Internet Engineering Task Force (IETF)
Request for Comments: 7939
Obsoletes: 6779
Category: Standards Track
ISSN: 2070-1721

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August 2016

Definition of Managed Objects for the Neighborhood Discovery Protocol

Abstract

This document replaces RFC 6779; it contains revisions and extensions to the original document. It 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 extensions described in this document add objects and values to support the NHDP optimization specified in RFC 7466. The MIB module defined in this document, denoted NHDP-MIB, also reports state, performance information, and notifications about NHDP. This additional state and performance information is useful to troubleshoot problems and performance issues during neighbor discovery.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc7939.

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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 Mobile Ad Hoc Network (MANET) Neighborhood Discovery Protocol (NHDP) [RFC6130] process on a router. The MIB module defined in this document, denoted NHDP-MIB, also reports state, performance information, and notifications about NHDP. This additional state and performance information is useful to troubleshoot problems and performance issues during neighbor discovery.

1.1. Differences from RFC 6779

This document obsoletes [RFC6779], replacing that document as the specification of the MIB module for [RFC6130]. This revision to [RFC6779] is necessitated by the update to [RFC6130] specified in [RFC7466].

The MIB module for [RFC6130], specified in this document, captures the new information and states for each symmetric 2-hop neighbor, recorded in the Neighbor Information Base of a router and to be reflected in the appropriate tables, introduced by [RFC7466], specifically:

- Addition of objects nhdpIib2HopSetN2Lost and nhdpIfPerfCounterDiscontinuityTime.
- Addition of extra value (notconsidered) to nhdp2HopNbrState.
- Revised full compliance state.

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 RFC 3410 [RFC3410].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIv2, which is described in STD 58, RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [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 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 predefined events on the managed router.
- Configuration Objects - switches, tables, and objects that are initialized to default settings or set through the management interface defined by this MIB module.
- State Objects - automatically generated values that define the current operating state of the NHDP instance in the router.
- Performance Objects - automatically generated values that help to assess the performance of the NHDP instance on the router and the overall discovery performance within the MANET.

4.2. Notation

The same notations as defined in [RFC6130] are used throughout this document.

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 that reflect the current state of the NHDP instance running on the router.
  - Performance Group - defining objects that 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 routing domains.

5.1.1. Introduction

Notifications can be emitted by a router running an instance of this specification as a reaction to a specific event. This allows an observer of these events to efficiently determine the source of problems or significant changes of configuration or topology, instead of polling a possibly large number of 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 router that originates the notification is included in the variable list so that the source of the notification may be determined.

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 2-hop neighbors of the 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 predefined and administratively configured time interval has elapsed. It is RECOMMENDED that this time interval be at least 3 times nhdpHelloInterval so that symmetric neighbors are discovered. The suppression window for notifications is started when the nhdpIfStatus transitions from its default value of 'false(2)' to 'true(1)'.

5.1.3.2. Throttling Notifications

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

Appropriate values for the window time and upper bound are to be administratively configured 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 routers running NHDP (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 traps with a window time of 10 seconds" as the 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 that the threshold value for the objects reflecting the change be set to a value of '10' and the DEFAULT values for these objects within the Notifications Group be set to this value. Further, a time window for the change objects is defined within this MIB module. If the number of occurrences exceeds the change threshold within the previous change window, then it is RECOMMENDED that the notification 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, and nhdp2HopNbrStateChangeWindow.

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

Two constructs, i.e., TEXTUAL-CONVENTIONs, are defined to support the tables in the State Group. NHDP 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 router) defined, unique identifiers of virtual neighbors and neighbor interfaces. Due to the nature of NHDP, 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 for updating MIB tables using these indexes as the local router learns more about its neighbors' topologies. 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 an observer determining unusual topology changes or other changes that affect stability and reliability of the MANET.

5.5. Tables and Indexing

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

- the local router,
- a local MANET interface on the router,
- other routers that are one hop removed from the local router,
- interfaces on other routers that are one hop removed from the local router, and
- other routers that are two hops removed from the local router.

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

- nhdpIfIndex - the IfIndex of the local router on which NHDP is configured.
- nhdpDiscIfIndex - a locally managed index representing a known interface on a neighboring router.
- nhdpDiscRouterIndex - a locally managed index representing an ID of a known neighboring router.

These tables and their indexing are:

- nhdpInterfaceTable - describes the configuration of the interfaces of this router. This table has INDEX { nhdpIfIndex }.
- nhdpLibLocalIfSetTable - records all network addresses that are defined as local interface network addresses on this router. This table has INDEX { nhdpLibLocalIfSetIndex }.

- nhdpLibRemovedIfAddrSetTable - records network addresses that were recently used as local interface network addresses on this router but have been removed. This table has INDEX { nhdpLibRemovedIfAddrSetIndex }.

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

- nhdpDiscIfSetTable - includes 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 - for each local interface, records all links belonging to other routers that are, or recently were, 1-hop neighbors to this router. This table has INDEX { nhdpIfIndex, nhdpDiscIfIndex }.

- nhdpIib2HopSetTable - for each local interface, records network addresses (one at a time) of symmetric 2-hop neighbors and the symmetric links to symmetric 1-hop neighbors of this router through which these symmetric 2-hop neighbors can be reached. This table has INDEX { nhdpIfIndex, nhdpDiscIfIndex, nhdpIib2HopSetIpAddressType, nhdpIib2HopSetIpAddress }.

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

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

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

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

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

- nhdpIib2HopSetPerfTable - records performance objects that are measured for discovered 2-hop neighbors of this 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. MIB modules and specific definitions imported from 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. Relationship to the If-MIB

The nhdpInterfaceTable in this MIB module describes the configuration of the interfaces of this router that are intended to use MANET control protocols. As such, this table 'sparse augments' the ifTable [RFC2863] specifically when NHDP is to be configured to operate over this interface. The interface is identified by the ifIndex from the Interfaces Group defined in the Interfaces Group MIB module [RFC2863].

A conceptual row in the nhdpInterfaceTable exists if and only if either the row has been administratively created or there is an interface on the managed device that supports and runs NHDP. This implies that for each entry in the nhdpInterfaceTable, there is a corresponding entry in the Interface Table where nhdpIfIndex and ifIndex are equal. If that corresponding entry in the Interface Table is deleted, then the entry in nhdpInterfaceTable is automatically deleted, NHDP is disabled on this interface, and all configuration and state information related to this interface is to be removed from memory.

6.4. MIB Modules Required for IMPORTS

The following NHDP-MIB module IMPORTS objects from SNMPv2-SMI [RFC2578], SNMPv2-TC [RFC2579], SNMPv2-CONF [RFC2580], IF-MIB [RFC2863], SNMP-FRAMEWORK-MIB [RFC3411], 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 (RFC 6130) - Mobile Ad Hoc Network (MANET)
-- Neighborhood Discovery Protocol (NHDP),
-- 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  -- RFC 2578

    TEXTUAL-CONVENTION, TruthValue, TimeStamp,
                RowStatus
                FROM SNMPv2-TC  -- RFC 2579

    MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
                FROM SNMPv2-CONF  -- STD 58

    SnmpAdminString
                FROM SNMP-FRAMEWORK-MIB  -- RFC 3411
```

```
    InetAddressType, InetAddress,
    InetAddressPrefixLength
                FROM INET-ADDRESS-MIB  -- RFC 4001

    InterfaceIndex
                FROM IF-MIB  -- RFC 2863

    Float32TC
                FROM FLOAT-TC-MIB  -- RFC 6340
    ;

nhdpMIB MODULE-IDENTITY
        LAST-UPDATED "201607120000Z" -- 12 July 2016
        ORGANIZATION "IETF MANET Working Group"
        CONTACT-INFO
        "WG Email: manet@ietf.org
         WG web page: https://datatracker.ietf.org/wg/manet

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```

```
        DESCRIPTION
            "This NHDP-MIB module is applicable to routers
             implementing the Mobile Ad Hoc Network (MANET)
             Neighborhood Discovery Protocol (NHDP)
             defined in RFC 6130.

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             BSD License set forth in Section 4.c of the IETF Trust's
             Legal Provisions Relating to IETF Documents
             (http://trustee.ietf.org/license-info)."

        -- revision
        REVISION "201607120000Z" -- 12 July 2016
        DESCRIPTION
             "Updated version of this MIB module,
              including updates made to NHDP by
              RFC 7466, published as RFC 7939."
        REVISION "201210221000Z" -- 22 October 2012
        DESCRIPTION
             "Initial version of this MIB module,
              published as RFC 6779."
        ::= { mib-2 213 }

--
-- 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 NHDP 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 IP Addresses 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 a 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,
       and it MUST update all tables in this
       MIB module that are indexed by indexes
       of type NeighborIfIndex.  It MAY 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 NHDP, the local router may identify
       multiple virtual neighbors that, in fact, are one and
       the same.  Neighbors that are two hops away 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 MAY 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 if an application is deleted
       and re-created.

       The specific value is meaningful only within a given SNMP
       entity.  A NeighborRouterIndex value MUST NOT be reused
       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 that configure specific options
-- that determine the overall performance and operation of
-- NHDP.


nhdpConfigurationObjGrp  OBJECT IDENTIFIER ::= { nhdpObjects 1 }

   nhdpInterfaceTable  OBJECT-TYPE
      SYNTAX      SEQUENCE OF NhdpInterfaceEntry
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The nhdpInterfaceTable describes the
          configuration of the interfaces of this router
          that are intended to use MANET control protocols.
          As such, this table 'sparse augments' the ifTable
          specifically when NHDP is to be configured to
          operate over this interface.  The interface is
          identified by the ifIndex from the Interfaces
          Group defined in the Interfaces Group MIB module.

          A conceptual row in this table exists if and only
          if the row has been administratively created
          or there is an interface on the managed device
          that supports and runs NHDP.

          A row can be administratively created by setting
          rowStatus to 'createAndGo' or 'createAndWait'.
          During the row creation, objects having associated
          DEFVAL clauses are automatically defined by
          the agent if not explicitly administratively defined.

          For each entry in the nhdpInterfaceTable, there is a
          corresponding entry in the Interface Table where
          nhdpIfIndex and ifIndex are equal.  If that corresponding
          entry in the Interface Table is deleted, then the entry in
          the nhdpInterfaceTable is automatically deleted,
```

```
            NHDP is disabled on this interface, and all configuration
            and state information related to this interface is to be
            removed from memory."
         REFERENCE
            "RFC 2863 - The Interfaces Group MIB, McCloghrie,
            K., and F. Kastenholtz, June 2000"
      ::= { nhdpConfigurationObjGrp 1 }

      nhdpInterfaceEntry  OBJECT-TYPE
         SYNTAX      NhdpInterfaceEntry
         MAX-ACCESS  not-accessible
         STATUS      current
         DESCRIPTION
            "The nhdpInterfaceEntry describes one NHDP
            local interface configuration as indexed by
            its ifIndex as defined in the Standard MIB II
            Interface Table (RFC 2863).

            The objects in this table are persistent, and when
            written, the device SHOULD save the change to
            nonvolatile storage.  For further information
            on the storage behavior for these objects, refer
            to the description for the nhdpIfRowStatus
            object."
         INDEX { nhdpIfIndex }
      ::= { nhdpInterfaceTable 1 }

      NhdpInterfaceEntry ::=
         SEQUENCE {
            nhdpIfIndex
               InterfaceIndex,
            nhdpIfName
               SnmpAdminString,
            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  not-accessible
      STATUS      current
      DESCRIPTION
         "This value MUST correspond to an ifIndex referring
          to a valid entry in the Interfaces Table."
      REFERENCE
         "RFC 2863 - The Interfaces Group MIB, McCloghrie, K.,
          and F. Kastenholtz, June 2000"
   ::= { nhdpInterfaceEntry 1 }

   nhdpIfName  OBJECT-TYPE
      SYNTAX      SnmpAdminString
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The textual name of the interface.  The value of this
          object SHOULD be the name of the interface as assigned by
          the local device.  This can be a text-name, such as 'le0'
          or a simple port number, such as '1',
          depending on the interface-naming syntax of the device.

          If there is no local name or this object is otherwise not
          applicable, then this object contains a zero-length string."
   ::= { nhdpInterfaceEntry 2 }

   nhdpIfStatus  OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-create
      STATUS      current
```

```
      DESCRIPTION
         "nhdpIfStatus indicates whether this interface is
          currently running NHDP.  A value of 'true(1)' indicates
          that NHDP is running on this interface.
          A value of 'false(2)' indicates that NHDP is not
          currently running on this interface.  This corresponds
          to the I_manet parameter in the Local Interface Set
          of NHDP."
      DEFVAL { false }
   ::= { nhdpInterfaceEntry 3 }

   --
   -- 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.

          Guidance for setting this object may be found
          in Section 5 of the NHDP specification (RFC 6130),
          which indicates that:
             o nhdpHelloInterval > 0
             o nhdpHelloInterval >= nhdpHelloMinInterval"
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of RFC 6130 - Mobile Ad Hoc
          Network (MANET) Neighborhood Discovery
          Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
      DEFVAL { 2000 }
   ::= { nhdpInterfaceEntry 4 }

   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.

          Guidance for setting this object may be found
          in Section 5 of the NHDP specification (RFC 6130),
          which indicates that:
             o nhdpHelloMinInterval <= nhdpHelloInterval"
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of RFC 6130 - Mobile Ad Hoc Network
          (MANET) Neighborhood Discovery Protocol (NHDP),
          Clausen, T., Dearlove, C., and J. Dean, April 2011"
      DEFVAL { 500 }
   ::= { nhdpInterfaceEntry 5 }

   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 of
          each 1-hop neighbor network address and its
          status.  Each advertisement is in a HELLO
          message on this MANET interface.

          Guidance for setting this object may be found
          in Section 5 of the NHDP specification (RFC 6130),
          which indicates that:
             o nhdpRefreshInterval >= nhdpHelloInterval"
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of RFC 6130 - Mobile Ad Hoc Network
          (MANET) Neighborhood Discovery Protocol (NHDP),
          Clausen, T., Dearlove, C., and J. Dean, April 2011"
      DEFVAL { 2000 }
   ::= { nhdpInterfaceEntry 6 }

   --
   -- 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.

          Guidance for setting this object may be found
          in Section 5 of the NHDP specification (RFC 6130),
          which indicates that it should be assigned a
          value significantly greater than the refresh
          interval held by nhdpRefreshInterval."
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of RFC 6130 - Mobile Ad Hoc Network
          (MANET) Neighborhood Discovery Protocol (NHDP),
          Clausen, T., Dearlove, C., and J. Dean, April 2011"
      DEFVAL { 6000 }
   ::= { nhdpInterfaceEntry 7 }

   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.

          Guidance for setting this object may be found
          in Section 5 of the NHDP specification (RFC 6130),
          which indicates that it should be assigned a
          value significantly greater than the refresh interval
          held by nhdpRefreshInterval and must be representable
          as described in RFC 5497."
```

```
      REFERENCE
         "RFC 5497 - Representing Multi-Value Time in Mobile Ad
          Hoc Networks (MANETs), Clausen, T., and C. Dearlove,
          March 2009.

          Section 5 on Protocol Parameters and
          Constraints of RFC 6130 - Mobile Ad Hoc Network
          (MANET) Neighborhood Discovery Protocol (NHDP),
          Clausen, T., Dearlove, C., and J. Dean, April 2011"
      DEFVAL { 6000 }
   ::= { nhdpInterfaceEntry 8 }

   --
   -- 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.

          Guidance for setting this object may be found
          in Section 5 of the NHDP specification (RFC 6130),
          which indicates that:
             o 0 <= nhdpHystRejectQuality
                 <= nhdpHystAcceptQuality <= 1.0

          The default value for this object is 1.0. According to
          RFC 6340:
             Since these textual conventions are defined in terms
             of the OCTET STRING type, the SMI's mechanisms for
             formally setting range constraints are not available.
             MIB designers using these textual conventions will need
             to use DESCRIPTION clauses to spell out any applicable
             range constraints beyond those implied by the underlying
             IEEE types.
          Therefore, this object does not have a DEFVAL clause."
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of RFC 6130 - Mobile Ad Hoc Network
          (MANET) Neighborhood Discovery Protocol (NHDP),
          Clausen, T., Dearlove, C., and J. Dean, April 2011"
--    DEFVAL { 1.0 }   see DESCRIPTION
```

```
   ::= { nhdpInterfaceEntry 9 }

   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.

          Guidance for setting this object may be found
          in Section 5 of the NHDP specification (RFC 6130),
          which indicates that:
             o 0 <= nhdpHystRejectQuality
                 <= nhdpHystAcceptQuality <= 1.0

          The default value for this object is 0.0. According to
          RFC 6340:
             Since these textual conventions are defined in terms
             of the OCTET STRING type, the SMI's mechanisms for
             formally setting range constraints are not available.
             MIB designers using these textual conventions will need
             to use DESCRIPTION clauses to spell out any applicable
             range constraints beyond those implied by the underlying
             IEEE types.
          Therefore, this object does not have a DEFVAL clause."
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of RFC 6130 - Mobile Ad Hoc Network
          (MANET) Neighborhood Discovery Protocol (NHDP),
          Clausen, T., Dearlove, C., and J. Dean, April 2011"
--    DEFVAL { 0.0 }   see DESCRIPTION
   ::= { nhdpInterfaceEntry 10 }

   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.

          Guidance for setting this object may be found
          in Section 5 of the NHDP specification (RFC 6130),
```

```
            which indicates that:
               o 0 <= nhdpInitialQuality <= 1.0

            The default value for this object is 1.0. According to
            RFC 6340:
               Since these textual conventions are defined in terms
               of the OCTET STRING type, the SMI's mechanisms for
               formally setting range constraints are not available.
               MIB designers using these textual conventions will need
               to use DESCRIPTION clauses to spell out any applicable
               range constraints beyond those implied by the underlying
               IEEE types.
            Therefore, this object does not have a DEFVAL clause."
         REFERENCE
            "Section 5 on Protocol Parameters and
            Constraints of RFC 6130 - Mobile Ad Hoc Network
            (MANET) Neighborhood Discovery Protocol (NHDP),
            Clausen, T., Dearlove, C., and J. Dean, April 2011"
--       DEFVAL { 1.0 }   see DESCRIPTION
      ::= { nhdpInterfaceEntry 11 }

      nhdpInitialPending  OBJECT-TYPE
         SYNTAX      TruthValue
         MAX-ACCESS  read-create
         STATUS      current
         DESCRIPTION
            "nhdpInitialPending corresponds to
            INITIAL_PENDING of NHDP.  If the value of this object
            is 'true(1)', then a newly identified link is considered
            pending and is not usable until the link quality
            has reached or exceeded the nhdpHystAcceptQuality
            threshold.

            Guidance for setting this object may be found
            in Section 5 of the NHDP specification (RFC 6130),
            which indicates that:
               o If nhdpInitialQuality >= nhdpHystAcceptQuality,
                 then nhdpInitialPending := false(2).
               o If nhdpInitialQuality < nhdpHystRejectQuality,
                 then nhdpInitialPending := true(1)."
         REFERENCE
            "Section 5 on Protocol Parameters and
            Constraints of RFC 6130 - Mobile Ad Hoc Network
            (MANET) Neighborhood Discovery Protocol (NHDP),
            Clausen, T., Dearlove, C., and J. Dean, April 2011"
         DEFVAL { false }
      ::= { nhdpInterfaceEntry 12 }
```

```
   --
   -- 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 RFC 5148 for
          periodically generated HELLO messages on
          this MANET interface.

          Guidance for setting this object may be found
          in Section 5 of RFC 5148, which indicates that:
             o nhdpHpMaxJitter <= nhdpHelloInterval / 2
             o nhdpHpMaxJitter should not be greater
               than nhdpHelloInterval / 4
             o If nhdpMinHelloInterval > 0, then
               nhdpHpMaxJitter <= nhdpHelloMinInterval; and
               nhdpHpMaxJitter should not be greater than
               nhdpHelloMinInterval / 2"
      REFERENCE
         "Section 5 of RFC 5148 - Jitter Considerations in
          Mobile Ad Hoc Networks (MANETs),
          Clausen, T., Dearlove, C., and B. Adamson, February 2008"
      DEFVAL { 500 }
   ::= { nhdpInterfaceEntry 13 }


   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 RFC 5148 for
          externally triggered HELLO messages on this
          MANET interface.

          Guidance for setting this object may be found
          in Section 5 of RFC 5148, which indicates that:
             o nhdpHtMaxJitter <= nhdpHelloInterval / 2
```

```
            o nhdpHtMaxJitter should not be greater
              than nhdpHelloInterval / 4
            o If nhdpMinHelloInterval > 0, then
              nhdpHtMaxJitter <= nhdpHelloMinInterval; and
              nhdpHtMaxJitter should not be greater than
              nhdpHelloMinInterval / 2"
      REFERENCE
         "Section 5 of RFC 5148 - Jitter Considerations in
          Mobile Ad Hoc Networks (MANETs),
          Clausen, T., Dearlove, C., and B. Adamson, February 2008"
      DEFVAL { 500 }
   ::= { nhdpInterfaceEntry 14 }

   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(1)' state unless all
          objects in the entry have a defined appropriate value.  For
          objects with DEFVAL clauses, the management station
          does not need to specify the value of this object in order
          for the row to transit to the 'active(1)' state; the default
          value for this object is used.  For objects that do not
          have DEFVAL clauses, the value of this object prior
          to this row transitioning to the 'active(1)' state MUST be
          administratively specified.


          When this object transitions to 'active(1)', all objects
          in this row SHOULD be written to nonvolatile (stable)
          storage.  Read-create objects in this row MAY be modified.
          When an object in a row with nhdpIfRowStatus of 'active(1)'
          is changed, then the updated value MUST be reflected in NHDP,
          and this new object value MUST be written to nonvolatile
          storage.

          If the value of this object is not equal to 'active(1)',
          all associated entries in the nhdpLibLocalIfSetTable,
          nhdpInterfaceStateTable, nhdpIibLinkSetTable, and
          nhdpInterfacePerfTable MUST be deleted."
```

```
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
      DEFVAL { active }
   ::= { nhdpInterfaceEntry 15 }


   --
   -- 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
          nonvolatile storage."
      REFERENCE
         "Section 5 on Protocol Parameters and
          Constraints of RFC 6130 - Mobile Ad Hoc Network
          (MANET) Neighborhood Discovery Protocol (NHDP),
          Clausen, T., Dearlove, C., and J. Dean, April 2011"
      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
            nonvolatile storage."
        REFERENCE
           "Section 5 on Protocol Parameters and
            Constraints of RFC 6130 - Mobile Ad Hoc Network
            (MANET) Neighborhood Discovery Protocol (NHDP),
            Clausen, T., Dearlove, C., and J. Dean, April 2011"
        DEFVAL { 6000 }
    ::= { nhdpConfigurationObjGrp 3 }


    -- A 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 that are defined as local
            MANET interface network addresses.
            As such, this table 'sparse augments' the
            nhdpInterfaceTable when network addresses are
            being defined for the interfaces existing within
            the nhdpInterfaceTable.  The local interface
            is defined by the nhdpIfIndex.

            The Local Interface Set consists of Local Interface
            Address Tuples per MANET interface and their prefix
            lengths (in order to determine the network addresses
            related to the interface).

            A conceptual row in this table exists if and only
            if one has been administratively created.  This can be done
            by setting rowStatus to 'createAndGo' or 'createAndWait'.

            Further guidance on the addition or removal of
            local addresses and network addresses is found
            in Section 9 of RFC 6130."
        REFERENCE
            "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
             Discovery Protocol (NHDP), Clausen, T., Dearlove,
             C., and J. Dean, April 2011"
    ::= { nhdpConfigurationObjGrp 4 }
```

```
   nhdpLibLocalIfSetEntry  OBJECT-TYPE
      SYNTAX      NhdpLibLocalIfSetEntry
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "A router's Local Interface Set consists
          of Local Interface Tuples for each network
          interface.

          The objects in this table are persistent, and when
          written, the device SHOULD save the change to
          nonvolatile storage.  For further information
          on the storage behavior for these objects, refer
          to the description for the nhdpLibLocalIfSetRowStatus
          object."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
      INDEX { nhdpLibLocalIfSetIndex }
   ::= { nhdpLibLocalIfSetTable 1 }

   NhdpLibLocalIfSetEntry ::=
      SEQUENCE {
         nhdpLibLocalIfSetIndex
            Integer32,
         nhdpLibLocalIfSetIfIndex
            InterfaceIndex,
         nhdpLibLocalIfSetIpAddrType
            InetAddressType,
         nhdpLibLocalIfSetIpAddr
            InetAddress,
         nhdpLibLocalIfSetIpAddrPrefixLen
            InetAddressPrefixLength,
         nhdpLibLocalIfSetRowStatus
            RowStatus
      }

   nhdpLibLocalIfSetIndex  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 nhdpIfIndex."
```

```
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpLibLocalIfSetEntry 1 }

   nhdpLibLocalIfSetIfIndex  OBJECT-TYPE
      SYNTAX      InterfaceIndex
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "Specifies the local nhdpIfIndex for which this
          IP address was added."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpLibLocalIfSetEntry 2 }

   nhdpLibLocalIfSetIpAddrType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  read-create
      STATUS      current
      DESCRIPTION
         "The type of the nhdpLibLocalIfSetIpAddr
          in the InetAddress MIB (RFC 4001).

          Only the values 'ipv4(1)' and
          'ipv6(2)' are supported."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpLibLocalIfSetEntry 3 }

   nhdpLibLocalIfSetIpAddr  OBJECT-TYPE
      SYNTAX      InetAddress (SIZE(4|16))
      MAX-ACCESS  read-create
      STATUS      current
      DESCRIPTION
         "nhdpLibLocalIfSetIpAddr is an
          address of an interface of
          this router.

          This object is interpreted according to
          the setting of nhdpLibLocalIfSetIpAddrType."
```

```
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
         C., and J. Dean, April 2011"
   ::= { nhdpLibLocalIfSetEntry 4 }

   nhdpLibLocalIfSetIpAddrPrefixLen  OBJECT-TYPE
      SYNTAX      InetAddressPrefixLength
      MAX-ACCESS  read-create
      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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpLibLocalIfSetEntry 5 }

   nhdpLibLocalIfSetRowStatus  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(1)' state unless all
          read-create objects in the entry have a defined
          appropriate value.  As no objects in this table have
          DEFVAL clauses, the management station MUST specify
          the values of all read-create objects prior to this row
          transitioning to the 'active(1)' state.

          When this object transitions to 'active(1)', all objects
          in this row SHOULD be written to nonvolatile (stable)
          storage.  Read-create objects in this row MAY be modified.
          When an object in a row with nhdpIfRowStatus of 'active(1)'
          is changed, then the updated value MUST be reflected in NHDP,
```

```
            and this new object value MUST be written to nonvolatile
            storage."
        REFERENCE
           "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
            Discovery Protocol (NHDP), Clausen, T., Dearlove,
            C., and J. Dean, April 2011"
        DEFVAL { notReady }
     ::= { nhdpLibLocalIfSetEntry 6 }



   --
   -- 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 that 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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 addresses and the
          router's Interface is found in RFC 4293 (ipAddressTable)"
```

```
      REFERENCE
         "RFC 4293 - Management Information Base for the Internet
          Protocol (IP), S. Routhier, Ed., April 2006.

          RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
      INDEX { nhdpLibRemovedIfAddrSetIndex }
   ::= { nhdpLibRemovedIfAddrSetTable 1 }

   NhdpLibRemovedIfAddrSetEntry ::=
      SEQUENCE {
         nhdpLibRemovedIfAddrSetIndex
            Integer32,
         nhdpLibRemovedIfAddrSetIpAddrType
            InetAddressType,
         nhdpLibRemovedIfAddrSetIpAddr
            InetAddress,
         nhdpLibRemovedIfAddrSetIpAddrPrefixLen
            InetAddressPrefixLength,
         nhdpLibRemovedIfAddrSetIfIndex
            InterfaceIndex,
         nhdpLibRemovedIfAddrSetIRTime
            TimeStamp
      }

   nhdpLibRemovedIfAddrSetIndex  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 nhdpIfIndex."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpLibRemovedIfAddrSetEntry 1 }

   nhdpLibRemovedIfAddrSetIpAddrType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The type of the nhdpLibRemovedIfAddrSetIpAddr
          in the InetAddress MIB (RFC 4001).
```

```
          Only the values 'ipv4(1)' and
          'ipv6(2)' are supported."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpLibRemovedIfAddrSetEntry 2 }

   nhdpLibRemovedIfAddrSetIpAddr  OBJECT-TYPE
      SYNTAX      InetAddress (SIZE(4|16))
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpLibRemovedIfAddrSetIpAddr is a
          recently used address of an interface of
          this router."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpLibRemovedIfAddrSetEntry 3 }

   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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpLibRemovedIfAddrSetEntry 4 }

   nhdpLibRemovedIfAddrSetIfIndex  OBJECT-TYPE
      SYNTAX      InterfaceIndex
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "Specifies the local IfIndex from which this
          IP address was recently removed."
```

```
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpLibRemovedIfAddrSetEntry 5 }

   nhdpLibRemovedIfAddrSetIRTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpLibRemovedIfAddrSetIRTime specifies the value
          of sysUpTime when this entry should expire and be
          removed from the nhdpLibRemovedIfAddrSetTable."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpLibRemovedIfAddrSetEntry 6 }

--
-- 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 the 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 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
            nonvolatile 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
          NHDP was last initialized on this
          MANET interface."
   ::= { nhdpInterfaceStateEntry 1 }


   --
   -- This table allows for the mapping between discovered
   -- remote interfaces and routers and their addresses.
   --

   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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
      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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpDiscIfSetEntry 3 }

   nhdpDiscIfSetIpAddrType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The type of the nhdpDiscIfSetIpAddr
          in the InetAddress MIB (RFC 4001).
```

```
          Only the values 'ipv4(1)' and
          'ipv6(2)' are supported."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpDiscIfSetEntry 4 }

   nhdpDiscIfSetIpAddr  OBJECT-TYPE
      SYNTAX      InetAddress (SIZE(4|16))
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "The nhdpDiscIfSetIpAddr is a
          recently used address of a neighbor
          of this router."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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 that are, or recently
          were, 1-hop neighbors."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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).

          The local interface is indexed via the
          nhdpIfIndex.  The 1-hop interface is
          indexed via the nhdpDiscIfIndex.  There
          SHOULD be an entry in this table for each
          local interface and associated 1-hop
          neighbor reachable on this local interface.

          Note that L_quality is not included in the
          entries below, because updates may be
          required too frequently."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
      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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpIibLinkSetEntry 4 }

   nhdpIibLinkSetLTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIibLinkSetLTime specifies the value
          of sysUpTime when this entry should expire and be
          removed from the nhdpIibLinkSetTable."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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_lost, N2_time).

          The entries include:
            - the 2-hop neighbor addresses
              ('N2_neighbor_iface_addr_list'), which
              act as the table index,
            - the associated symmetric 1-hop
              neighbor address set ('N2_2hop_addr'), designated
              through nhdpDiscIfIndex,
            - a flag indicating if the 1-hop neighbor
              through which this 2-hop neighbor is reachable
              ('N2_lost') is considered lost due to link quality,
              or not,
            - and the expiration time ('N2_time').

          The nhdpIfIndex in the INDEX is the interface index of
          the local interface through which these 2-hop addresses
          are accessible.  The nhdpDiscIfIndex in the INDEX
```

```
          represents the 1-hop neighbor interface through which
          these 2-hop neighbor addresses are reachable."

      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011
          and
          RFC 7466 - An Optimization for the Mobile Ad Hoc
          Network (MANET) Neighborhood Discovery Protocol (NHDP),
          Dearlove, C., and T. Clausen, March 2015"
      INDEX { nhdpIfIndex,
              nhdpDiscIfIndex,
              nhdpIib2HopSetIpAddressType,
              nhdpIib2HopSetIpAddress
      }
   ::= { nhdpIib2HopSetTable 1 }

   NhdpIib2HopSetEntry ::=
      SEQUENCE {
         nhdpIib2HopSetIpAddressType
            InetAddressType,
         nhdpIib2HopSetIpAddress
            InetAddress,
         nhdpIib2HopSetIpAddrPrefixLen
            InetAddressPrefixLength,
         nhdpIib2HopSet1HopIfIndex
            NeighborIfIndex,
         nhdpIib2HopSetN2Time
            TimeStamp,
         nhdpIib2HopSetN2Lost
            TruthValue
      }

   nhdpIib2HopSetIpAddressType  OBJECT-TYPE
      SYNTAX      InetAddressType
      MAX-ACCESS  not-accessible
      STATUS      current
      DESCRIPTION
         "The type of the nhdpIib2HopSetIpAddress
          in the InetAddress MIB module (RFC 4001).

          Only the values 'ipv4(1)' and
          'ipv6(2)' are supported."
```

```
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpIib2HopSetEntry 1 }

   nhdpIib2HopSetIpAddress  OBJECT-TYPE
      SYNTAX      InetAddress (SIZE(4|16))
      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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpIib2HopSetEntry 3 }

   nhdpIib2HopSet1HopIfIndex  OBJECT-TYPE
      SYNTAX      NeighborIfIndex
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpIib2HopSet1HopIfIndex is
          nhdpDiscIfIndex of the 1-hop
```

```
            neighbor that communicated the ipAddress
            of the 2-hop neighbor in this row entry."
        REFERENCE
           "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
            Discovery Protocol (NHDP), Clausen, T., Dearlove,
            C., and J. Dean, April 2011"
    ::= { nhdpIib2HopSetEntry 4 }

    nhdpIib2HopSetN2Time  OBJECT-TYPE
        SYNTAX      TimeStamp
        MAX-ACCESS  read-only
        STATUS      current
        DESCRIPTION
           "nhdpIib2HopSetN2Time specifies the value
            of sysUpTime when this entry should expire and be
            removed from the nhdpIib2HopSetTable."
        REFERENCE
           "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
            Discovery Protocol (NHDP), Clausen, T., Dearlove,
            C., and J. Dean, April 2011"
    ::= { nhdpIib2HopSetEntry 5 }


        nhdpIib2HopSetN2Lost OBJECT-TYPE
        SYNTAX          TruthValue
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
           "nhdpIib2HopSetN2Lost corresponds to N2_lost of NHDP and
            is a boolean flag, describing if for a 2-Hop Tuple, the
            corresponding Link Tuple currently is considered lost
            due to link quality."

        REFERENCE
           "RFC 7466 - An Optimization for the Mobile Ad Hoc
            Network (MANET) Neighborhood Discovery Protocol (NHDP),
            Dearlove, C., and T. Clausen, March 2015"
    ::= {nhdpIib2HopSetEntry 6}


    --
    -- 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
      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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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 that were recently
          symmetric 1-hop neighbors but are now
          advertised as lost."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
      INDEX { nhdpDiscRouterIndex }
   ::= { nhdpNibLostNeighborSetTable 1 }
```

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

   nhdpNibLostNeighborSetNLTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "nhdpNibLostNeighborSetNLTime
          specifies the value of sysUpTime when this entry
          should expire and be removed from the
          nhdpNibLostNeighborSetTable."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpNibLostNeighborSetEntry 1 }


--
-- nhdpPerformanceObjGrp
--
-- Contains objects that 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.
          nhdpIfPerfCounterDiscontinuityTime indicates
          the most recent occasion at which any one or more
          of this interface's counters listed in this table
          suffered a discontinuity."
```

```
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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,
         nhdpIfPerfCounterDiscontinuityTime
            TimeStamp
      }

   nhdpIfHelloMessageXmits  OBJECT-TYPE
      SYNTAX      Counter32
      UNITS       "messages"
      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
      UNITS       "messages"
      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
      UNITS       "octets"
      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
      UNITS       "octets"
      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
      UNITS       "messages"
      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
      UNITS       "messages"
      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
         UNITS       "neighbors"
         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
         UNITS       "neighbors"
         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
         UNITS       "neighbors"
         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 }

      nhdpIfPerfCounterDiscontinuityTime  OBJECT-TYPE
         SYNTAX      TimeStamp
         MAX-ACCESS  read-only
         STATUS      current
         DESCRIPTION
            "The value of sysUpTime on the most recent occasion at which
             any one or more of this interface's counters suffered a
             discontinuity.  If no such discontinuities have occurred
             since the last reinitialization of the local management
             subsystem, then this object contains a zero value."
      ::= { nhdpInterfacePerfEntry 10 }
```

```
   --
   -- Objects per discovered neighbor interface
   --
   nhdpDiscIfSetPerfTable OBJECT-TYPE
      SYNTAX       SEQUENCE OF NhdpDiscIfSetPerfEntry
      MAX-ACCESS   not-accessible
      STATUS       current
      DESCRIPTION
         "A router's set of performance properties for
          each discovered interface of a neighbor."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
      INDEX { nhdpDiscIfIndex }
   ::= { nhdpDiscIfSetPerfTable 1 }

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

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

```
          "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
           Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpDiscIfSetPerfEntry 1 }

   nhdpDiscIfExpectedPackets  OBJECT-TYPE
      SYNTAX      Counter32
      UNITS       "packets"
      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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpDiscIfSetPerfEntry 2 }


   --
   -- Objects concerning the Neighbor Set
   --
   nhdpNibNeighborSetChanges  OBJECT-TYPE
      SYNTAX      Counter32
      UNITS       "changes"
      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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
      INDEX { nhdpDiscRouterIndex }
   ::= { nhdpDiscNeighborSetPerfTable 1 }

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

   nhdpDiscNeighborNibNeighborSetChanges  OBJECT-TYPE
      SYNTAX      Counter32
      UNITS       "changes"
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This object returns the number of changes
          to the given Neighbor Tuple."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpDiscNeighborSetPerfEntry 1 }
```

```
   nhdpDiscNeighborNibNeighborSetUpTime  OBJECT-TYPE
      SYNTAX      TimeStamp
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
         "This object returns the sysUpTime when a new
          nhdpNibNeighborSetEntry has been created for a
          particular nhdpNibNeighborSetRouterIndex."
      REFERENCE
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpDiscNeighborSetPerfEntry 2 }

   nhdpDiscNeighborNibNeighborSetReachableLinkChanges  OBJECT-TYPE
      SYNTAX      Counter32
      UNITS       "changes"
      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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
      INDEX { nhdpDiscRouterIndex }
   ::= { nhdpIib2HopSetPerfTable 1 }

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

   nhdpIib2HopSetPerfChanges  OBJECT-TYPE
      SYNTAX      Counter32
      UNITS       "changes"
      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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { 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
         "RFC 6130 - Mobile Ad Hoc Network (MANET) Neighborhood
          Discovery Protocol (NHDP), Clausen, T., Dearlove,
          C., and J. Dean, April 2011"
   ::= { nhdpIib2HopSetPerfEntry 2 }


--
-- nhdpNotifications
--

nhdpNotificationsObjects OBJECT IDENTIFIER ::= { nhdpNotifications 0 }
nhdpNotificationsControl OBJECT IDENTIFIER ::= { nhdpNotifications 1 }
nhdpNotificationsStates  OBJECT IDENTIFIER ::= { nhdpNotifications 2 }

   -- nhdpNotificationsObjects

   nhdpNbrStateChange  NOTIFICATION-TYPE
      OBJECTS { nhdpIfName,  -- The originator of the notification.
                nhdpNbrState  -- The new state
      }
      STATUS       current
      DESCRIPTION
         "nhdpNbrStateChange is a notification sent when
          more than nhdpNbrStateChangeThreshold neighbors change
          their status (i.e., 'down(0)', 'asymmetric(1)', or
          'symmetric(2)') within a time window of
          nhdpNbrStateChangeWindow."
   ::= { nhdpNotificationsObjects 1 }

   nhdp2HopNbrStateChange  NOTIFICATION-TYPE
      OBJECTS { nhdpIfName,      -- The originator
                                 -- of the notification
                nhdp2HopNbrState  -- The new state
      }
      STATUS      current
      DESCRIPTION
         "nhdp2HopNbrStateChange is a notification sent
          when more than nhdp2HopNbrStateChangeThreshold 2-hop
          neighbors change their nhdp2HopNbrState
          within a time window of
          nhdp2HopNbrStateChangeWindow."
   ::= { nhdpNotificationsObjects 2 }
```

```
   nhdpIfStateChange  NOTIFICATION-TYPE
      OBJECTS { nhdpIfName,  -- The local interface
                nhdpIfStatus  -- The new status
      }
      STATUS       current
      DESCRIPTION
         "nhdpIfStateChange is a notification sent when
          nhdpIfStatus has changed on this interface."
   ::= { nhdpNotificationsObjects 3 }

   -- nhdpNotificationsControl

   nhdpNbrStateChangeThreshold  OBJECT-TYPE
      SYNTAX      Integer32 (0..255)
      UNITS       "changes"
      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)
         UNITS       "changes"
         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 }
```

```
    -- 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 'asymmetric(1)' or 'symmetric(2)'.  If 'down(0)',
          the direct neighbor is also added to the
          nhdpNibLostNeighborSetTable."
   ::= { nhdpNotificationsStates 1 }

  nhdp2HopNbrState  OBJECT-TYPE
     SYNTAX      INTEGER {
                    down(0),
                    up(1),
                    notconsidered(2)
                 }
     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, it is either 'up(1)', if
         N2_lost for the 2-Hop Tuple is equal to false, or
         'notconsidered(2)' otherwise."
     ::= { nhdpNotificationsStates 2 }

--
-- nhdpConformance information
--

nhdpCompliances       OBJECT IDENTIFIER ::= { nhdpConformance 1 }
nhdpMIBGroups         OBJECT IDENTIFIER ::= { nhdpConformance 2 }
```

```
   -- Compliance Statements
   nhdpBasicCompliance  MODULE-COMPLIANCE
      STATUS      current
      DESCRIPTION
         "The basic implementation requirements for
          managed network entities that implement
          NHDP."
      MODULE -- this module
      MANDATORY-GROUPS { nhdpConfigurationGroup }
   ::= { nhdpCompliances 1 }

   nhdpFullCompliance2  MODULE-COMPLIANCE
      STATUS      current
      DESCRIPTION
         "The full implementation requirements for
          managed network entities that implement
          NHDP."
      MODULE -- this module
      MANDATORY-GROUPS { nhdpConfigurationGroup,
                         nhdpStateGroup2,
                         nhdpNotificationObjectGroup,
                         nhdpNotificationGroup,
                         nhdpPerformanceGroup
      }
   ::= { nhdpCompliances 3 }


--
-- Units of Conformance
--

   nhdpConfigurationGroup  OBJECT-GROUP
      OBJECTS {
         nhdpIfName,
         nhdpIfStatus,
         nhdpHelloInterval,
         nhdpHelloMinInterval,
         nhdpRefreshInterval,
         nhdpLHoldTime,
         nhdpHHoldTime,
         nhdpHystAcceptQuality,
         nhdpHystRejectQuality,
         nhdpInitialQuality,
         nhdpInitialPending,
         nhdpHpMaxJitter,
         nhdpHtMaxJitter,
         nhdpNHoldTime,
         nhdpIHoldTime,
```

```
         nhdpIfRowStatus,
         nhdpLibLocalIfSetIfIndex,
         nhdpLibLocalIfSetIpAddrType,
         nhdpLibLocalIfSetIpAddr,
         nhdpLibLocalIfSetIpAddrPrefixLen,
         nhdpLibLocalIfSetRowStatus,
         nhdpLibRemovedIfAddrSetIpAddrType,
         nhdpLibRemovedIfAddrSetIpAddr,
         nhdpLibRemovedIfAddrSetIpAddrPrefixLen,
         nhdpLibRemovedIfAddrSetIfIndex,
         nhdpLibRemovedIfAddrSetIRTime
      }
      STATUS      current
      DESCRIPTION
         "Set of NHDP configuration objects implemented
          in this module."
   ::= { nhdpMIBGroups 2 }

   nhdpPerformanceGroup  OBJECT-GROUP
      OBJECTS {
         nhdpIfHelloMessageXmits,
         nhdpIfHelloMessageRecvd,
         nhdpIfHelloMessageXmitAccumulatedSize,
         nhdpIfHelloMessageRecvdAccumulatedSize,
         nhdpIfHelloMessageTriggeredXmits,
         nhdpIfHelloMessagePeriodicXmits,
         nhdpIfHelloMessageXmitAccumulatedSymmetricNeighborCount,
         nhdpIfHelloMessageXmitAccumulatedHeardNeighborCount,
         nhdpIfHelloMessageXmitAccumulatedLostNeighborCount,
         nhdpIfPerfCounterDiscontinuityTime,
         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,
         nhdpNbrState,
         nhdp2HopNbrState
      }
      STATUS      current
      DESCRIPTION
         "Set of NHDP notification objects implemented
          in this module."
   ::= { nhdpMIBGroups 5 }

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

   nhdpStateGroup2  OBJECT-GROUP
      OBJECTS {
         nhdpUpTime,
         nhdpIfStateUpTime,
         nhdpDiscRouterIndex,
         nhdpDiscIfIndex,
         nhdpDiscIfSetIpAddrType,
         nhdpDiscIfSetIpAddr,
         nhdpDiscIfSetIpAddrPrefixLen,
         nhdpIibLinkSetLHeardTime,
         nhdpIibLinkSetLSymTime,
         nhdpIibLinkSetLPending,
         nhdpIibLinkSetLLost,
         nhdpIibLinkSetLTime,
         nhdpIib2HopSetIpAddrPrefixLen,
         nhdpIib2HopSet1HopIfIndex,
         nhdpIib2HopSetN2Time,
         nhdpIib2HopSetN2Lost,
         nhdpNibNeighborSetNSymmetric,
         nhdpNibLostNeighborSetNLTime
      }
```

```
      STATUS      current
      DESCRIPTION
         "Set of NHDP state objects implemented
          in this module."
   ::= { nhdpMIBGroups 7 }


--
-- Deprecated compliance statements and groups
--

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

          For version-independence, this compliance statement
          is deprecated in favor of nhdpFullCompliance2."
      MODULE -- this module
      MANDATORY-GROUPS { nhdpConfigurationGroup,
                         nhdpStateGroup,
                         nhdpNotificationObjectGroup,
                         nhdpNotificationGroup,
                         nhdpPerformanceGroup
      }
   ::= { nhdpCompliances 2 }

   nhdpStateGroup  OBJECT-GROUP
      OBJECTS {
         nhdpUpTime,
         nhdpIfStateUpTime,
         nhdpDiscRouterIndex,
         nhdpDiscIfIndex,
         nhdpDiscIfSetIpAddrType,
         nhdpDiscIfSetIpAddr,
         nhdpDiscIfSetIpAddrPrefixLen,
         nhdpIibLinkSetLHeardTime,
         nhdpIibLinkSetLSymTime,
         nhdpIibLinkSetLPending,
         nhdpIibLinkSetLLost,
         nhdpIibLinkSetLTime,
         nhdpIib2HopSetIpAddrPrefixLen,
         nhdpIib2HopSet1HopIfIndex,
         nhdpIib2HopSetN2Time,
         nhdpNibNeighborSetNSymmetric,
         nhdpNibLostNeighborSetNLTime
```

```
      }
      STATUS      deprecated
      DESCRIPTION
         "Set of NHDP state objects implemented
          in this module.

          For version-independence, this compliance statement
          is deprecated in favor of nhdpStateGroup2."
   ::= { nhdpMIBGroups 3 }


END
```

8. Security Considerations

This MIB module defines objects for the configuration, monitoring, and notification of the Mobile Ad Hoc Network (MANET) Neighborhood Discovery Protocol (NHDP) [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 opens devices to attack. 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 denial-of-service (DoS) attack by overloading interface resources.

- nhdpHystAcceptQuality, nhdpHystRejectQuality, nhdpInitialQuality, and 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 used 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, it is RECOMMENDED to provide support for the Transport Security Model (TSM) [RFC5591] in combination with TLS/DTLS [RFC6353].

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.

Implementations SHOULD provide the security features described by the SNMPv3 framework (see [RFC3410]), and implementations claiming compliance to the SNMPv3 standard MUST include full support for authentication and privacy via the User-based Security Model (USM) [RFC3414] with the AES cipher algorithm [RFC3826]. Implementations MAY also provide support for the Transport Security Model (TSM) [RFC5591] in combination with a secure transport such as SSH [RFC5592] or TLS/DTLS [RFC6353].

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. Applicability Statement

This document describes objects for configuring parameters of the Mobile Ad Hoc Network (MANET) Neighborhood Discovery Protocol (NHDP) [RFC6130] process on a router. This MIB module, denoted NHDP-MIB, also reports state, performance information, and notifications. This section provides some examples of how this MIB module can be used in MANET network deployments.

NHDP is designed to allow routers to automatically discover and track routers one hop remote (denoted "neighbors") and routers two hops remote (denoted "2-hop neighbors"). This information is used by other MANET protocols in operation on the router to perform routing, multicast forwarding, and other functions with ad hoc and mobile networks. In the following, three example scenarios are listed where this MIB module is useful:

- For a Parking Lot Initial Configuration Situation - It is common for the vehicles comprising the MANET being forward deployed at a remote location, e.g., the site of a natural disaster, to be off-loaded in a parking lot where an initial configuration of the networking devices is performed. The configuration is loaded into the devices from a fixed location Network Operations Center (NOC) at the parking lot, and the vehicles are stationary at the parking lot while the configuration changes are made. Standards-based methods for configuration management from the co-located NOC are necessary for this deployment option.

- For Mobile Vehicles with Low-Bandwidth Satellite Link to a Fixed NOC - Here, the vehicles carrying the MANET routers carry multiple wireless interfaces, one of which is a relatively low-bandwidth, on-the-move satellite connection that interconnects a fix NOC to the nodes of the MANET. Standards-based methods for monitoring and fault management from the fixed NOC are necessary for this deployment option.

- For Fixed NOC and Mobile Local Manager in Larger Vehicles - for larger vehicles, a hierarchical network management arrangement is useful. Centralized network management is performed from a fixed NOC while local management is performed locally from within the

vehicles. Standards-based methods for configuration, monitoring, and fault management are necessary for this deployment option.

10. IANA Considerations

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

Description	OBJECT IDENTIFIER value
NHDP-MIB	{ mib-2 213 }

11. References

11.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <http://www.rfc-editor.org/info/rfc2119>.

[RFC2578] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, DOI 10.17487/RFC2578, April 1999, <http://www.rfc-editor.org/info/rfc2578>.

[RFC2579] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Textual Conventions for SMIv2", STD 58, RFC 2579, DOI 10.17487/RFC2579, April 1999, <http://www.rfc-editor.org/info/rfc2579>.

[RFC2580] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Conformance Statements for SMIv2", STD 58, RFC 2580, DOI 10.17487/RFC2580, April 1999, <http://www.rfc-editor.org/info/rfc2580>.

[RFC2863] McCloghrie, K. and F. Kastenholz, "The Interfaces Group MIB", RFC 2863, DOI 10.17487/RFC2863, June 2000, <http://www.rfc-editor.org/info/rfc2863>.

[RFC3414] Blumenthal, U. and B. Wijnen, "User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)", STD 62, RFC 3414, DOI 10.17487/RFC3414, December 2002, <http://www.rfc-editor.org/info/rfc3414>.

[RFC3418] Presuhn, R., Ed., "Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)", STD 62, RFC 3418, DOI 10.17487/RFC3418, December 2002, <http://www.rfc-editor.org/info/rfc3418>.

[RFC3826] Blumenthal, U., Maino, F., and K. McCloghrie, "The Advanced Encryption Standard (AES) Cipher Algorithm in the SNMP User-based Security Model", RFC 3826, DOI 10.17487/RFC3826, June 2004, <http://www.rfc-editor.org/info/rfc3826>.

[RFC4001] Daniele, M., Haberman, B., Routhier, S., and J. Schoenwaelder, "Textual Conventions for Internet Network Addresses", RFC 4001, DOI 10.17487/RFC4001, February 2005, <http://www.rfc-editor.org/info/rfc4001>.

[RFC5591] Harrington, D. and W. Hardaker, "Transport Security Model for the Simple Network Management Protocol (SNMP)", STD 78, RFC 5591, DOI 10.17487/RFC5591, June 2009, <http://www.rfc-editor.org/info/rfc5591>.

[RFC5592] Harrington, D., Salowey, J., and W. Hardaker, "Secure Shell Transport Model for the Simple Network Management Protocol (SNMP)", RFC 5592, DOI 10.17487/RFC5592, June 2009, <http://www.rfc-editor.org/info/rfc5592>.

[RFC6130] Clausen, T., Dearlove, C., and J. Dean, "Mobile Ad Hoc Network (MANET) Neighborhood Discovery Protocol (NHDP)", RFC 6130, DOI 10.17487/RFC6130, April 2011, <http://www.rfc-editor.org/info/rfc6130>.

[RFC6340] Presuhn, R., "Textual Conventions for the Representation of Floating-Point Numbers", RFC 6340, DOI 10.17487/RFC6340, August 2011, <http://www.rfc-editor.org/info/rfc6340>.

[RFC6353] Hardaker, W., "Transport Layer Security (TLS) Transport Model for the Simple Network Management Protocol (SNMP)", STD 78, RFC 6353, DOI 10.17487/RFC6353, July 2011, <http://www.rfc-editor.org/info/rfc6353>.

[RFC7466] Dearlove, C. and T. Clausen, "An Optimization for the Mobile Ad Hoc Network (MANET) Neighborhood Discovery Protocol (NHDP)", RFC 7466, DOI 10.17487/RFC7466, March 2015, <http://www.rfc-editor.org/info/rfc7466>.

11.2. Informative References

[RFC3410] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction and Applicability Statements for Internet-Standard Management Framework", RFC 3410, DOI 10.17487/RFC3410, December 2002, <http://www.rfc-editor.org/info/rfc3410>.

[RFC3411] Harrington, D., Presuhn, R., and B. Wijnen, "An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks", STD 62, RFC 3411, DOI 10.17487/RFC3411, December 2002, <http://www.rfc-editor.org/info/rfc3411>.

[RFC4750] Joyal, D., Ed., Galecki, P., Ed., Giacalone, S., Ed., Coltun, R., and F. Baker, "OSPF Version 2 Management Information Base", RFC 4750, DOI 10.17487/RFC4750, December 2006, <http://www.rfc-editor.org/info/rfc4750>.

[RFC5148] Clausen, T., Dearlove, C., and B. Adamson, "Jitter Considerations in Mobile Ad Hoc Networks (MANETs)", RFC 5148, DOI 10.17487/RFC5148, February 2008, <http://www.rfc-editor.org/info/rfc5148>.

[RFC6779] Herberg, U., Cole, R., and I. Chakeres, "Definition of Managed Objects for the Neighborhood Discovery Protocol", RFC 6779, DOI 10.17487/RFC6779, October 2012, <http://www.rfc-editor.org/info/rfc6779>.

Acknowledgements

The authors wish to thank Benoit Claise, Elwyn Davies, Justin Dean, Adrian Farrel, Joel Halpern, Michael MacFaden, Al Morton, and Thomas Nadeau for their detailed reviews and insightful comments regarding RFC 6779 and this document.

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

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