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3. Abstract

This memo is an extension to the SNMP MIB. 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 was converted to use the SNMPv2 SMI, as well as updates references to the current SNMP framework documents.

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

Distribution of this memo is unlimited. Please forward comments to idr@merit.net.

4. 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 [BGP, BGPAPPL].

5. The SNMP Management Framework

The SNMP Management Framework presently consists of five major components:

-- An overall architecture, described in RFC 2571 [RFC2571].

-- Mechanisms for describing and naming objects and events for the purpose of management. The first version of this Structure of Management Information (SMI) is called SMIV1 and described in STD 16, RFC 1155 [RFC1155], STD 16, RFC 1212 [RFC1212] and RFC 1215 [RFC1215]. The second version, called SMIV2, is described in STD 58, RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [RFC2580].
-- Message protocols for transferring management information. The first version of the SNMP message protocol is called SNMPv1 and described in STD 15, RFC 1157 [RFC1157]. A second version of the SNMP message protocol, which is not an Internet standards track protocol, is called SNMPv2c and described in RFC 1901 [RFC1901] and RFC 1906 [RFC1906]. The third version of the message protocol is called SNMPv3 and described in RFC 1906 [RFC1906], RFC 2572 [RFC2572] and RFC 2574 [RFC2574].

-- Protocol operations for accessing management information. The first set of protocol operations and associated PDU formats is described in STD 15, RFC 1157 [RFC1157]. A second set of protocol operations and associated PDU formats is described in RFC 1905 [RFC1905].

-- A set of fundamental applications described in RFC 2573 [RFC2573] and the view-based access control mechanism described in RFC 2575 [RFC2575].

A more detailed introduction to the current SNMP Management Framework can be found in RFC 2570 [RFC2570].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. Objects in the MIB are defined using the mechanisms defined in the SMI.

This memo specifies a MIB module that is compliant to the SMIv2. A MIB conforming to the SMIv1 can be produced through the appropriate translations. The resulting translated MIB must be semantically equivalent, except where objects or events are omitted because no translation is possible (use of Counter64). Some machine readable information in SMIv2 will be converted into textual descriptions in SMIv1 during the translation process. However, this loss of machine readable information is not considered to change the semantics of the MIB.

6. 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 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.
7. 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 "200203010000Z"
    ORGANIZATION "IETF IDR Working Group"
    CONTACT-INFO "E-mail: idr@merit.net
                     Jeff Haas, Sue Hares (Editors)
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                     E-mail: jhaas@nexthop.com
                     skh@nexthop.com"

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

Changes since RFC 1657:

1) Fixed the definitions of the traps to
   make them equivalent to their initial
   definition in RFC 1269.
2) Added compliance and conformance info.
3) Updated for latest BGP information
   draft-ietf-idr-bgp4-17.txt for value of
   bgpPeerNegotiatedVersion, bgp4PathAttrLocalPref,
   bgp4PathAttrCalcLocalPref, bgp4PathAttrMultiExitDisc,
   bgp4PathAttrASPathSegment.
4) Added additional clarification comments where
   needed.
5) Noted where objects do not fully reflect
   the protocol as Known Issues."

 ::= { 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."
::= { bgp 1 }

bgpLocalAs OBJECT-TYPE
SYNTAX      Integer32 (0..65535)
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION "The local autonomous system number."
::= { 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 should be 0.0.0.0
  unless the bgpPeerState is in the openconfirm or the established state."
::= { 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."
::= { 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 Start Event to be generated. A transition from 'start' to 'stop' will cause the BGP 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.

::= { bgpPeerEntry 3 }

bgpPeerNegotiatedVersion OBJECT-TYPE
SYNTAX Integer32 (0..255)
MAX-ACCESS read-only
STATUS current
DESCRIPTION "The negotiated version of BGP running between the two peers.

This entry should be zero (0) unless the bgpPeerState is in the openconfirm or the established state."

::= { 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."
 ::= { bgpPeerEntry 9 }

bgpPeerInUpdates OBJECT-TYPE
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION  "The number of BGP UPDATE messages received on this connection. This object should be initialized to zero (0) when the connection is established. The value of this object, when not in the established state, is undefined."
 ::= { bgpPeerEntry 10 }

bgpPeerOutUpdates OBJECT-TYPE
SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS     current
DESCRIPTION
 "The number of BGP UPDATE messages transmitted on this connection. This object should be initialized to zero (0) when the connection is established. The value of this object, when not in the established state, is undefined."
::= { 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. This object should be initialized to zero when the connection is established. The value of this object, when not in the established state, is undefined."
::= { 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. This object should be initialized to zero when the connection is established. The value of this object, when not in the established state, is undefined."
::= { 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."
::= { 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."
::= { bgpPeerEntry 15 }

bgpPeerFsmEstablishedTime OBJECT-TYPE
SYNTAX Gauge32
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 the router is
booted."
::= { bgpPeerEntry 16 }

bgpPeerConnectRetryInterval OBJECT-TYPE
SYNTAX Integer32 (1..65535)
MAX-ACCESS read-write
STATUS current
DESCRIPTION
"Time interval in seconds for the
ConnectRetry timer. The suggested value
for this timer is 120 seconds."
::= { bgpPeerEntry 17 }

bgpPeerHoldTime OBJECT-TYPE
SYNTAX Integer32 { 0 | 3..65535 }
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 by using the smaller of the value 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 value is zero (0), the Hold Timer has either not been established with the peer, or, the value of bgpPeerHoldTimeConfigured is zero (0)."

::= { bgpPeerEntry 18 }

bgpPeerKeepAlive OBJECT-TYPE
SYNTAX     Integer32 ( 0 | 1..21845 )
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 as what bgpPeerKeepAliveConfigured has when compared with bgpPeerHoldTimeConfigured. If the value of this object is zero (0), it indicates that the KeepAlive timer has not been established with the peer, or, the value of bgpPeerKeepAliveConfigured is zero (0)."

::= { bgpPeerEntry 19 }

bgpPeerHoldTimeConfigured OBJECT-TYPE
SYNTAX     Integer32 ( 0 | 3..65535 )
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) in which case the Hold Time is NOT to be
established with the peer. The suggested value for this timer is 90 seconds.

::= { bgpPeerEntry 20 }

bgpPeerKeepAliveConfigured OBJECT-TYPE
SYNTAX Integer32 ( 0 | 1..21845 )
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 configured to 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."

::= { bgpPeerEntry 21 }

bgpPeerMinASOriginationInterval OBJECT-TYPE
SYNTAX Integer32 (1..65535)
MAX-ACCESS read-write
STATUS current
DESCRIPTION
"Time interval in seconds for the MinASOriginationInterval timer.
The suggested value for this timer is 15 seconds."

::= { bgpPeerEntry 22 }

bgpPeerMinRouteAdvertisementInterval OBJECT-TYPE
SYNTAX Integer32 (1..65535)
MAX-ACCESS read-write
STATUS current
DESCRIPTION
"Time interval in seconds for the MinRouteAdvertisementInterval timer. The suggested value for this timer is 30 seconds."

::= { bgpPeerEntry 23 }

bgpPeerInUpdateElapsedTime OBJECT-TYPE
SYNTAX Gauge32
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)."

::= { bgpPeerEntry 24 }

bgpIdentifier OBJECT-TYPE
SYNTAX IpAddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION "The BGP Identifier of local system."

::= { bgp 4 }

-- Received Path Attribute Table. This table contains, -- one entry per path to a network, path attributes -- received from all peers running BGP version 3 or less. -- This table is obsolete, having been replaced in -- functionality with 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."
 ::= { 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."
::= { bgpPathAttrEntry 3 }

bgpPathAttrASPath OBJECT-TYPE
SYNTAX OCTET STRING (SIZE (2..255))
MAX-ACCESS read-only
STATUS obsolete
DESCRIPTION
"The set of ASs 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 = ASN / 256;
  second-byte-of-pair = ASN & 255;

::= { 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."
::= { 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."
::= { bgpPathAttrEntry 6 }

-- BGP-4 Received Path Attribute Table. This table
-- contains, one entry per path to a network, 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,
    bgp4PathAttrIpPrefix   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."
 ::= { 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."
 ::= { 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 which has two
 possible values:
  1  AS_SET: unordered set of ASs a
         route in the UPDATE message
         has traversed

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

 The length is a 1-octet field containing the
 number of ASs 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 value 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.

 ::= { 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 nexthop
   address received in the UPDATE packet."
 ::= { 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 and thus this
    object cannot represent the full
    range of the protocol."
 ::= { 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.

 ::= { bgp4PathAttrEntry 8 }

bgp4PathAttrAtomicAggregate OBJECT-TYPE
SYNTAX     INTEGER {
    lessSpecificRouteNotSelected(1),
    lessSpecificRouteSelected(2)
}
MAX-ACCESS read-only
STATUS     current
DESCRIPTION
 "Whether or not a system has selected a less specific route without selecting a more specific route."
 ::= { 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."
 ::= { 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."
Note propagation of AS of zero is illegal in the Internet.

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

::= { 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 or not this route was chosen as the best BGP4 route for this destination."

::= { 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 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."

::= { 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 BGP Established event is generated when the BGP FSM enters the ESTABLISHED state.

This object obsoletes bgpEstablished."
::= { 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 object obsoletes bgpBackwardsTransition.

::= { bgpNotification 2 }

-- { bgp 7 } is obsoleted

bgpTraps OBJECT IDENTIFIER ::= { bgp 7 }

bgpEstablished NOTIFICATION-TYPE

OBJECTS { bgpPeerRemoteAddr,
            bgpPeerLastError,
            bgpPeerState }

STATUS obsolete

DESCRIPTION

"The BGP Established event is generated when the BGP FSM enters the ESTABLISHED state.

This object has been obsoleted in favor of bgpEstablishedNotification."

::= { bgpTraps 1 }

bgpBackwardTransition NOTIFICATION-TYPE

OBJECTS { bgpPeerRemoteAddr,
            bgpPeerLastError,
            bgpPeerState }

STATUS current

DESCRIPTION

"The BGPBackwardTransition Event is generated when the BGP FSM moves from a higher numbered state to a lower numbered state.

This object has been obsoleted in favor of bgpBackwardTransNotification."

::= { bgpTraps 2 }

-- conformance information

bgpMIBConformance OBJECT IDENTIFIER ::= { bgp 8 }

bgpMIBCompliances OBJECT IDENTIFIER ::= { bgpMIBConformance 1 }
bgpMIBGroups OBJECT IDENTIFIER
  ::= { bgpMIBConformance 2 }

-- compliance statements

bgpMIBCompliance MODULE-COMPLIANCE
  STATUS  current
  DESCRIPTION
    "The compliance statement for entities which
     implement the BGP4 mib."
  MODULE  -- this module
    MANDATORY-GROUPS { bgp4MIBGlobalsGroup,
     bgp4MIBPeerGroup,
     bgp4MIBPathAttrGroup,
     bgp4MIBNotificationGroup,
     bgp4MIBNewNotificationGroup }
  ::= { bgpMIBCompliances 1 }

-- units of conformance

bgp4MIBGlobalsGroup OBJECT-GROUP
  OBJECTS { bgpVersion,
     bgpLocalAs,
     bgpIdentifier }
  STATUS  current
  DESCRIPTION
    "A collection of objects providing
     information on global BGP state."
  ::= { bgpMIBGroups 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."
::= { bgpMIBGroups 2 }

bgp4MIBRcvdPathAttrGroup OBJECT-GROUP
OBJECTS { bgpPathAttrPeer,
         bgpPathAttrDestNetwork,
         bgpPathAttrOrigin,
         bgpPathAttrASPath,
         bgpPathAttrNextHop,
         bgpPathAttrInterASMetric }
STATUS  obsolete
DESCRIPTION
"A collection of objects for managing BGP
path entries.

This conformance group is obsolete,
replaced by bgp4MIBPathAttrGroup."
::= { bgpMIBGroups 3 }

bgp4MIBPathAttrGroup OBJECT-GROUP
OBJECTS { bgp4PathAttrPeer,
         bgp4PathAttrIpPrefixLen,
         bgp4PathAttrIpPrefix,
         bgp4PathAttrOrigin,
         bgp4PathAttrASPathSegment,
         bgp4PathAttrNextHop,
         bgp4PathAttrMultiExitDisc,
         bgp4PathAttrLocalPref,
         bgp4PathAttrAtomicAggregate,
         bgp4PathAttrAggregatorAS,
bgp4PathAttrAggregatorAddr,
bgp4PathAttrCalcLocalPref,
bgp4PathAttrBest,
bgp4PathAttrUnknown

STATUS current
DESCRIPTION
"A collection of objects for managing
BGP path entries."
 ::= { bgpMIBGroups 4 }

bgp4MIBNotificationGroup NOTIFICATION-GROUP
NOTIFICATIONS { bgpEstablished,
                 bgpBackwardTransition }
STATUS obsolete
DESCRIPTION
"A collection of notifications for signaling
changes in BGP peer relationships.

Obsoleted by bgp4MIBNewNotificationGroup"
 ::= { bgpMIBGroups 5 }

bgp4MIBNewNotificationGroup NOTIFICATION-GROUP
NOTIFICATIONS { bgpEstablishedNotification,
                 bgpBackwardTransNotification }
STATUS current
DESCRIPTION
"A collection of notifications for signaling
changes in BGP peer relationships.

Obsoletes bgp4MIBNotificationGroup."
 ::= { bgpMIBGroups 6 }

END
8. Intellectual Property

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9. 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.

- 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.

- 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.

- 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 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 objects when sending them over the network via SNMP.

SNMPv1 by itself is not a secure environment. Even if the network itself is secure (for example by using IPSec), there is still 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.

It is recommended that the implementers consider the security features as provided by the SNMPv3 framework. Specifically, the implementation and use of the User-based Security Model and the View-based Access Control Model is recommended to provide appropriate security controls.

It is then an operator/user responsibility to ensure that the SNMP entity giving access to an instance of this MIB, 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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11. References


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