.

6.2. Relationship to Routing Protocol MIB Modules Relying on the NHDP-MIB Module

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

6.3. 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 FLOAT-TC-MIB [RFC6340].

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
-- 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

    InterfaceIndex, InterfaceIndexOrZero
                FROM IF-MIB  -- RFC2863
```

```
    Float32TC
                FROM FLOAT-TC-MIB  -- RFC6340
    ;

nhdpMIB MODULE-IDENTITY
       LAST-UPDATED "201205021000Z" -- May 02, 2012
       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 (2012). This version
            of this MIB module is part of RFCXXXX; see the RFC
```

```
            itself for full legal notices."

       -- revision
       REVISION "201205021000Z" -- May 02, 2012
       DESCRIPTION
            "The first version of this MIB module,
             published as RFCXXXX.
            "
       -- RFC-Editor assigns XXXX
       ::= { mib-2 998 }   -- to be assigned by IANA

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


--
-- Textual Conventions
--
   -- Two new Textual Conventions have been defined in
   -- this MIB module for indexing into the following
   -- tables and indexing into other tables in other MIB modules.
   -- This was necessary because the NHDP protocol manages and
   -- indexes based upon dynamic address tuples, i.e.,
   -- address sets, 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
   -- neighbor within the MANET. The NeighborRouterIndex defines a
   -- unique (to the local router) index referencing a discovered
   -- virtual neighbor within the MANET.
   --
   -- Due to the nature of NHDP,
   -- 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
   -- neighbor interface or virtual neighbor under discussion.


NeighborIfIndex ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS       current
    DESCRIPTION
        "An arbitrary, locally unique identifier associated with a
        virtual interface of a discovered NHDP neighbor.
        Due to the nature of NHDP, the local router
        may not know if two distinct addresses belong to the
        same interface of a 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 may not remain constant from
        one re-initialization of the entity's network management
        agent to the next re-initialization.  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 chosen from the set of aggregated indexes,
        it must update all tables in this
        MIB module 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
```

```
        "An arbitrary, locally unique identifier associated with a
        virtual discovered neighbor (one or two hop).  Due to the
        nature of the NHDP protocol, the local router may identify
        multiple virtual neighbors  which in fact are one and
        the same.  Two hop neighbors with more than one advertised
        address will exhibit this behavior.  As the
        local router's knowledge of its neighbors' topology
        increases, the local router will be able to associate
        multiple virtual neighbor indexes into a single virtual
        neighbor index chosen from the set of aggregated indexes,
        it must update all tables in this MIB module 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 neighbor 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. If the
          corresponding entry with ifIndex value is deleted
          from the Interface Table, then the entry in
          this table is automatically deleted.

          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
            InterfaceIndex,
         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      InterfaceIndex
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The ifIndex for this interface."
      ::= { nhdpInterfaceEntry 1 }

   nhdpIfStatus  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-create
      STATUS      current
      DESCRIPTION
         "nhdpIfStatus 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 of NHDP.
         "
      DEFVAL { false }
   ::= { nhdpInterfaceEntry 2 }


   --
   -- Interface Parameters - Message Intervals
   --
```

```
   nhdpHelloInterval  OBJECT-TYPE
      SYNTAX      Unsigned32
      UNITS       "milliseconds"
      MAX-ACCESS  read-create
      STATUS      current
      DESCRIPTION
         "nhdpHelloInterval corresponds to
          HELLO_INTERVAL of NHDP and represents the
          maximum time between the transmission of two
          successive HELLO messages on this MANET interface.

          The following constraint applies to this
          parameter:
             o nhdpHelloInterval >= 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-create
      STATUS      current
      DESCRIPTION
         "nhdpHelloMinInterval corresponds to
         HELLO_MIN_INTERVAL of NHDP and represents
         the minimum interval between transmission
         of two successive HELLO messages on this
         MANET interface.

         The following constraint applies to this
         parameter:
             o nhdpHelloInterval >= nhdpHelloMinInterval"
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of RFC6130."
      DEFVAL { 500 }
   ::= { nhdpInterfaceEntry 4 }


   nhdpRefreshInterval  OBJECT-TYPE
      SYNTAX      Unsigned32
      UNITS       "milliseconds"
      MAX-ACCESS  read-create
      STATUS      current
```

```
      DESCRIPTION
         "nhdpRefreshInterval corresponds to
         REFRESH_INTERVAL of NHDP and represents the
         maximum interval between advertisements, in
         a HELLO message on this MANET interface, of
         each 1-hop neighbor network address and its
         status.

         The following constraint applies to this
         parameter:
             o 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-create
      STATUS      current
      DESCRIPTION
         "nhdpLHoldTime corresponds to
         L_HOLD_TIME of NHDP and represents the period
         of advertisement, on this MANET interface, of
         former 1-hop neighbor network addresses as lost
         in HELLO messages, allowing recipients of these
         HELLO messages to accelerate removal of this
         information from their Link Sets.

         The following constraint applies to this
         parameter:
             o nhdpLHoldTime should be significantly greater
                  than nhdpRefreshInterval"
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of RFC6130."
      DEFVAL { 6000 }
   ::= { nhdpInterfaceEntry 6 }

   nhdpHHoldTime  OBJECT-TYPE
      SYNTAX      Unsigned32
      UNITS       "milliseconds"
```

```
      MAX-ACCESS  read-create
      STATUS      current
      DESCRIPTION
         "nhdpHHoldTime corresponds to
         H_HOLD_TIME of NHDP and is used as the Value
         in the VALIDITY_TIME Message TLV included in all
         HELLO messages on this MANET interface. It is then
         used by each router receiving such a HELLO message
         to indicate the validity of the information taken
         from that HELLO message and recorded in the receiving
         router's Information Bases.

         The following constraints apply to this
         parameter:
             o nhdpHHoldTime >= nhdpRefreshInterval
             o nhdpHHoldTime should be significantly greater
                  than nhdpRefreshInterval
             o nhdpHHoldTime must be representable as
                  described in RFC5497"
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of RFC6130."
      DEFVAL { 6000 }
   ::= { nhdpInterfaceEntry 7 }

   --
   -- Interface Parameters - Link Quality
   --

   nhdpHystAcceptQuality  OBJECT-TYPE
      SYNTAX      Float32TC
      MAX-ACCESS  read-create
      STATUS      current
      DESCRIPTION
         "nhdpHystAcceptQuality corresponds to
         HYST_ACCEPT of NHDP and represents the link
         quality threshold at or above which a link becomes
         usable, if it was not already so.

         The following constraint applies to this
         parameter:
              o 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-create
      STATUS      current
      DESCRIPTION
         "nhdpHystRejectQuality corresponds to
         HYST_REJECT of NHDP and represents the
         link quality threshold below which a
         link becomes unusable, if it was not
         already so.

          The following constraint applies to this
          parameter:
              o 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-create
      STATUS      current
      DESCRIPTION
         "nhdpInitialQuality corresponds to
         INITIAL_QUALITY of NHDP and represents the
         initial quality of a newly identified link.

          The following constraint applies to this
          parameter:
              o 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. If true, then a
```

```
        newly identified link is considered pending, and
        is not usable until the link quality has reached
        or exceeded the nhdpHystAcceptQuality threshold.

        The following constraints apply to this
        parameter:
            o If nhdpInitialQuality >= nhdpHystAcceptQuality,
              then nhdpInitialPending := false.
            o If nhdpInitialQuality < nhdpHystRejectQuality,
              then nhdpInitialPending := true."
    REFERENCE
        "Section 5 on Protocol Parameters and
         Constraints of RFC6130."
  ::= { nhdpInterfaceEntry 11 }

  --
  -- Interface Parameters - Jitter
  --
  nhdpHpMaxJitter  OBJECT-TYPE
    SYNTAX      Unsigned32
    UNITS       "milliseconds"
    MAX-ACCESS  read-create
    STATUS      current
    DESCRIPTION
        "nhdpHpMaxJitter corresponds to
        HP_MAXJITTER of NHDP and represents the
        value of MAXJITTER used in RFC5148 for
        periodically generated HELLO messages on
        this MANET interface.

        The following constraints apply to this
        parameter:
            o nhdpHpMaxJitter <= nhdpHelloInterval / 2
            o If nhdpHelloInterval > 0, then
              nhdpHpMaxJitter <= nhdpHelloMinInterval
              "
    REFERENCE
        "Section 5 on Protocol Parameters and
         Constraints of RFC6130."
    DEFVAL { 500 }
  ::= { nhdpInterfaceEntry 12 }


  nhdpHtMaxJitter  OBJECT-TYPE
    SYNTAX      Unsigned32
    UNITS       "milliseconds"
    MAX-ACCESS  read-create
    STATUS      current
```

```
      DESCRIPTION
         "nhdpHtMaxJitter corresponds to
         HT_MAXJITTER of NHDP and represents the
         value of MAXJITTER used in RFC5148 for
         externally triggered HELLO messages on this
         MANET interface.

         The following constraints apply to this
         parameter:
             o nhdpHtMaxJitter <= nhdpHelloInterval / 2
             o If nhdpHelloInterval > 0, then
               nhdpHtMaxJitter <= nhdpHelloMinInterval"
      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.

         An entry may not exist in the active state unless all
         objects in the entry have an appropriate value.

         If this object is not equal to active(1), all associated
         entries in the nhdpLibLocalIfSetTable, nhdpInterfaceStateTable,
         nhdpIibLinkSetTable and the nhdpInterfacePerfTable must be
         deleted."
      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 and is used as the period
         during which former 1-hop neighbor network
         addresses are advertised as lost in HELLO
         messages, allowing recipients of these HELLO
         messages to accelerate removal of this information
         from their 2-Hop Sets.

         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 and represents the period
         for which a recently used local interface network
         address is recorded.

         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
```

```
    --

    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 nhdpIfIndex.

           The Local Interface Set consists of Local Interface
           Address Tuples per network interface and their prefix
           lengths (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 for each 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 (RFC4001).

          Only the values ipv4(1) and
          ipv6(2) are supported."
      REFERENCE
         "RFC6130."
   ::= { nhdpLibLocalIfSetEntry 1 }

   nhdpLibLocalIfSetIpAddr  OBJECT-TYPE
      SYNTAX      InetAddress
      MAX-ACCESS  read-write
      STATUS      current
      DESCRIPTION
         "nhdpLibLocalIfSetIpAddr is an
          address of an interface of
          this router.

          This object is interpreted according to
          the setting of nhdpLibLocalIfSetIpAddrType."
      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. The mask is logically-ANDed
          to the nhdpLibLocalIfSetIpAddr to determine
          the address prefix.  A row match is true
          if the address used as an index falls within
          the network address range defined by the
          address prefix."
      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
   --

   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  read-only
      STATUS      current
      DESCRIPTION
         "The type of the nhdpLibRemovedIfAddrSetIpAddr
          in the InetAddress MIB (RFC4001).

          Only the values ipv4(1) and
          ipv6(2) are supported."
      REFERENCE
         "RFC6130."
   ::= { nhdpLibRemovedIfAddrSetEntry 1 }

   nhdpLibRemovedIfAddrSetIpAddr  OBJECT-TYPE
      SYNTAX      InetAddress
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpLibRemovedIfAddrSetIpAddr 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. The mask is logically-ANDed
          to the nhdpLibRemovedIfAddrSetIpAddr to determine
          the address prefix. A row match is true
          if the address used as an index falls within
          the network address range defined by the
          address prefix."
      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
           "nhdpLibRemovedIfAddrSetIRTime specifies the sysUptime
          when to expire this entry and remove it from the
          'nhdpNibLostNeighborSetTable'"
        REFERENCE
           "RFC6130."
     ::= { nhdpLibRemovedIfAddrSetEntry 5 }




--
-- nhdpStateObjGrp
--

-- Contains information describing the current state of the NHDP
```

```
-- process on this router.

nhdpStateObjGrp    OBJECT IDENTIFIER ::= { nhdpObjects 2 }


   nhdpUpTime OBJECT-TYPE
       SYNTAX TimeStamp
        MAX-ACCESS read-only
        STATUS current
        DESCRIPTION
             "The value of sysUpTime at the time current NHDP
              process was initialized.
             "
    ::= { 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 value of nhdpIfIndex is an ifIndex 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 nhdpIfIndex."
      INDEX { nhdpIfIndex }
   ::= { nhdpInterfaceStateTable 1 }

   NhdpInterfaceStateEntry ::=
      SEQUENCE {
```

```
        nhdpIfStateUpTime
           TimeStamp
        }

   nhdpIfStateUpTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
             "The value of the sysUpTime when this
              interface was last initialized as a
              MANET interface."
   ::= { 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 { nhdpDiscIfSetIndex }
    ::= { nhdpDiscIfSetTable 1 }

    NhdpDiscIfSetEntry ::=
       SEQUENCE {
          nhdpDiscIfSetIndex
            Integer32,
          nhdpDiscIfIndex
            NeighborIfIndex,
          nhdpDiscRouterIndex
            NeighborRouterIndex,
          nhdpDiscIfSetIpAddrType
            InetAddressType,
          nhdpDiscIfSetIpAddr
            InetAddress,
          nhdpDiscIfSetIpAddrPrefixLen
            InetAddressPrefixLength
         }

   nhdpDiscIfSetIndex  OBJECT-TYPE
      SYNTAX      Integer32 (0..65535)
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The index for this table. Necessary
          because multiple addresses may be associated
          with a given nhdpDiscIfIndex."
      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
          MIB modules."
      REFERENCE
         "RFC6130."
   ::= { nhdpDiscIfSetEntry 2 }

   nhdpDiscRouterIndex  OBJECT-TYPE
      SYNTAX      NeighborRouterIndex
      MAX-ACCESS  read-only
      STATUS      current
```

```
      DESCRIPTION
         "The NHDP neighbor index (locally created)
          of a neighboring router.  Used for cross
          indexing into other NHDP tables and other
          MIB modules."
      REFERENCE
         "RFC6130."
   ::= { nhdpDiscIfSetEntry 3 }

   nhdpDiscIfSetIpAddrType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The type of the nhdpDiscIfSetIpAddr
          in the InetAddress MIB (RFC4001).

          Only the values ipv4(1) and
          ipv6(2) are supported."
      REFERENCE
         "RFC6130."
   ::= { nhdpDiscIfSetEntry 4 }

   nhdpDiscIfSetIpAddr  OBJECT-TYPE
      SYNTAX      InetAddress
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The nhdpDiscIfSetIpAddr is a
          recently used address of a neighbor
          of this router."
      REFERENCE
         "RFC6130."
   ::= { nhdpDiscIfSetEntry 5 }

   nhdpDiscIfSetIpAddrPrefixLen  OBJECT-TYPE
      SYNTAX      InetAddressPrefixLength
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "Indicates the number of leading one bits that
          form the mask. The mask is logically-ANDed
          to the nhdpDiscIfSetIpAddr to determine
          the address prefix. A row match is true
          if the address used as an index falls within
          the network address range defined by the
          address prefix."
      REFERENCE
```

```
          "RFC6130."
   ::= { nhdpDiscIfSetEntry 6 }


   -- Interface Information Base (IIB)

   --
   -- Link Set
   --

   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 and represents the
         time up to which the MANET interface of the
         1-hop neighbor would be considered heard if
         not considering link quality."
      REFERENCE
         "RFC6130."
   ::= { nhdpIibLinkSetEntry 1 }

   nhdpIibLinkSetLSymTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLSymTime corresponds
         to L_SYM_time of NHDP and represents the time
         up to which the link to the 1-hop neighbor
         would be considered symmetric if not considering
         link quality."
      REFERENCE
         "RFC6130."
   ::= { nhdpIibLinkSetEntry 2 }

   nhdpIibLinkSetLPending  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLPending corresponds
         to L_pending of NHDP and is a boolean flag,
         describing if a link is considered pending
         (i.e., a candidate, but not yet established,
         link)."
```

```
      REFERENCE
         "RFC6130."
   ::= { nhdpIibLinkSetEntry 3 }

   nhdpIibLinkSetLLost  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLLost corresponds
         to L_lost of NHDP and is a boolean flag,
         describing if a link is considered lost due
         to low link quality."
      REFERENCE
         "RFC6130."
   ::= { nhdpIibLinkSetEntry 4 }

   nhdpIibLinkSetLTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLTime specifies the sysUptime
          when to expire this entry and remove it from the
          'nhdpIibLinkSetTable'.
         "
      REFERENCE
         "RFC6130."
   ::= { nhdpIibLinkSetEntry 5 }


  --
  -- 2-Hop Set
  --
    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."
       REFERENCE
          "RFC6130."
    ::= { nhdpStateObjGrp 5 }
```

```
    nhdpIib2HopSetEntry  OBJECT-TYPE
       SYNTAX      NhdpIib2HopSetEntry
       MAX-ACCESS  not-accessible
       STATUS      current
       DESCRIPTION
          "nhdpIib2HopSetTable 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).

           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.
           The nhdpIfIndex in the INDEX is
           interface index of the local interface
           through which these 2-hop addresses are
           accessible."
       REFERENCE
          "RFC6130."
       INDEX { nhdpIfIndex,
               nhdpIib2HopSetIpAddressType,
               nhdpIib2HopSetIpAddress }
    ::= { nhdpIib2HopSetTable 1 }

    NhdpIib2HopSetEntry ::=
       SEQUENCE {
          nhdpIib2HopSetIpAddressType
            InetAddressType,
          nhdpIib2HopSetIpAddress
            InetAddress,
          nhdpIib2HopSetIpAddrPrefixLen
            InetAddressPrefixLength,
          nhdpIib2HopSet1HopIfIndex
            NeighborIfIndex,
          nhdpIib2HopSetN2Time
            TimeStamp
        }

   nhdpIib2HopSetIpAddressType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The type of the nhdpIib2HopSetIpAddress
```

```
          in the InetAddress MIB module (RFC4001).

          Only the values ipv4(1) and
          ipv6(2) are supported."
      REFERENCE
         "RFC6130."
   ::= { nhdpIib2HopSetEntry 1 }

   nhdpIib2HopSetIpAddress  OBJECT-TYPE
      SYNTAX      InetAddress
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "nhdpIib2HopSetIpAddr corresponds
         to N2_2hop_addr of NHDP and is a network
         address of a symmetric 2-hop neighbor that
         has a symmetric link (using any MANET
         interface) to the indicated symmetric
         1-hop neighbor."
      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. The mask is logically-ANDed
          to the nhdpIib2HopSetIpAddress to determine
          the address prefix. A row match is true
          if the address used as an index falls within
          the network address range defined by the
          address prefix."
      REFERENCE
         "RFC6130."
   ::= { nhdpIib2HopSetEntry 3 }

   nhdpIib2HopSet1HopIfIndex  OBJECT-TYPE
      SYNTAX      NeighborIfIndex
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIib2HopSet1HopIfIndex is
          nhdpDiscIfIndex of the 1-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 the sysUptime
          when to expire this entry and remove it from the
          'nhdpIib2HopSetTable'."
      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.


   --
   -- Neighbor Set
   --
   --     The 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)
           "
      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 and is a boolean flag,
         describing if this is a symmetric 1-hop neighbor."
      REFERENCE
         "RFC6130."
  ::= { nhdpNibNeighborSetEntry 1 }


  --
  -- Lost Neighbor Set
  --
    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 the sysUptime
          when to expire this entry and remove it from the
          'nhdpNibLostNeighborSetTable'."
      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
           TimeStamp,
         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      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This object returns the sysUpTime when
         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.
          A change in the set of Link Tuples corresponding
          to the appropriate Neighbor Tuple is registered,
          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
            TimeStamp
        }

   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      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This object returns the sysUpTime
         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

   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 occurrences exceeds this threshold
              within the previous nhdpNbrStateChangeWindow,
              then the nhdpNbrStateChange notification
              is to be sent.

              It is recommended that the value of this
              threshold be set to at least 10, and higher
              in dense topologies with frequent expected
              topology changes.
             "
          DEFVAL { 10 }
          ::= { nhdpNotificationsControl 1 }
```

```
   nhdpNbrStateChangeWindow OBJECT-TYPE
          SYNTAX       TimeTicks
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A time window for the
              nhdpNbrStateChange object. If the
              number of occurrences exceeds the
              nhdpNbrStateChangeThreshold
              within the previous nhdpNbrStateChangeWindow,
              then the nhdpNbrStateChange notification
              is to be sent.

              It is recommended that the value for this
              window be set to at least 5 times the
              nhdpHelloInterval.

              This object represents the time in hundredths
              of a second.
             "
          DEFVAL { 1000 }
          ::= { nhdpNotificationsControl 2 }

   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 occurrences exceeds this threshold
              within the previous nhdp2HopNbrStateChangeWindow,
              then the nhdp2HopNbrStateChange notification
              is to be sent.

              It is recommended that the value of this
              threshold be set to at least 10, and higher
              when topologies are expected to be highly dynamic.
             "
          DEFVAL { 10 }
          ::= { nhdpNotificationsControl 3 }

   nhdp2HopNbrStateChangeWindow OBJECT-TYPE
          SYNTAX       TimeTicks
          MAX-ACCESS   read-write
          STATUS       current
          DESCRIPTION
             "A time window for the
```

```
            nhdp2HopNbrStateChange object. If the
            number of occurrences exceeds the
            nhdp2HopNbrStateChangeThreshold
            within the previous nhdp2HopNbrStateChangeWindow,
            then the nhdp2HopNbrStateChange notification
            is to be sent.

            It is recommended that the value for this
            window be set to at least 5 times
            nhdpHelloInterval.

            This object represents the time in hundredths
            of a second.
           "
        DEFVAL { 1000 }
        ::= { nhdpNotificationsControl 4 }

   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 occurrences exceeds this threshold
            within the previous nhdpIfRxBadPacketWindow,
            then the nhdpIfRxBadPacket notification
            is to be sent.
           "
        DEFVAL { 10 }
        ::= { nhdpNotificationsControl 5 }

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

            It is recommended that the value for this
            window be set to 5 times the nhdpHelloInterval.
```

```
             This object represents the time in hundredths
             of a second.
            "
          DEFVAL { 1000 }
          ::= { nhdpNotificationsControl 6 }



   -- 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
                    nhdpPacketSrcAddrType, -- The type of the source IP
                                         -- address of the packet
                    nhdpPacketSrcAddr    -- 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. In NHDP it is not
           necessary to remove Protocol Tuples from Protocol Sets
           at the exact time indicated, only to behave as if the
           Protocol Tuples were removed at that time. This case is
           indicated here as 'down(0)', all other cases being
           indicated as 'assymetric(1)' or 'symmetric(2)'. If down,
           the direct neighbor is also added to the
           nhdpNibLostNeighborSetTable.
```

```
          "
      ::= { nhdpNotificationsStates 1 }

   nhdp2HopNbrState OBJECT-TYPE
       SYNTAX       INTEGER {
                       down(0),
                       up(1)
                       }
       MAX-ACCESS   read-only
       STATUS       current
       DESCRIPTION
          "NHDP 2-hop neighbor states.  In NHDP it is not
           necessary to remove Protocol Tuples from Protocol Sets
           at the exact time indicated, only to behave as if the
           Protocol Tuples were removed at that time. This case is
           indicated here as 'down(0)', otherwise as 'up(1)'."
       ::= { nhdpNotificationsStates 2 }

   nhdpIfState OBJECT-TYPE
       SYNTAX       TruthValue
       MAX-ACCESS   read-only
       STATUS       current
       DESCRIPTION
          "NHDP MANET interface states. This indicates whether
           the 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.
          "
       ::= { nhdpNotificationsStates 3 }

  nhdpPacketSrcAddrType 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.

           Only the values ipv4(1) and ipv6(2) are supported.
           "
          ::= { nhdpNotificationsStates 4 }

   nhdpPacketSrcAddr 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,
             the 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 }

  OBJECT  nhdpLibLocalIfSetIpAddrType
  SYNTAX  InetAddressType { ipv4(1), ipv6(2) }
  DESCRIPTION
      "An implementation is only required to support
       IPv4 and IPv6 addresses."

  OBJECT  nhdpLibLocalIfSetIpAddr
  SYNTAX  InetAddress (SIZE(4|16))
  DESCRIPTION
      "An implementation is only required to support
       IPv4 and IPv6 addresses."

  OBJECT  nhdpLibRemovedIfAddrSetIpAddrType
  SYNTAX  InetAddressType { ipv4(1), ipv6(2) }
  DESCRIPTION
```

```
      "An implementation is only required to support
       IPv4 and IPv6 addresses."

  OBJECT  nhdpLibRemovedIfAddrSetIpAddr
  SYNTAX  InetAddress (SIZE(4|16))
  DESCRIPTION
      "An implementation is only required to support
       IPv4 and IPv6 addresses."

  ::= { 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 }

  -- Configuration Group
  OBJECT  nhdpLibLocalIfSetIpAddrType
  SYNTAX  InetAddressType { ipv4(1), ipv6(2) }
  DESCRIPTION
      "An implementation is only required to support
       IPv4 and IPv6 addresses."

  OBJECT  nhdpLibLocalIfSetIpAddr
  SYNTAX  InetAddress (SIZE(4|16))
  DESCRIPTION
      "An implementation is only required to support
       IPv4 and IPv6 addresses."

  OBJECT  nhdpLibRemovedIfAddrSetIpAddrType
  SYNTAX  InetAddressType { ipv4(1), ipv6(2) }
  DESCRIPTION
      "An implementation is only required to support
       IPv4 and IPv6 addresses."

  OBJECT  nhdpLibRemovedIfAddrSetIpAddr
  SYNTAX  InetAddress (SIZE(4|16))
```

```
  DESCRIPTION
      "An implementation is only required to support
       IPv4 and IPv6 addresses."

  -- State Group
  OBJECT  nhdpDiscIfSetIpAddrType
  SYNTAX  InetAddressType { ipv4(1), ipv6(2) }
  DESCRIPTION
      "An implementation is only required to support
       IPv4 and IPv6 addresses."

  OBJECT  nhdpDiscIfSetIpAddr
  SYNTAX  InetAddress (SIZE(4|16))
  DESCRIPTION
      "An implementation is only required to support
       IPv4 and IPv6 addresses."

  -- Notification Group
  OBJECT  nhdpPacketSrcAddrType
  SYNTAX  InetAddressType { ipv4(1), ipv6(2) }
  DESCRIPTION
      "An implementation is only required to support
       IPv4 and IPv6 addresses."

  OBJECT  nhdpPacketSrcAddr
  SYNTAX  InetAddress (SIZE(4|16))
  DESCRIPTION
      "An implementation is only required to support
       IPv4 and IPv6 addresses."



  ::= { nhdpCompliances 2 }


--
-- Units of Conformance
--

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

```
              nhdpHystRejectQuality,
              nhdpInitialQuality,
              nhdpInitialPending,
              nhdpHpMaxJitter,
              nhdpHtMaxJitter,
              nhdpNHoldTime,
              nhdpIHoldTime,
              nhdpIfRowStatus,
              nhdpLibLocalIfSetIpAddrType,
              nhdpLibLocalIfSetIpAddr,
              nhdpLibLocalIfSetIpAddrPrefixLen,
              nhdpLibLocalIfSetIsManet,
              nhdpLibRemovedIfAddrSetIpAddrType,
              nhdpLibRemovedIfAddrSetIpAddr,
              nhdpLibRemovedIfAddrSetIpAddrPrefixLen,
              nhdpLibRemovedIfAddrSetIfIndex,
              nhdpLibRemovedIfAddrSetIRTime
            }
    STATUS  current
    DESCRIPTION
       "Set of NHDP configuration objects implemented
        in this module."
 ::= { nhdpMIBGroups 2 }

nhdpStateGroup OBJECT-GROUP
   OBJECTS {
              nhdpUpTime,
              nhdpIfIndex,
              nhdpIfStateUpTime,
              nhdpDiscRouterIndex,
              nhdpDiscIfIndex,
              nhdpDiscIfSetIpAddrType,
              nhdpDiscIfSetIpAddr,
              nhdpDiscIfSetIpAddrPrefixLen,
              nhdpIibLinkSetLHeardTime,
              nhdpIibLinkSetLSymTime,
              nhdpIibLinkSetLPending,
              nhdpIibLinkSetLLost,
              nhdpIibLinkSetLTime,
              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 {
            nhdpNbrStateChangeThreshold,
            nhdpNbrStateChangeWindow,
            nhdp2HopNbrStateChangeThreshold,
            nhdp2HopNbrStateChangeWindow,
            nhdpIfRxBadPacketThreshold,
            nhdpIfRxBadPacketWindow,
            nhdpIfState,
            nhdpNbrState,
            nhdp2HopNbrState,
            nhdpPacketSrcAddrType,
            nhdpPacketSrcAddr
      }
      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 module 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 an 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 module 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 object 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. Acknowledgements

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Appendix A.

```
   ************************************************************
   * Note to the RFC Editor (to be removed prior to publication) *
   *                                                          *
   * 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.                              *
   *                                                          *
   ************************************************************
```

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