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Definitions of Managed Objects for BGP-4

Status of This Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

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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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                                  skh@nexthop.com"

            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
```

```
                    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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7. Normative References

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