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Definitions of Managed Objects for BGP-4

Status of This Memo

Copyright Notice

Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community In particular, it describes managed objects used for managing the Border Gateway Protocol Version 4 or lower.

The origin of this memo is from RFC 1269 "Definitions of Managed Objects for the Border Gateway Protocol (Version 3)", which was updated to support BGP-4 in RFC 1657. This memo fixes errors introduced when the MIB module was converted to use the SMIv2 language. This memo also updates references to the current SNMP framework documents.

This memo is intended to document deployed implementations of this MIB module in a historical context, to provide clarifications of some items, and to note errors where the MIB module fails to fully represent the BGP protocol. Work is currently in progress to replace this MIB module with a new one representing the current state of the BGP protocol and its extensions.

This document obsoletes RFC 1269 and RFC 1657.

Table of Contents

1. Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects used for managing the Border Gateway Protocol Version 4 or lower [BGP4, BGP4APP].

This memo obsoletes RFC 1657 and RFC 1269.

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. Overview

These objects are used to control and manage a BGP-4 implementation.

Apart from a few system-wide scalar objects, this MIB is broken into three tables: the BGP Peer Table, the BGP Received Path Attribute Table, and the BGP-4 Received Path Attribute Table. The BGP Peer Table contains information about state and current activity of connections with the BGP peers. The BGP Received Path Attribute Table contains path attributes received from all peers running BGP version 3 or less. The BGP-4 Received Path Attribute Table contains path attributes received from all BGP-4 peers. The actual attributes used in determining a route are a subset of the received attribute tables after local routing policy has been applied.

4. Definitions

```
BGP4-MIB DEFINITIONS ::= BEGIN

    IMPORTS
        MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
        IpAddress, Integer32, Counter32, Gauge32, mib-2
            FROM SNMPv2-SMI
        MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
            FROM SNMPv2-CONF;

    bgp MODULE-IDENTITY
        LAST-UPDATED "200601110000Z"
        ORGANIZATION "IETF IDR Working Group"
        CONTACT-INFO "E-mail:  idr@ietf.org

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        DESCRIPTION
                "The MIB module for the BGP-4 protocol.

                 Copyright (C) The Internet Society (2006).  This
                 version of this MIB module is part of RFC 4273;
                 see the RFC itself for full legal notices."

        REVISION "200601110000Z"
        DESCRIPTION
               "Changes from RFC 1657:

                1) Fixed the definitions of the notifications
                   to make them equivalent to their initial
                   definition in RFC 1269.
                2) Added compliance and conformance info.
                3) Updated information for the values of
                   bgpPeerNegotiatedVersion, bgp4PathAttrLocalPref,
                   bgp4PathAttrCalcLocalPref,
                   bgp4PathAttrMultiExitDisc,
                   bgp4PathAttrASPathSegement.
                4) Added additional clarification comments where
                   needed.
```

```
                5) Noted where objects do not fully reflect
                   the protocol as Known Issues.
                6) Updated the DESCRIPTION for the
                   bgp4PathAttrAtomicAggregate object.
                7) The following objects have had their DESCRIPTION
                   clause modified to remove the text that suggested
                   (using 'should' verb) initializing the counter
                   to zero on a transition to the established state:
                     bgpPeerInUpdates, bgpPeerOutUpdates,
                     bgpPeerInTotalMessages, bgpPeerOutTotalMessages
                   Those implementations that still do this are
                   still compliant with this new wording.
                   Applications should not assume counters have
                   started at zero.

                 Published as RFC 4273."

        REVISION "199405050000Z"
        DESCRIPTION
                "Translated to SMIv2 and published as RFC 1657."

        REVISION "199110261839Z"
        DESCRIPTION
                "Initial version, published as RFC 1269."
        ::= { mib-2 15 }

    bgpVersion OBJECT-TYPE
        SYNTAX     OCTET STRING (SIZE (1..255))
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "Vector of supported BGP protocol version
                 numbers.  Each peer negotiates the version
                 from this vector.  Versions are identified
                 via the string of bits contained within this
                 object.  The first octet contains bits 0 to
                 7, the second octet contains bits 8 to 15,
                 and so on, with the most significant bit
                 referring to the lowest bit number in the
                 octet (e.g., the MSB of the first octet
                 refers to bit 0).  If a bit, i, is present
                 and set, then the version (i+1) of the BGP
                 is supported."
        REFERENCE
                "RFC 4271, Section 4.2."
        ::= { bgp 1 }

    bgpLocalAs OBJECT-TYPE
```

```
        SYNTAX     Integer32 (0..65535)
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The local autonomous system number."
        REFERENCE
                 "RFC 4271, Section 4.2, 'My Autonomous System'."
        ::= { bgp 2 }

    -- BGP Peer table.  This table contains, one entry per
    -- BGP peer, information about the BGP peer.

    bgpPeerTable OBJECT-TYPE
        SYNTAX     SEQUENCE OF BgpPeerEntry
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
                "BGP peer table.  This table contains,
                 one entry per BGP peer, information about the
                 connections with BGP peers."
        ::= { bgp 3 }

    bgpPeerEntry OBJECT-TYPE
        SYNTAX     BgpPeerEntry
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
                "Entry containing information about the
                 connection with a BGP peer."
        INDEX { bgpPeerRemoteAddr }
        ::= { bgpPeerTable 1 }

    BgpPeerEntry ::= SEQUENCE {
            bgpPeerIdentifier
                IpAddress,
            bgpPeerState
                INTEGER,
            bgpPeerAdminStatus
                INTEGER,
            bgpPeerNegotiatedVersion
                Integer32,
            bgpPeerLocalAddr
                IpAddress,
            bgpPeerLocalPort
                Integer32,
            bgpPeerRemoteAddr
                IpAddress,
            bgpPeerRemotePort
```

```
            Integer32,
        bgpPeerRemoteAs
            Integer32,
        bgpPeerInUpdates
            Counter32,
        bgpPeerOutUpdates
            Counter32,
        bgpPeerInTotalMessages
            Counter32,
        bgpPeerOutTotalMessages
            Counter32,
        bgpPeerLastError
            OCTET STRING,
        bgpPeerFsmEstablishedTransitions
            Counter32,
        bgpPeerFsmEstablishedTime
            Gauge32,
        bgpPeerConnectRetryInterval
            Integer32,
        bgpPeerHoldTime
            Integer32,
        bgpPeerKeepAlive
            Integer32,
        bgpPeerHoldTimeConfigured
            Integer32,
        bgpPeerKeepAliveConfigured
            Integer32,
        bgpPeerMinASOriginationInterval
            Integer32,
        bgpPeerMinRouteAdvertisementInterval
            Integer32,
        bgpPeerInUpdateElapsedTime
            Gauge32
        }

    bgpPeerIdentifier OBJECT-TYPE
        SYNTAX     IpAddress
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The BGP Identifier of this entry's BGP peer.
                 This entry MUST be 0.0.0.0 unless the
                 bgpPeerState is in the openconfirm or the
                 established state."
        REFERENCE
                "RFC 4271, Section 4.2, 'BGP Identifier'."
        ::= { bgpPeerEntry 1 }
```

```
    bgpPeerState OBJECT-TYPE
        SYNTAX     INTEGER {
                           idle(1),
                           connect(2),
                           active(3),
                           opensent(4),
                           openconfirm(5),
                           established(6)
                   }
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The BGP peer connection state."
        REFERENCE
                "RFC 4271, Section 8.2.2."
        ::= { bgpPeerEntry 2 }

    bgpPeerAdminStatus OBJECT-TYPE
        SYNTAX     INTEGER {
                           stop(1),
                           start(2)
                   }
        MAX-ACCESS read-write
        STATUS     current
        DESCRIPTION
                "The desired state of the BGP connection.
                 A transition from 'stop' to 'start' will cause
                 the BGP Manual Start Event to be generated.
                 A transition from 'start' to 'stop' will cause
                 the BGP Manual Stop Event to be generated.
                 This parameter can be used to restart BGP peer
                 connections.  Care should be used in providing
                 write access to this object without adequate
                 authentication."
        REFERENCE
                "RFC 4271, Section 8.1.2."
        ::= { bgpPeerEntry 3 }

    bgpPeerNegotiatedVersion OBJECT-TYPE
        SYNTAX     Integer32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The negotiated version of BGP running between
                 the two peers.

                 This entry MUST be zero (0) unless the
                 bgpPeerState is in the openconfirm or the
```

```
                established state.

                Note that legal values for this object are
                between 0 and 255."
        REFERENCE
                "RFC 4271, Section 4.2.
                 RFC 4271, Section 7."
        ::= { bgpPeerEntry 4 }

    bgpPeerLocalAddr OBJECT-TYPE
        SYNTAX     IpAddress
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The local IP address of this entry's BGP
                 connection."
        ::= { bgpPeerEntry 5 }

    bgpPeerLocalPort OBJECT-TYPE
        SYNTAX     Integer32 (0..65535)
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The local port for the TCP connection between
                 the BGP peers."
        ::= { bgpPeerEntry 6 }

    bgpPeerRemoteAddr OBJECT-TYPE
        SYNTAX     IpAddress
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The remote IP address of this entry's BGP
                 peer."
        ::= { bgpPeerEntry 7 }

    bgpPeerRemotePort OBJECT-TYPE
        SYNTAX     Integer32 (0..65535)
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The remote port for the TCP connection
                 between the BGP peers.  Note that the
                 objects bgpPeerLocalAddr,
                 bgpPeerLocalPort, bgpPeerRemoteAddr, and
                 bgpPeerRemotePort provide the appropriate
                 reference to the standard MIB TCP
                 connection table."
```

```
        ::= { bgpPeerEntry 8 }

    bgpPeerRemoteAs OBJECT-TYPE
        SYNTAX     Integer32 (0..65535)
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The remote autonomous system number received in
                 the BGP OPEN message."
        REFERENCE
                "RFC 4271, Section 4.2."
        ::= { bgpPeerEntry 9 }

    bgpPeerInUpdates OBJECT-TYPE
        SYNTAX     Counter32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The number of BGP UPDATE messages
                 received on this connection."
        REFERENCE
                "RFC 4271, Section 4.3."
        ::= { bgpPeerEntry 10 }

    bgpPeerOutUpdates OBJECT-TYPE
        SYNTAX     Counter32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The number of BGP UPDATE messages
                 transmitted on this connection."
        REFERENCE
                "RFC 4271, Section 4.3."
        ::= { bgpPeerEntry 11 }

    bgpPeerInTotalMessages OBJECT-TYPE
        SYNTAX     Counter32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The total number of messages received
                 from the remote peer on this connection."
        REFERENCE
                "RFC 4271, Section 4."
        ::= { bgpPeerEntry 12 }

    bgpPeerOutTotalMessages OBJECT-TYPE
        SYNTAX     Counter32
```

```
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The total number of messages transmitted to
                 the remote peer on this connection."
        REFERENCE
                "RFC 4271, Section 4."
        ::= { bgpPeerEntry 13 }

    bgpPeerLastError OBJECT-TYPE
        SYNTAX     OCTET STRING (SIZE (2))
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The last error code and subcode seen by this
                 peer on this connection.  If no error has
                 occurred, this field is zero.  Otherwise, the
                 first byte of this two byte OCTET STRING
                 contains the error code, and the second byte
                 contains the subcode."
        REFERENCE
                "RFC 4271, Section 4.5."
        ::= { bgpPeerEntry 14 }

    bgpPeerFsmEstablishedTransitions OBJECT-TYPE
        SYNTAX     Counter32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The total number of times the BGP FSM
                 transitioned into the established state
                 for this peer."
        REFERENCE
                "RFC 4271, Section 8."
        ::= { bgpPeerEntry 15 }

    bgpPeerFsmEstablishedTime OBJECT-TYPE
        SYNTAX     Gauge32
        UNITS      "seconds"
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "This timer indicates how long (in
                 seconds) this peer has been in the
                 established state or how long
                 since this peer was last in the
                 established state.  It is set to zero when
                 a new peer is configured or when the router is
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```
                booted."
        REFERENCE
                "RFC 4271, Section 8."
        ::= { bgpPeerEntry 16 }

    bgpPeerConnectRetryInterval OBJECT-TYPE
        SYNTAX     Integer32 (1..65535)
        UNITS      "seconds"
        MAX-ACCESS read-write
        STATUS     current
        DESCRIPTION
                "Time interval (in seconds) for the
                 ConnectRetry timer.  The suggested value
                 for this timer is 120 seconds."
        REFERENCE
                "RFC 4271, Section 8.2.2.  This is the value used
                 to initialize the 'ConnectRetryTimer'."
        ::= { bgpPeerEntry 17 }

    bgpPeerHoldTime OBJECT-TYPE
        SYNTAX     Integer32  ( 0 | 3..65535 )
        UNITS      "seconds"
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "Time interval (in seconds) for the Hold
                 Timer established with the peer.  The
                 value of this object is calculated by this
                 BGP speaker, using the smaller of the
                 values in bgpPeerHoldTimeConfigured and the
                 Hold Time received in the OPEN message.

                 This value must be at least three seconds
                 if it is not zero (0).

                 If the Hold Timer has not been established
                 with the peer this object MUST have a value
                 of zero (0).

                 If the bgpPeerHoldTimeConfigured object has
                 a value of (0), then this object MUST have a
                 value of (0)."
        REFERENCE
                "RFC 4271, Section 4.2."
        ::= { bgpPeerEntry 18 }

    bgpPeerKeepAlive OBJECT-TYPE
        SYNTAX     Integer32 ( 0 | 1..21845 )
```

```
        UNITS      "seconds"
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "Time interval (in seconds) for the KeepAlive
                 timer established with the peer.  The value
                 of this object is calculated by this BGP
                 speaker such that, when compared with
                 bgpPeerHoldTime, it has the same proportion
                 that bgpPeerKeepAliveConfigured has,
                 compared with bgpPeerHoldTimeConfigured.

                 If the KeepAlive timer has not been established
                 with the peer, this object MUST have a value
                 of zero (0).

                 If the of bgpPeerKeepAliveConfigured object
                 has a value of (0), then this object MUST have
                 a value of (0)."
        REFERENCE
                "RFC 4271, Section 4.4."
        ::= { bgpPeerEntry 19 }

    bgpPeerHoldTimeConfigured OBJECT-TYPE
        SYNTAX     Integer32 ( 0 | 3..65535 )
        UNITS      "seconds"
        MAX-ACCESS read-write
        STATUS     current
        DESCRIPTION
                "Time interval (in seconds) for the Hold Time
                 configured for this BGP speaker with this
                 peer.  This value is placed in an OPEN
                 message sent to this peer by this BGP
                 speaker, and is compared with the Hold
                 Time field in an OPEN message received
                 from the peer when determining the Hold
                 Time (bgpPeerHoldTime) with the peer.
                 This value must not be less than three
                 seconds if it is not zero (0).  If it is
                 zero (0), the Hold Time is NOT to be
                 established with the peer.  The suggested
                 value for this timer is 90 seconds."
        REFERENCE
                "RFC 4271, Section 4.2.
                 RFC 4271, Section 10."
        ::= { bgpPeerEntry 20 }

    bgpPeerKeepAliveConfigured OBJECT-TYPE
```

```
        SYNTAX     Integer32 ( 0 | 1..21845 )
        UNITS      "seconds"
        MAX-ACCESS read-write
        STATUS     current
        DESCRIPTION
                "Time interval (in seconds) for the
                 KeepAlive timer configured for this BGP
                 speaker with this peer.  The value of this
                 object will only determine the
                 KEEPALIVE messages' frequency relative to
                 the value specified in
                 bgpPeerHoldTimeConfigured; the actual
                 time interval for the KEEPALIVE messages is
                 indicated by bgpPeerKeepAlive.  A
                 reasonable maximum value for this timer
                 would be one third of that of
                 bgpPeerHoldTimeConfigured.
                 If the value of this object is zero (0),
                 no periodical KEEPALIVE messages are sent
                 to the peer after the BGP connection has
                 been established.  The suggested value for
                 this timer is 30 seconds."
        REFERENCE
                "RFC 4271, Section 4.4.
                 RFC 4271, Section 10."
        ::= { bgpPeerEntry 21 }

    bgpPeerMinASOriginationInterval OBJECT-TYPE
        SYNTAX     Integer32 (1..65535)
        UNITS      "seconds"
        MAX-ACCESS read-write
        STATUS     current
        DESCRIPTION
                "Time interval (in seconds) for the
                 MinASOriginationInterval timer.
                 The suggested value for this timer is 15
                 seconds."
        REFERENCE
                "RFC 4271, Section 9.2.1.2.
                 RFC 4271, Section 10."
        ::= { bgpPeerEntry 22 }

    bgpPeerMinRouteAdvertisementInterval OBJECT-TYPE
        SYNTAX     Integer32 (1..65535)
        UNITS      "seconds"
        MAX-ACCESS read-write
        STATUS     current
        DESCRIPTION
```

```
                "Time interval (in seconds) for the
                 MinRouteAdvertisementInterval timer.
                 The suggested value for this timer is 30
                 seconds for EBGP connections and 5
                 seconds for IBGP connections."
        REFERENCE
                "RFC 4271, Section 9.2.1.1.
                 RFC 4271, Section 10."
        ::= { bgpPeerEntry 23 }

    bgpPeerInUpdateElapsedTime OBJECT-TYPE
        SYNTAX     Gauge32
        UNITS      "seconds"
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "Elapsed time (in seconds) since the last BGP
                 UPDATE message was received from the peer.
                 Each time bgpPeerInUpdates is incremented,
                 the value of this object is set to zero (0)."
        REFERENCE
                "RFC 4271, Section 4.3.
                 RFC 4271, Section 8.2.2, Established state."
        ::= { bgpPeerEntry 24 }

    bgpIdentifier OBJECT-TYPE
        SYNTAX     IpAddress
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The BGP Identifier of the local system."
        REFERENCE
                "RFC 4271, Section 4.2."
        ::= { bgp 4 }

    -- BGP Received Path Attribute Table.  This table contains
    -- one entry per path to a network, and path attributes
    -- received from all peers running BGP version 3 or less.
    -- This table is obsolete, having been replaced in
    -- functionality by the bgp4PathAttrTable.

    bgpRcvdPathAttrTable OBJECT-TYPE
        SYNTAX     SEQUENCE OF BgpPathAttrEntry
        MAX-ACCESS not-accessible
        STATUS     obsolete
        DESCRIPTION
                "The BGP Received Path Attribute Table
                 contains information about paths to
```

```
                destination networks, received from all
                peers running BGP version 3 or less."
        ::= { bgp 5 }

    bgpPathAttrEntry OBJECT-TYPE
        SYNTAX     BgpPathAttrEntry
        MAX-ACCESS not-accessible
        STATUS     obsolete
        DESCRIPTION
                "Information about a path to a network."
        INDEX { bgpPathAttrDestNetwork,
                bgpPathAttrPeer        }
        ::= { bgpRcvdPathAttrTable 1 }

    BgpPathAttrEntry ::= SEQUENCE {
        bgpPathAttrPeer
             IpAddress,
        bgpPathAttrDestNetwork
             IpAddress,
        bgpPathAttrOrigin
             INTEGER,
        bgpPathAttrASPath
             OCTET STRING,
        bgpPathAttrNextHop
             IpAddress,
        bgpPathAttrInterASMetric
             Integer32
    }

    bgpPathAttrPeer OBJECT-TYPE
        SYNTAX     IpAddress
        MAX-ACCESS read-only
        STATUS     obsolete
        DESCRIPTION
                "The IP address of the peer where the path
                 information was learned."
        ::= { bgpPathAttrEntry 1 }

    bgpPathAttrDestNetwork OBJECT-TYPE
        SYNTAX     IpAddress
        MAX-ACCESS read-only
        STATUS     obsolete
        DESCRIPTION
                "The address of the destination network."
        REFERENCE
                "RFC 1267, Section 4.3."
        ::= { bgpPathAttrEntry 2 }
```

```
    bgpPathAttrOrigin OBJECT-TYPE
        SYNTAX     INTEGER {
                       igp(1),-- networks are interior
                       egp(2),-- networks learned via the
                              -- EGP protocol
                       incomplete(3) -- networks that
                              -- are learned by some other
                              -- means
                   }
        MAX-ACCESS read-only
        STATUS     obsolete
        DESCRIPTION
                "The ultimate origin of the path information."
        REFERENCE
                "RFC 1267, Section 4.3.
                 RFC 1267, Section 5."
        ::= { bgpPathAttrEntry 3 }

    bgpPathAttrASPath OBJECT-TYPE
        SYNTAX     OCTET STRING (SIZE (2..255))
        MAX-ACCESS read-only
        STATUS     obsolete
        DESCRIPTION
                "The set of ASes that must be traversed to reach
                 the network.  This object is probably best
                 represented as SEQUENCE OF INTEGER.  For SMI
                 compatibility, though, it is represented as
                 OCTET STRING.  Each AS is represented as a pair
                 of octets according to the following algorithm:

                    first-byte-of-pair = ASNumber / 256;
                    second-byte-of-pair = ASNumber & 255;"
        REFERENCE
                "RFC 1267, Section 4.3.
                 RFC 1267, Section 5."
        ::= { bgpPathAttrEntry 4 }

    bgpPathAttrNextHop OBJECT-TYPE
        SYNTAX     IpAddress
        MAX-ACCESS read-only
        STATUS     obsolete
        DESCRIPTION
                "The address of the border router that should
                 be used for the destination network."
        REFERENCE
                "RFC 1267, Section 4.3.
                 RFC 1267, Section 5."
        ::= { bgpPathAttrEntry 5 }
```

```
    bgpPathAttrInterASMetric OBJECT-TYPE
        SYNTAX     Integer32
        MAX-ACCESS read-only
        STATUS     obsolete
        DESCRIPTION
                "The optional inter-AS metric.  If this
                 attribute has not been provided for this route,
                 the value for this object is 0."
        REFERENCE
                "RFC 1267, Section 4.3.
                 RFC 1267, Section 5."
        ::= { bgpPathAttrEntry 6 }

    -- BGP-4 Received Path Attribute Table.  This table
    -- contains one entry per path to a network, and path
    -- attributes received from all peers running BGP-4.

    bgp4PathAttrTable OBJECT-TYPE
        SYNTAX     SEQUENCE OF Bgp4PathAttrEntry
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
                "The BGP-4 Received Path Attribute Table
                 contains information about paths to
                 destination networks, received from all
                 BGP4 peers."
        ::= { bgp 6 }

    bgp4PathAttrEntry OBJECT-TYPE
        SYNTAX     Bgp4PathAttrEntry
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
                "Information about a path to a network."
        INDEX { bgp4PathAttrIpAddrPrefix,
                bgp4PathAttrIpAddrPrefixLen,
                bgp4PathAttrPeer            }
        ::= { bgp4PathAttrTable 1 }

    Bgp4PathAttrEntry ::= SEQUENCE {
        bgp4PathAttrPeer
             IpAddress,
        bgp4PathAttrIpAddrPrefixLen
             Integer32,
        bgp4PathAttrIpAddrPrefix
             IpAddress,
        bgp4PathAttrOrigin
             INTEGER,
```

```
        bgp4PathAttrASPathSegment
             OCTET STRING,
        bgp4PathAttrNextHop
             IpAddress,
        bgp4PathAttrMultiExitDisc
             Integer32,
        bgp4PathAttrLocalPref
             Integer32,
        bgp4PathAttrAtomicAggregate
             INTEGER,
        bgp4PathAttrAggregatorAS
             Integer32,
        bgp4PathAttrAggregatorAddr
             IpAddress,
        bgp4PathAttrCalcLocalPref
             Integer32,
        bgp4PathAttrBest
             INTEGER,
        bgp4PathAttrUnknown
             OCTET STRING
    }

    bgp4PathAttrPeer OBJECT-TYPE
        SYNTAX     IpAddress
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The IP address of the peer where the path
                 information was learned."
        ::= { bgp4PathAttrEntry 1 }

    bgp4PathAttrIpAddrPrefixLen OBJECT-TYPE
        SYNTAX     Integer32 (0..32)
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "Length in bits of the IP address prefix in
                 the Network Layer Reachability
                 Information field."
        ::= { bgp4PathAttrEntry 2 }

    bgp4PathAttrIpAddrPrefix OBJECT-TYPE
        SYNTAX     IpAddress
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "An IP address prefix in the Network Layer
                 Reachability Information field.  This object
```

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                is an IP address containing the prefix with
                length specified by
                bgp4PathAttrIpAddrPrefixLen.
                Any bits beyond the length specified by
                bgp4PathAttrIpAddrPrefixLen are zeroed."
        REFERENCE
                "RFC 4271, Section 4.3."
        ::= { bgp4PathAttrEntry 3 }

    bgp4PathAttrOrigin OBJECT-TYPE
        SYNTAX     INTEGER {
                       igp(1),-- networks are interior
                       egp(2),-- networks learned via the
                              -- EGP protocol
                       incomplete(3) -- networks that
                              -- are learned by some other
                              -- means
                   }
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The ultimate origin of the path
                 information."
        REFERENCE
                "RFC 4271, Section 4.3.
                 RFC 4271, Section 5.1.1."
        ::= { bgp4PathAttrEntry 4 }

    bgp4PathAttrASPathSegment OBJECT-TYPE
        SYNTAX     OCTET STRING (SIZE (2..255))
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The sequence of AS path segments.  Each AS
                 path segment is represented by a triple
                 <type, length, value>.

                 The type is a 1-octet field that has two
                 possible values:
                     1      AS_SET: unordered set of ASes that a
                                 route in the UPDATE message
                                 has traversed

                     2      AS_SEQUENCE: ordered set of ASes that
                                 a route in the UPDATE message
                                 has traversed.

                 The length is a 1-octet field containing the
```

```
                number of ASes in the value field.

                The value field contains one or more AS
                numbers.  Each AS is represented in the octet
                string as a pair of octets according to the
                following algorithm:

                   first-byte-of-pair = ASNumber / 256;
                   second-byte-of-pair = ASNumber & 255;

                Known Issues:
                o BGP Confederations will result in
                  a type of either 3 or 4.
                o An AS Path may be longer than 255 octets.
                  This may result in this object containing
                  a truncated AS Path."
        REFERENCE
                "RFC 4271, Section 4.3.
                 RFC 4271, Section 5.1.2."
        ::= { bgp4PathAttrEntry 5 }

    bgp4PathAttrNextHop OBJECT-TYPE
        SYNTAX     IpAddress
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The address of the border router that
                 should be used for the destination
                 network.  This address is the NEXT_HOP
                 address received in the UPDATE packet."
        REFERENCE
                "RFC 4271, Section 4.3.
                 RFC 4271, Section 5.1.3."
        ::= { bgp4PathAttrEntry 6 }

    bgp4PathAttrMultiExitDisc OBJECT-TYPE
        SYNTAX     Integer32 (-1..2147483647)
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "This metric is used to discriminate
                 between multiple exit points to an
                 adjacent autonomous system.  A value of -1
                 indicates the absence of this attribute.

                 Known Issues:
                 o The BGP-4 specification uses an
                   unsigned 32 bit number.  Thus, this
```

```
                  object cannot represent the full
                  range of the protocol."
        REFERENCE
                "RFC 4271, Section 4.3.
                 RFC 4271, Section 5.1.4."
        ::= { bgp4PathAttrEntry 7 }

    bgp4PathAttrLocalPref OBJECT-TYPE
        SYNTAX     Integer32 (-1..2147483647)
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The originating BGP4 speaker's degree of
                 preference for an advertised route.  A
                 value of -1 indicates the absence of this
                 attribute.

                 Known Issues:
                 o The BGP-4 specification uses an
                   unsigned 32 bit number and thus this
                   object cannot represent the full
                   range of the protocol."
        REFERENCE
                "RFC 4271, Section 4.3.
                 RFC 4271, Section 5.1.5."
        ::= { bgp4PathAttrEntry 8 }

    bgp4PathAttrAtomicAggregate OBJECT-TYPE
        SYNTAX     INTEGER {
                       lessSpecificRouteNotSelected(1),
                           -- Typo corrected from RFC 1657
                       lessSpecificRouteSelected(2)
                   }
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "If the ATOMIC_AGGREGATE attribute is present
                 in the Path Attributes then this object MUST
                 have a value of 'lessSpecificRouteNotSelected'.

                 If the ATOMIC_AGGREGATE attribute is missing
                 in the Path Attributes then this object MUST
                 have a value of 'lessSpecificRouteSelected'.

                 Note that ATOMIC_AGGREGATE is now a primarily
                 informational attribute."
        REFERENCE
                "RFC 4271, Sections 5.1.6 and 9.1.4."
```

```
        ::= { bgp4PathAttrEntry 9 }

    bgp4PathAttrAggregatorAS OBJECT-TYPE
        SYNTAX     Integer32 (0..65535)
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The AS number of the last BGP4 speaker that
                 performed route aggregation.  A value of
                 zero (0) indicates the absence of this
                 attribute.

                 Note that propagation of AS of zero is illegal
                 in the Internet."
        REFERENCE
                "RFC 4271, Section 5.1.7.
                 RFC 4271, Section 9.2.2.2."
        ::= { bgp4PathAttrEntry 10 }

    bgp4PathAttrAggregatorAddr OBJECT-TYPE
        SYNTAX     IpAddress
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The IP address of the last BGP4 speaker
                 that performed route aggregation.  A
                 value of 0.0.0.0 indicates the absence
                 of this attribute."
        REFERENCE
                "RFC 4271, Section 5.1.7.
                 RFC 4271, Section 9.2.2.2."
        ::= { bgp4PathAttrEntry 11 }

    bgp4PathAttrCalcLocalPref OBJECT-TYPE
        SYNTAX     Integer32 (-1..2147483647)
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "The degree of preference calculated by the
                 receiving BGP4 speaker for an advertised
                 route.  A value of -1 indicates the
                 absence of this attribute.

                 Known Issues:
                 o The BGP-4 specification uses an
                   unsigned 32 bit number and thus this
                   object cannot represent the full
                   range of the protocol."
```

```
        REFERENCE
                "RFC 4271, Section 9.1.1."
        ::= { bgp4PathAttrEntry 12 }

    bgp4PathAttrBest OBJECT-TYPE
        SYNTAX     INTEGER {
                       false(1),-- not chosen as best route
                       true(2) -- chosen as best route
                   }
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "An indication of whether this route
                 was chosen as the best BGP4 route for this
                 destination."
        REFERENCE
                "RFC 4271, Section 9.1.2."
        ::= { bgp4PathAttrEntry 13 }

    bgp4PathAttrUnknown OBJECT-TYPE
        SYNTAX     OCTET STRING (SIZE(0..255))
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
                "One or more path attributes not understood by
                 this BGP4 speaker.

                 Path attributes are recorded in the Update Path
                 attribute format of type, length, value.

                 Size zero (0) indicates the absence of such
                 attributes.

                 Octets beyond the maximum size, if any, are not
                 recorded by this object.

                 Known Issues:
                 o Attributes understood by this speaker, but not
                   represented in this MIB, are unavailable to
                   the agent."
        REFERENCE
                "RFC 4271, Section 5."
        ::= { bgp4PathAttrEntry 14 }

    -- Traps.
    -- Note that in RFC 1657, bgpTraps was incorrectly
    -- assigned a value of { bgp 7 } and each of the
    -- traps had the bgpPeerRemoteAddr object inappropriately
```

```
-- removed from their OBJECTS clause.  The following
-- definitions restore the semantics of the traps as
-- they were initially defined in RFC 1269.

bgpNotification OBJECT IDENTIFIER ::= { bgp 0 }

bgpEstablishedNotification NOTIFICATION-TYPE
    OBJECTS { bgpPeerRemoteAddr,
              bgpPeerLastError,
              bgpPeerState      }
    STATUS  current
    DESCRIPTION
            "The bgpEstablishedNotification event is generated
             when the BGP FSM enters the established state.

             This Notification replaces the bgpEstablished
             Notification."
    ::= { bgpNotification 1 }

bgpBackwardTransNotification NOTIFICATION-TYPE
    OBJECTS { bgpPeerRemoteAddr,
              bgpPeerLastError,
              bgpPeerState      }
    STATUS  current
    DESCRIPTION
            "The bgpBackwardTransNotification event is
             generated when the BGP FSM moves from a higher
             numbered state to a lower numbered state.

             This Notification replaces the
             bgpBackwardsTransition Notification."
    ::= { bgpNotification 2 }

-- { bgp 7 } is deprecated.  Do not allocate new objects or
--           notifications underneath this branch.

bgpTraps        OBJECT IDENTIFIER ::= { bgp 7 } -- deprecated

bgpEstablished NOTIFICATION-TYPE
    OBJECTS { bgpPeerLastError,
              bgpPeerState      }
    STATUS  deprecated
    DESCRIPTION
            "The bgpEstablished event is generated when
             the BGP FSM enters the established state.

             This Notification has been replaced by the
             bgpEstablishedNotification Notification."
```

```
    ::= { bgpTraps 1 }

bgpBackwardTransition NOTIFICATION-TYPE
    OBJECTS { bgpPeerLastError,
              bgpPeerState      }
    STATUS  deprecated
    DESCRIPTION
            "The bgpBackwardTransition event is generated
             when the BGP FSM moves from a higher numbered
             state to a lower numbered state.

             This Notification has been replaced by the
             bgpBackwardTransNotification Notification."
    ::= { bgpTraps 2 }

-- Conformance information

bgp4MIBConformance OBJECT IDENTIFIER
    ::= { bgp 8 }
bgp4MIBCompliances OBJECT IDENTIFIER
            ::= { bgp4MIBConformance 1 }
bgp4MIBGroups      OBJECT IDENTIFIER
    ::= { bgp4MIBConformance 2 }

-- Compliance statements

bgp4MIBCompliance MODULE-COMPLIANCE
    STATUS  current
    DESCRIPTION
            "The compliance statement for entities which
             implement the BGP4 mib."
    MODULE  -- this module
        MANDATORY-GROUPS { bgp4MIBGlobalsGroup,
                           bgp4MIBPeerGroup,
                           bgp4MIBPathAttrGroup }
        GROUP bgp4MIBNotificationGroup
        DESCRIPTION
                "Implementation of BGP Notifications are
                 completely optional in this MIB."
    ::= { bgp4MIBCompliances 1 }

bgp4MIBDeprecatedCompliances MODULE-COMPLIANCE
    STATUS  deprecated
    DESCRIPTION
            "The compliance statement documenting deprecated
             objects in the BGP4 mib."
    MODULE  -- this module
        GROUP bgp4MIBTrapGroup
```

```
            DESCRIPTION
                "Group containing TRAP objects that were
                 improperly converted from SMIv1 in RFC 1657.
                 The proper semantics have been restored
                 with the objects in bgp4MIBNotificationGroup."
        ::= { bgp4MIBCompliances 2 }

    bgp4MIBObsoleteCompliances MODULE-COMPLIANCE
        STATUS  obsolete
        DESCRIPTION
                "The compliance statement documenting obsolete
                 objects in the BGP4 mib."
        MODULE  -- this module
            GROUP bgpRcvdPathAttrGroup
            DESCRIPTION
                "Group containing objects relevant to BGP-3
                 and earlier objects."
        ::= { bgp4MIBCompliances 3 }

    -- Units of conformance

    bgp4MIBGlobalsGroup OBJECT-GROUP
        OBJECTS { bgpVersion,
                  bgpLocalAs,
                  bgpIdentifier }
        STATUS  current
        DESCRIPTION
                "A collection of objects providing
                 information on global BGP state."
        ::= { bgp4MIBGroups 1 }

    bgp4MIBPeerGroup OBJECT-GROUP
        OBJECTS { bgpPeerIdentifier,
                  bgpPeerState,
                  bgpPeerAdminStatus,
                  bgpPeerNegotiatedVersion,
                  bgpPeerLocalAddr,
                  bgpPeerLocalPort,
                  bgpPeerRemoteAddr,
                  bgpPeerRemotePort,
                  bgpPeerRemoteAs,
                  bgpPeerInUpdates,
                  bgpPeerOutUpdates,
                  bgpPeerInTotalMessages,
                  bgpPeerOutTotalMessages,
                  bgpPeerLastError,
                  bgpPeerFsmEstablishedTransitions,
                  bgpPeerFsmEstablishedTime,
```

```
                bgpPeerConnectRetryInterval,
                bgpPeerHoldTime,
                bgpPeerKeepAlive,
                bgpPeerHoldTimeConfigured,
                bgpPeerKeepAliveConfigured,
                bgpPeerMinASOriginationInterval,
                bgpPeerMinRouteAdvertisementInterval,
                bgpPeerInUpdateElapsedTime }
    STATUS  current
    DESCRIPTION
            "A collection of objects for managing
             BGP peers."
    ::= { bgp4MIBGroups 2 }

bgpRcvdPathAttrGroup OBJECT-GROUP
    OBJECTS { bgpPathAttrPeer,
              bgpPathAttrDestNetwork,
              bgpPathAttrOrigin,
              bgpPathAttrASPath,
              bgpPathAttrNextHop,
              bgpPathAttrInterASMetric }
    STATUS  obsolete
    DESCRIPTION
            "A collection of objects for managing BGP-3 and
            earlier path entries.

            This conformance group, like BGP-3, is obsolete."
    ::= { bgp4MIBGroups 3 }

bgp4MIBPathAttrGroup OBJECT-GROUP
    OBJECTS { bgp4PathAttrPeer,
              bgp4PathAttrIpAddrPrefixLen,
              bgp4PathAttrIpAddrPrefix,
              bgp4PathAttrOrigin,
              bgp4PathAttrASPathSegment,
              bgp4PathAttrNextHop,
              bgp4PathAttrMultiExitDisc,
              bgp4PathAttrLocalPref,
              bgp4PathAttrAtomicAggregate,
              bgp4PathAttrAggregatorAS,
              bgp4PathAttrAggregatorAddr,
              bgp4PathAttrCalcLocalPref,
              bgp4PathAttrBest,
              bgp4PathAttrUnknown }
    STATUS  current
    DESCRIPTION
            "A collection of objects for managing
             BGP path entries."
```

```
            ::= { bgp4MIBGroups 4 }

        bgp4MIBTrapGroup NOTIFICATION-GROUP
            NOTIFICATIONS { bgpEstablished,
                            bgpBackwardTransition }
            STATUS  deprecated
            DESCRIPTION
                    "A collection of notifications for signaling
                     changes in BGP peer relationships.

                     Obsoleted by bgp4MIBNotificationGroup"
            ::= { bgp4MIBGroups 5 }

        bgp4MIBNotificationGroup NOTIFICATION-GROUP
            NOTIFICATIONS { bgpEstablishedNotification,
                            bgpBackwardTransNotification }
            STATUS current
            DESCRIPTION
                    "A collection of notifications for signaling
                     changes in BGP peer relationships.

                     Obsoletes bgp4MIBTrapGroup."
            ::= { bgp4MIBGroups 6 }

    END
```

5. Security Considerations

This MIB relates to a system providing inter-domain routing. As such, improper manipulation of the objects represented by this MIB may result in denial of service to a large number of end-users.

There are several management objects defined in this MIB that have a MAX-ACCESS clause of read-write and/or read-create. Such objects should be considered sensitive or vulnerable in most network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations. These objects include:

- bgpPeerAdminStatus

  Improper change of bgpPeerAdminStatus, from start to stop, can cause significant disruption of the connectivity to those portions of the Internet reached via the applicable remote BGP peer.

- o bgpPeerConnectRetryInterval

  Improper change of this object can cause connections to be disrupted for extremely long time periods when otherwise they would be restored in a relatively short period of time.

- o bgpPeerHoldTimeConfigured, bgpPeerKeepAliveConfigured

  Misconfiguration of these objects can make BGP sessions more fragile and less resilient to denial of service attacks on the inter-domain routing system.

- o bgpPeerMinASOriginationInterval, bgpPeerMinRouteAdvertisementInterval

  Misconfiguration of these objects may adversely affect global Internet convergence of the routes advertised by this BGP speaker. This may result in long-lived routing loops and blackholes for the portions of the Internet that utilize these routes.

There are a number of managed objects in this MIB that contain sensitive information regarding the operation of a network. For example, a BGP peer's local and remote addresses might be sensitive for ISPs who want to keep interface addresses on routers confidential in order to prevent router addresses used for a denial of service attack or spoofing.

Therefore, it is important in most environments to control read access to these objects and possibly to even encrypt the values of these object when sending them over the network via SNMP.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPsec), even then, there is no control as to who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in this MIB module.

It is RECOMMENDED that implementers consider the security features as provided by the SNMPv3 framework (see [RFC3410], section 8), including full support for the SNMPv3 cryptographic mechanisms (for authentication and privacy).

Further, deployment of SNMP versions prior to SNMPv3 is NOT RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of this MIB module is properly configured to give access to

the objects only to those principals (users) that have legitimate rights to indeed GET or SET (change/create/delete) them.

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