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November 21, 2001

Definitions of Managed Objects
for the Fourth Version of Border Gateway Protocol (BGP-4),
Second Version
<draft-ietf-idr-bgp4-mibv2-01.txt>

Status of this Memo

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Abstract

   This memo defines a portion of the Management Information Base (MIB)
   for use with network management protocols in TCP/IP-based internets.
   In particular, this MIB defines objects that facilitate the

management of the Border Gateway Protocol Version 4 (BGP4).

Distribution of this memo is unlimited.

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.

The SNMP Management Framework presently consists of five major compo-
nents:

   o   An overall architecture, described in RFC 2571 [1].

   o   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 [2], STD 16, RFC 1212 [3] and RFC 1215
         [4]. The second version, called SMIv2, is described in STD 58,
         RFC 2578 [5], RFC 2579 [6] and RFC 2580 [7].

   o   Message protocols for transferring management information. The
         first version of the SNMP message protocol is called SNMPv1
         and described in STD 15, RFC 1157 [8]. A second version of the
         SNMP message protocol, which is not an Internet standards
         track protocol, is called SNMPv2c and described in RFC 1901
         [9] and RFC 1906 [10]. The third version of the message proto-
         col is called SNMPv3 and described in RFC 1906 [10], RFC 2572
         [11] and RFC 2574 [12].

   o   Protocol operations for accessing management information. The
         first set of protocol operations and associated PDU formats is
         described in STD 15, RFC 1157 [8]. A second set of protocol
         operations and associated PDU formats is described in RFC 1905
         [13].

   o   A set of fundamental applications described in RFC 2573 [14]
         and the view-based access control mechanism described in RFC
         2575 [15].

A more detailed introduction to the current SNMP Management Framework
can be found in RFC 2570 [18].

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.

2. Objectives

This MIB Module is meant to broadly update and replace a prior MIB
Module defined in RFC 1657 [12]. Additionally, there is another
effort underway to address very specific limited objectives in updat-
ing points in the RFC 1657 object definition and managed object
attributes [13]. The MIB Module described herein is intended to
fully serve the functions and scope of RFC 1657 and these RFC 1657
updates.

2.1. Protocol Extensions

Additionally, however, there are a number of ways in which the BGP
Protocol has been enhanced through its ability for added capabili-
ties. Implementations of those capabilities have not been able to
have any management capabilities present in RFC 1657-compliant MIB
module agents, since the capabilities themselves postdated the adop-
tion of RFC 1657. For several significant capabilities, in the form
of BGP Communities [17], Autonomous System Confederation [16] , BGP
Multiprotocol Extensions [18], and Route Reflection [19], the MIB
Module defined in this document exposes object types to manage those
extended capabilities and their operation.

One of these extensions in particular (the multiprotocol extensions)
requires a thorough redefinition of MIB table row indices from the
RFC 1657 state. This allows transport-independent address indices
consistent with the Address Family Identifier (AFI) and Subsequent
Address Family Identifier (SAFI) mechanisms of that extension.

2.2. Mechanisms for MIB Extensibility

Moreover, the requirement for the incremental update of support for
capabilities such as these begs the issue of placing modular extensi-
bility for protocol extensions within the framework of the MIB
itself. Going forward, it would be very desirable to have attributes
of the MIB structure, and administrative procedures, to allow the
incremental update of the MIB scope to cover any such new protocol
extensions, without requiring a reissue of the entire MIB. In this
sense, we seek to structure the MIB much like the underlying BGP4
itself, allowing capability-by-capability update.

2.3. BGP Configuration

   Finally, the definition and adoption of Version 3 of the SNMP has
   occurred since the adoption of the RFC 1657 MIB. As a result, the
   ability to deploy secure configuration of managed elements via SNMP
   in a standardized way has become a reality for managed networks. In
   this MIB definition effort, we seek to expose a more thorough capac-
   ity for configuration of BGP4 and its capabilities than was present
   in RFC 1657 or than was common practice at the time of its adoption.

3. MIB Organization

   The MIB is broken down into several top level sections. This sec-
   tionalization is important to create an organization for extensibil-
   ity.

   In general, a top level section of the MIB module will identify some
   number of "core" scalar and tabular objects rooted off of it. If
   there is sufficient depth within a subsection of one of these top-
   level sections, the "core" subdivision off of the top level section
   may provide multiple levels to the OBJECT IDENTIFIER scope necessary
   to define its management data.

   Once this core section is defined, however, each top-level section
   has an explicit provision for an 'extensions' section OBJECT IDENTI-
   FIER. The intent of the extensions section is to be containment for
   discrete per-extension sections. By 'extension' here, we refer to
   protocol mechanisms, capabilities, and exchanges which are not
   defined in the base Border Gateway Protocol definition, or is not
   configuration for protocol operations of similarly 'core' status.
   Currently, we propose keying the identification within the per-exten-
   sion section in one of two ways.

   Where the extension is keyed to a defined capability which has an
   associated BGP capability number assiged by IANA (for example, multi-
   protocol BGP extensions), the per extension section will be that
   defined IANA capability number. Where the extension has management
   information suitable for a MIB extension but does not correspond to
   an exchanged protocol capability (for example, BGP Route Reflection),
   the extension section shall have its final OBJECT IDENTIFIER fragment
   correspond to the RFC number which first uniquely defined the exten-
   sion (i.e., not requiring renumbering at the time a defining RFC for
   a protocol mechanism is outdated by a later RFC).

3.1. bgpBaseScalars

   The bgpBaseScalars section (and corresponding OBJECT IDENTIFIER) is
   used to delineate object types used for basic management and monitor-
   ing of the protocol implementation.   These are core parameters for
   the local configuration. While notifications are designed to be
   extensible into any other section in the MIB module, the currently
   defined traps are located here, in a subsection 'bgpBaseNotifica-
   tions'. This is rooted at index level zero (0) here, owing to con-
   ventions established in [4].

   Support for multiple concurrently supported versions of BGP is
   exposed through the entries of the bgpVersionTable. Similarly, sup-
   port for multiple capabilities and authentication mechanisms, as
   identified by their assigned numbers, are reported in the bgpSupport-
   edCapabilitiesTable and bgpSupportedAuthTable respectively.

   In the MIB document, there are currently basic scalar extension mech-
   anisms to allow the agent to report membership of a local BGP Confed-
   eration [21] or Route Reflection Cluster ID [24]. These are consis-
   tent with the non-capability based extension section indexing guide-
   lines as presented above.

3.2. bgpPeerData

   The bgpPeerData section is per-peer object type definitions. The pre-
   dominant table in that section (bgpPeerTable) describes the session,
   negotiation state, and authentication state on a per peer basis. A
   second table (bgpPrefixCountersTable) exposes information about indi-
   vidual route prefixes received over each peer session. A separate
   subsection and its subordinate table (bgpPeerErrorsTable) reports
   information about the last error encountered on a given peering ses-
   sion.

   Further subsections report authentication state with the peer and
   elapsed time it has taken to advance the peering session into various
   states defined in the protocol FSM.

   The bgpPeerConfiguredTimersTable reports and allows dynamic reset of
   key timers on the peer session. These currently allow reset of hold
   time and keepalive timer, for compatibility wity the same capabili-
   ties in RFC 1657 [17]. For these resettable timers, their end-to-end
   negotiated current values are reflected in the bgpPeerNegotiated-
   TimersTable.

3.2.1. bgpPeerCapabilities

bgpPeerCapabilitiesData has objects and tables to describe BGP capa-
bilities locally supported, and those reported and negotiated over
each peer session.   For tables supporting each of these capability
sets, capability code and data value are provided. Attention must be
given to the fact that multiple instances of a given capability can
be transmitted between BGP speakers.

3.2.2. bgpPeerCounters

The bgpCountersTable and bgpPrefixCountersTable report protocol
exhanges/FSM transitions, and discrete number of NLRIs exchanged per
peering session, respectively. This is independent of actual
exhanged path attributes, which are tabularized later in the MIB mod-
ule.

3.2.3. Peering Data Extensions

Route reflector status on a per-peer basis (whether the peer is a
client or nonClient of the local BGP router's reflected route propa-
gation), and peer confederation membership is reported in non capa-
bility extensions of the peering data section.

3.3. BGP Routing Information Base Data

An important table for providing index information for other tables
in the MIB module is the bgpNlriTable. This discriminates on a given
network prefix (by AFI/SAFI), and the peer which advertised the pre-
fix (since it can be heard of from multiple spakers). The bgpPathAt-
trIndex column which identifies each row in this table is used as an
index for other per-attribute tables through the remainder of the MIB
module.

The bgpPathAttrTable provides discrete BGP NLRI attributes which were
recieved with the advertisement of the prefix by its advertising
peer. Specific information about the autonomous system path (AS
Path) advertised with the NLRI, on a per AS value, is to be found in
the bgpAsPathTable.

Finally, where attributes which were unable to be reported in the
bgpPathAttrTable, the AS Path table, or any defined per-NLRI tables
in the agent were recieved with the prefix, those attributes are
reported via the bgpPathAttrUnknownTable. Short of advertised
attribute type, no semantic breakdown of the unknown attribute data
is provided. That data is only available as a raw OCTET STRING in
the bgpPathAttrUnknownValue column of this table.

3.3.1. Routing Information Base Extensions

There are two extension sections and five subordinate tables to the
bgp4PathAttrTable and RIB data OBJECT IDENTIFIER-delimited MIB module
section. The bgpPathAttrRouteReflectionExts and its contained bgp-
PathAttrOriginatorIdTable report on the originating route reflector.
The bgpPathAttrClusterTable specifically reports on the reflection
route a NLRI has traversed to get to the local BGP routing process.

The bgpPathAttrCommunityExts section deals with extended and non-
exteded communities for network routes. The bgpPathAttrCommTable
bgpPathAttrExtCommTable contained herein report community membership
(if any) on a per network-prefix basis.

3.4. Consideration On Table Indexing

There are certain efficiency concerns for row index management for
management applications which are useful to take into consideration,
given the nature of some of the tables implied in the preceding sec-
tion.

In the first place, it is valuable to exploit the direct relationship
of entries in, for example, the bgpPrefixCountersTable as they relate
to the entry in the bgpPeerTable to which they are related. More
compelling is the case of the one-to-many relationship between a row
entry in the bgpPeerTable and the bgp4PathAttrTable, the latter of
which maintains per-row entries for potentially many NLRIs as
received from a peer in a BGP UPDATE message. From the point of view
of normalizing these relationships, it would be useful to have a
direct reference to the "governing" bgpPeerTable row entry for the
peer which is a "dependency" for the subordinate table row entry for
other peer data.

Second, the nature of protocol-independent addressing makes the
indexing of these entries indirectly even more compelling. Even
accounting for the addressing requirements of IPv6 and the provision
of AFI and SAFI qualifiers, the logical addressing of a row in the
bgp4PathAttrClusterTable (for example) would extend out some 50 bytes
if there was no direct index linkage to the "governing" bgp4PathAt-
trTable, and bgpPeerTable entries.

For this reason, the tables are structured in such a way that, where
there is such a linkage to a "dependent" table (where, for example,
the bgpPrefixCountersTable "depends on" the bgpPeerTable), a table
will contain a per-row numeric index (e.g., bgpPeerIndex), which the
"dependent" table will use as one of its own row index values. These
indices are manufactured by the agent, and are otherwise opaque to
the management application (or, for that matter, even to the

organization of the "dependent" table[s]).

[4](#). Definitions

```
 BGP4-V2-MIB DEFINITIONS ::= BEGIN

     IMPORTS
         MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
         Integer32, Counter32, Gauge32, mib-2,
         Unsigned32
             FROM SNMPv2-SMI
         InetAddressType, InetAddress
             FROM INET-ADDRESS-MIB
         TEXTUAL-CONVENTION, TruthValue, DisplayString, RowStatus
             FROM SNMPv2-TC
         MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
             FROM SNMPv2-CONF;


     bgp MODULE-IDENTITY
         LAST-UPDATED "200111200000Z"
         ORGANIZATION "IETF IDR Working Group"
         CONTACT-INFO "E-mail:  idr@merit.net

                        Jeff Haas  (Editor)
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                        Ann Arbor, MI 48103-4943
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         DESCRIPTION
             "This MIB module defines management objects for
             the Border Gateway Protocol, Version 4."
         ::= { mib-2 XXX }

     BgpIdentifier ::= TEXTUAL-CONVENTION
         DISPLAY-HINT "1d:"
         -- jmh - is this right?
         STATUS     current
         DESCRIPTION
             "The representation of a BGP Identifier."
         SYNTAX OCTET STRING(SIZE (4))

     BgpSafi ::= TEXTUAL-CONVENTION
         DISPLAY-HINT "d"
         STATUS current
         DESCRIPTION
```

```
             "The representation of a BGP Safi"
         SYNTAX Unsigned32(0..255)

     BgpAutonomousSystemNumber ::= TEXTUAL-CONVENTION
         -- JMH - how is Cisco et al. representing the 4byte
         -- versions?
         DISPLAY-HINT "d"
         STATUS current
         DESCRIPTION
             "An autonomous System Number.  If bgpAsSize is
             two-octet, the range is 0..65535.  If it is
             four-octet, it is the full range of Unsigned32."
         SYNTAX Unsigned32

     bgpBaseScalars
     OBJECT IDENTIFIER ::= { bgp 1 }


     bgpBaseNotifications
     OBJECT IDENTIFIER ::= { bgpBaseScalars 0 }

     bgpEstablished NOTIFICATION-TYPE
         OBJECTS {
             bgpPeerLocalAddrType,
             bgpPeerLocalAddr,
             bgpPeerRemoteAddrType,
             bgpPeerRemoteAddr,
             bgpPeerLastError,
             bgpPeerState
          }
         STATUS  current
         DESCRIPTION
             "The BGP Established event is generated when
              the BGP FSM enters the ESTABLISHED state."
         ::= { bgpBaseNotifications 1 }


     bgpBackwardTransition NOTIFICATION-TYPE
         OBJECTS {
             bgpPeerLocalAddrType,
             bgpPeerLocalAddr,
             bgpPeerRemoteAddrType,
             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."
         ::= { bgpBaseNotifications 2 }

     bgpVersion
     OBJECT IDENTIFIER ::= { bgpBaseScalars 1 }

       --
     -- BGP Supported Version Table
     --

     bgpVersionTable OBJECT-TYPE
         SYNTAX     SEQUENCE OF BgpVersionEntry
         MAX-ACCESS not-accessible
         STATUS     current
         DESCRIPTION
             "Table of supported BGP versions."
         ::= { bgpVersion 1 }

     bgpVersionEntry OBJECT-TYPE
         SYNTAX     BgpVersionEntry
         MAX-ACCESS not-accessible
         STATUS     current
     DESCRIPTION
             "Entry containing data on a given supported version of
                 the Border Gateway Protocol and the level of support
                 provided.  It is expected that any agent implementation
                 supporting this MIB module will report support for
                 Version 4 of the Border Gateway Protocol at the very
                 minimum."
      INDEX { bgpVersionIndex }
        ::= { bgpVersionTable 1 }

     BgpVersionEntry ::= SEQUENCE {
             bgpVersionIndex
                 Unsigned32,
             bgpVersionSupported
                 TruthValue
             }

     bgpVersionIndex OBJECT-TYPE
         SYNTAX     Unsigned32(0..255)
         MAX-ACCESS read-only
         STATUS     current
         DESCRIPTION
             "The version number of the BGP Protocol."
         ::= { bgpVersionEntry 1 }
```

```
bgpVersionSupported OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS read-only
    STATUS      current
    DESCRIPTION
        "This value is TRUE if the version of the BGP protocol
         identified in 'bgpVersionIndex' is supported."
    ::= { bgpVersionEntry 2 }

bgpSupportedAuthentication
OBJECT IDENTIFIER ::= { bgpBaseScalars 2 }


--
-- Supported authentication mechanisms
--

bgpSupportedAuthTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF BgpSupportedAuthEntry
    MAX-ACCESS not-accessible
    STATUS      current
    DESCRIPTION
        "The supported BGP authentication mechanisms."
    ::= { bgpSupportedAuthentication 1 }

bgpSupportedAuthEntry OBJECT-TYPE
    SYNTAX      BgpSupportedAuthEntry
    MAX-ACCESS not-accessible
    STATUS      current
    DESCRIPTION
        "Entry containing information whether a given BGP
         authentication mechanism is supported by this
         implementation."
    INDEX { bgpSupportedAuthCode }
    ::= { bgpSupportedAuthTable 1 }

BgpSupportedAuthEntry ::= SEQUENCE {
        bgpSupportedAuthCode
            Unsigned32,
        bgpSupportedAuthValue
            TruthValue
        }

bgpSupportedAuthCode OBJECT-TYPE
    SYNTAX      Unsigned32(0..255)
    MAX-ACCESS read-only
    STATUS      current
    DESCRIPTION
```

```
              "The BGP authentication code."
          ::= { bgpSupportedAuthEntry 1 }


      bgpSupportedAuthValue OBJECT-TYPE
          SYNTAX     TruthValue
          MAX-ACCESS read-only
          STATUS     current
          DESCRIPTION
              "This value is TRUE if a given authentication method
               is supported by the local implementation."
          ::= { bgpSupportedAuthEntry 2 }


      bgpSupportedCapabilities
      OBJECT IDENTIFIER ::= { bgpBaseScalars 3 }



      --
      -- Supported BGP Capabilities
      --


      bgpCapabilitySupportAvailable OBJECT-TYPE
          SYNTAX     TruthValue
          MAX-ACCESS read-write
          STATUS     current
          DESCRIPTION
              "This variable determines whether BGP-4
               capabilities are supported in this
               implementation.  This variable may be set to
               false to disable capability support."
          ::= { bgpSupportedCapabilities 1 }


      bgpSupportedCapabilitiesTable OBJECT-TYPE
          SYNTAX     SEQUENCE OF BgpSupportedCapabilityEntry
          MAX-ACCESS not-accessible
          STATUS     current
          DESCRIPTION
              "Table of supported BGP-4 capabilities."
          ::= { bgpSupportedCapabilities 2 }


      bgpSupportedCapabilitiesEntry OBJECT-TYPE
          SYNTAX     BgpSupportedCapabilityEntry
          MAX-ACCESS not-accessible
          STATUS     current
          DESCRIPTION
              "Information about supported capabilities indexed
               by capability number."
```

```
        INDEX {
            bgpSupportedCapabilityIndex
        }
        ::= { bgpSupportedCapabilitiesTable 1 }


    BgpSupportedCapabilityEntry ::= SEQUENCE {
            bgpSupportedCapabilityIndex
                Unsigned32,
            bgpSupportedCapability
                TruthValue
            }


    bgpSupportedCapabilityIndex OBJECT-TYPE
        SYNTAX     Unsigned32 (0..255)
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "Index of supported capability.  The index directly
             corresponds with the BGP-4 Capability Advertisement
             Capability Code."
        ::= { bgpSupportedCapabilitiesEntry 1 }


    bgpSupportedCapability OBJECT-TYPE
        SYNTAX     TruthValue
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "This value is True if this capability is supported,
             False otherwise."
        ::= { bgpSupportedCapabilitiesEntry 2 }

    bgpAsSize OBJECT-TYPE
        SYNTAX     INTEGER {
            twoOctet(1),
            fourOctet(2)
        }
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "The size of the AS value in this implementation.

             The semantics of this are determined as per the
             as-4bytes draft."
        REFERENCE
            "draft-ietf-idr-as4bytes-04"
```

```
             ::= { bgpBaseScalars 4 }

         bgpLocalAs OBJECT-TYPE
             SYNTAX      BgpAutonomousSystemNumber
             MAX-ACCESS  read-write
             STATUS      current
             DESCRIPTION
                 "The local autonomous system number.

                  If the bgpAsSize is twoOctet, then the range is
                  constrained to be 0-65535."
             ::= { bgpBaseScalars 5 }

         bgpLocalIdentifier OBJECT-TYPE
             SYNTAX      BgpIdentifier
             MAX-ACCESS  read-write
             STATUS      current
             DESCRIPTION
                 "The BGP Identifier of the local system.

                  Current practice is trending away from this value being
                  treated as an IP address and more as a generic
                  identifier."
             ::= { bgpBaseScalars 6 }

         --
         -- Base Scalar Extensions
         --

         bgpBaseScalarExtensions     OBJECT IDENTIFIER ::=
             { bgpBaseScalars 7 }

         bgpBaseScalarNonCapExts OBJECT IDENTIFIER ::=
             { bgpBaseScalarExtensions 1 }

         bgpBaseScalarCapExts OBJECT IDENTIFIER ::=
             { bgpBaseScalarExtensions 2 }

         --
         -- Base Scalar AS Confederation Extensions
         --

         bgpBaseScalarASConfederationExts OBJECT IDENTIFIER ::=
              { bgpBaseScalarNonCapExts 1965 }

         bgpConfederationId OBJECT-TYPE
             SYNTAX      BgpAutonomousSystemNumber
             MAX-ACCESS  read-write
```

```
             STATUS      current
             DESCRIPTION
                 "The local Confederation Identification Number.

                 A value of zero (0) indicates the absence of this
                 value."
             REFERENCE
                 "RFC 3065 - Autonomous System Confederations for BGP"
             ::= { bgpBaseScalarASConfederationExts 1 }

       --
     -- Base Scalar Route Reflection Extensions
     --

     bgpBaseScalarRouteReflectionExts OBJECT IDENTIFIER ::=
         { bgpBaseScalarNonCapExts 1966 }

     bgpClusterId OBJECT-TYPE
         SYNTAX      BgpIdentifier
         MAX-ACCESS  read-write
         STATUS      current
         DESCRIPTION
             "The configured Cluster-ID of the local router.

             A value of 0.0.0.0 indicates the absence of this
             value."
         REFERENCE
             "RFC 2796 - BGP Route Reflection"
         ::= { bgpBaseScalarRouteReflectionExts 1 }


     bgpPeer
     OBJECT IDENTIFIER ::= { bgp 2 }


     bgpPeerData
     OBJECT IDENTIFIER ::= { bgpPeer 1 }


     --
     -- BGP Peer Data
     --

     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,
             and information about the connections with BGP
             peers."
        ::= { bgpPeerData 1 }

    bgpPeerEntry OBJECT-TYPE
        SYNTAX      BgpPeerEntry
        MAX-ACCESS not-accessible
        STATUS      current
        DESCRIPTION
            "Entry containing information about the connection with
            a BGP peer."
        INDEX {
            -- JMH We should only need one AddrType?
            bgpPeerLocalAddrType,
            bgpPeerLocalAddr,
            bgpPeerRemoteAddrType,
            bgpPeerRemoteAddr
        }
        ::= { bgpPeerTable 1 }


    BgpPeerEntry ::= SEQUENCE {
            bgpPeerIdentifier
                BgpIdentifier,
            bgpPeerState
                INTEGER,
            bgpPeerAdminStatus
                INTEGER,
            bgpPeerConfiguredVersion
                Unsigned32,
            bgpPeerNegotiatedVersion
                Unsigned32,
            bgpPeerLocalAddrType
                InetAddressType,
            bgpPeerLocalAddr
                InetAddress,
            bgpPeerLocalPort
                Integer32,
            bgpPeerLocalAs
                BgpAutonomousSystemNumber,
            bgpPeerRemoteAddrType
                InetAddressType,
            bgpPeerRemoteAddr
                InetAddress,
            bgpPeerRemotePort
```

```
                    Integer32,
             bgpPeerRemoteAs
                 BgpAutonomousSystemNumber,
             bgpPeerIndex
                 Unsigned32,
             bgpPeerRowEntryStatus
                 RowStatus
             }


        bgpPeerIdentifier OBJECT-TYPE
            SYNTAX     BgpIdentifier
            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's FSM state."
            ::= { bgpPeerEntry 2 }


        -- JMH
        -- The work here is done by a transition.
        -- This implies that we stay in a state even though
        -- automatic start/stop events imply strobing something
        -- even when the state machine is running.
        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 }


        -- JMH
        -- Added this
        bgpPeerConfiguredVersion OBJECT-TYPE
            SYNTAX      Unsigned32 (1..255)
            MAX-ACCESS read-write
            STATUS      current
            DESCRIPTION
                "The configured version to originally start with this
                 peer.  The BGP speaker may permit negotiation to a
                 lower version number of the protocol."
            ::= { bgpPeerEntry 4 }


        bgpPeerNegotiatedVersion OBJECT-TYPE
            SYNTAX      Unsigned32 (1..255)
            MAX-ACCESS read-only
            STATUS      current
            DESCRIPTION
                "The negotiated version of BGP running between the two
                 peers."
            ::= { bgpPeerEntry 5 }


        bgpPeerLocalAddrType OBJECT-TYPE
            SYNTAX      InetAddressType
            MAX-ACCESS read-write
            STATUS      current
            DESCRIPTION
                "The address family of the local end of the peering
                 session."
            ::= { bgpPeerEntry 6 }
```

```
        bgpPeerLocalAddr OBJECT-TYPE
            SYNTAX      InetAddress (SIZE (20))
            MAX-ACCESS read-write
            STATUS      current
            DESCRIPTION
                "The address of the local end of the peering session."
            ::= { bgpPeerEntry 7 }


        bgpPeerLocalPort OBJECT-TYPE
            SYNTAX      Integer32 (-1 | 0..65535)
            MAX-ACCESS read-only
            STATUS      current
            DESCRIPTION
                "The local port for the transport connection between the BGP
                 peers.  In the case of a transport for which the notion of
                 'port' is irrelevant, an instance value of -1 should be
returned
                 by the agent for this object."
            ::= { bgpPeerEntry 8 }


        bgpPeerLocalAs OBJECT-TYPE
            SYNTAX      BgpAutonomousSystemNumber
            MAX-ACCESS read-write
            STATUS      current
            DESCRIPTION
                "Some implementations of BGP can represent themselves
                 as multiple ASs.  This is the AS that this peering
                 session is representing itself as to the remote peer."
            ::= { bgpPeerEntry 9 }


        bgpPeerRemoteAddrType OBJECT-TYPE
            SYNTAX      InetAddressType
            MAX-ACCESS read-write
            STATUS      current
            DESCRIPTION
                "The address family of the remote end of the peering
                 session."
            ::= { bgpPeerEntry 10 }


        bgpPeerRemoteAddr OBJECT-TYPE
            SYNTAX      InetAddress (SIZE (20))
            MAX-ACCESS read-write
            STATUS      current
            DESCRIPTION
                "The address of the remote end of the peering session."
```

                 ::= { bgpPeerEntry 11 }

          bgpPeerRemotePort OBJECT-TYPE
              SYNTAX   Integer32 (-1 | 0..65535)
              MAX-ACCESS   read-write
              STATUS   current
              DESCRIPTION
                  "The remote port for the TCP connection between
                   the BGP peers. In the case of a transport for
                   which the notion of 'port' is irrelevant, an
                   instance value of -1 should be returned
                   by the agent for this object.

                   -- JMH - this text needs updating
                   Note that the objects bgpPeerLocalAddr,
                   bgpPeerLocalPort, bgpPeerRemoteAddr and
                   bgpPeerRemotePort provide the appropriate reference to
                   the standard MIB TCP connection table. or even the ipv6
                   tcp MIB as in rfc2452."
              ::= { bgpPeerEntry 12 }

          bgpPeerRemoteAs OBJECT-TYPE
              SYNTAX   BgpAutonomousSystemNumber
              MAX-ACCESS read-write
              STATUS   current
              DESCRIPTION
                  "The remote autonomous system number."
              ::= { bgpPeerEntry 13 }

          bgpPeerIndex OBJECT-TYPE
              SYNTAX   Unsigned32
              MAX-ACCESS read-only
              STATUS   current
              DESCRIPTION
                  "This value is a unique index for the peer entry in the
                   bgpPeerTable. It is assigned by the agent at the point
                   of creation of the bgpPeerTable row entry. While its
                   value is guaranteed to be unique at any time, it is
                   otherwise opaque to the management application with
                   respect to its value or the contiguity of bgpPeerIndex
                   row instance values across rows of the bgpPeerTable. It
                   is used to provide an index structure for other tables
                   whose data is logically per-peer."
-- +++wayne (from Tom Nadeau): need text describing fate sharing of index, if
-- peering session comes up, peer disconnects, and then this or other peer

-- connects again. Will this grow monotonically? (I think that's the question)
              ::= { bgpPeerEntry 14 }

        bgpPeerRowEntryStatus OBJECT-TYPE
            SYNTAX   RowStatus
            MAX-ACCESS read-only
            STATUS   current
            DESCRIPTION
                "This object type reflects the status of the row within the
                agent. Note that this is independent of the bgpPeerAdminStatus
                which reflects the underlying peering session itself. An
instance
                of this row is returned by the agent to reflect the validity of
the
                current state of this row. The valid RowStatus enumeration
values
                for this are 'active', 'notInService', and 'notReady'."
-- +++wayne need better definition of the three states, better analysis of
-- whether this should be read-write, and what, if any, the interaction of
setting
-- bgpPeerAdminStatus to 'stop'. At some point, the entry should age out of
the
-- agent, and this needs to track that (in addition to its creation from
-- bgpPeerCfgTable row data).
              ::= { bgpPeerEntry 15 }

        bgpPeerErrors
        OBJECT IDENTIFIER ::= { bgpPeer 2 }

        bgpPeerErrorsTable OBJECT-TYPE
            SYNTAX   SEQUENCE OF BgpPeerErrorsEntry
            MAX-ACCESS not-accessible
            STATUS   current
            DESCRIPTION
                "On a per peer basis, this table reflects the last
                    protocol-defined error encountered and reported on the
                    peer session. If no entry for a given peer, by its
                    bgpPeerIndex, exists in this table, then no such errors
                    have been observed, reported, and recorded on the
                    session."
            ::= { bgpPeerErrors 1 }

        bgpPeerErrorsEntry OBJECT-TYPE
            SYNTAX   BgpPeerErrorsEntry
            MAX-ACCESS not-accessible
            STATUS   current
            DESCRIPTION
                "Each entry contains information about an error on

```
                a given BGP peer session."
            INDEX { bgpPeerIndex }
            ::= { bgpPeerErrorsTable 1 }

        BgpPeerErrorsEntry ::= SEQUENCE {
```

```
            bgpPeerLastError
                OCTET STRING,
            bgpPeerLastErrorData
                Unsigned32
        }

        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
                "draft-ietf-bgp4-15.txt, Sec. 4.5"
            ::= { bgpPeerErrorsEntry 1 }

        bgpPeerLastErrorData OBJECT-TYPE
            SYNTAX      Unsigned32 (0..4075)
            MAX-ACCESS read-only
            STATUS      current
            DESCRIPTION
                "The last error code's data seen by this peer on this
                 connection."
            ::= { bgpPeerErrorsEntry 2 }

        bgpPeerAuthentication
        OBJECT IDENTIFIER ::= { bgpPeer 3 }


        --
        -- Peer Authentication
        --

        bgpPeerAuthTable OBJECT-TYPE
            SYNTAX      SEQUENCE OF BgpPeerAuthEntry
            MAX-ACCESS not-accessible
            STATUS      current
            DESCRIPTION
                "BGP peer authentication table.

                 This table contains, one entry per BGP peer,
                 information about the authentication with BGP peers."
            ::= { bgpPeerAuthentication 1 }
```

```
bgpPeerAuthEntry OBJECT-TYPE
    SYNTAX      BgpPeerAuthEntry
    MAX-ACCESS not-accessible
    STATUS      current
    DESCRIPTION
        "Entry containing information about the authentication
         with a BGP peer."
    INDEX { bgpPeerIndex }
    ::= { bgpPeerAuthTable 1 }


BgpPeerAuthEntry ::= SEQUENCE {
    bgpPeerAuthSent
        TruthValue,
    bgpPeerAuthSentCode
        Unsigned32,
    bgpPeerAuthSentValue
        OCTET STRING,
    bgpPeerAuthRcvd
        TruthValue,
    bgpPeerAuthRcvdCode
        Unsigned32,
    bgpPeerAuthRcvdValue
        OCTET STRING
}


bgpPeerAuthSent OBJECT-TYPE
    SYNTAX TruthValue
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
        "The local peer has sent authentication
        to the remote peer in the BGP Authentication
            field."
        ::= { bgpPeerAuthEntry 1 }


 bgpPeerAuthSentCode OBJECT-TYPE
    SYNTAX  Unsigned32 (0..255)
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
        "The code of the authentication information sent
        the remote peer."
    ::= { bgpPeerAuthEntry 2 }
```

```
        bgpPeerAuthSentValue OBJECT-TYPE
            SYNTAX  OCTET STRING (SIZE (0..255))
        -- jmh length is too much
        -- +++wayne get value from...IPSec MIB? Any opaque TC there to use?
            MAX-ACCESS read-write
            STATUS current
            DESCRIPTION
                "The payload of the authentication information
                from the remote peer."
            ::= { bgpPeerAuthEntry 3 }


        bgpPeerAuthRcvd OBJECT-TYPE
            SYNTAX TruthValue
            MAX-ACCESS read-only
            STATUS current
            DESCRIPTION
                "The local peer has received authentication
                from the remote peer in the BGP Authentication
                field."
                ::= { bgpPeerAuthEntry 4 }


        bgpPeerAuthRcvdCode OBJECT-TYPE
            SYNTAX  Unsigned32 (0..255)
            MAX-ACCESS read-only
            STATUS current
            DESCRIPTION
                "The code of the authentication information
                from the remote peer."
            ::= { bgpPeerAuthEntry 5 }


        bgpPeerAuthRcvdValue OBJECT-TYPE
            SYNTAX  OCTET STRING (SIZE (0..255))
        -- jmh length is too much
            MAX-ACCESS read-only
            STATUS current
            DESCRIPTION
                "The payload of the authentication information
                from the remote peer."
            ::= { bgpPeerAuthEntry 6 }

        bgpPeerTimers
        OBJECT IDENTIFIER ::= { bgpPeer 4 }


        --
```

```
            -- Peer Event Times
            --

            bgpPeerEventTimesTable OBJECT-TYPE
                SYNTAX      SEQUENCE OF BgpPeerEventTimesEntry
                MAX-ACCESS not-accessible
                STATUS      current
                DESCRIPTION
                    "A table reporting the per-peering session amount of time
                        elapsed and update events since the peering session
                    advanced into the 'established' state."
                ::= { bgpPeerTimers 1 }

            bgpPeerEventTimesEntry OBJECT-TYPE
                SYNTAX      BgpPeerEventTimesEntry
                MAX-ACCESS not-accessible
                STATUS      current
                DESCRIPTION
                    "Each row contains a set of statistics about time
                        spent and events encountered in the peer session
                    'established' state."
                INDEX { bgpPeerIndex }
                ::= { bgpPeerEventTimesTable 1 }

            BgpPeerEventTimesEntry ::= SEQUENCE {
                bgpPeerFsmEstablishedTime
                    Gauge32,
                bgpPeerInUpdatesElapsedTime
                    Gauge32
        }

            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."
                ::= { bgpPeerEventTimesEntry 1 }


            bgpPeerInUpdatesElapsedTime OBJECT-TYPE
                SYNTAX      Gauge32
                MAX-ACCESS read-only
                STATUS      current
```

```
        DESCRIPTION
             "Elapsed time in seconds since the last BGP
            message was received from the peer.  Each time
            bgpPeerInUpdates is incremented, the value of this
            object is set to zero (0)."
        ::= { bgpPeerEventTimesEntry 2 }


    --
    -- Peer Configured Timers
    --

    bgpPeerConfiguredTimersTable OBJECT-TYPE
        SYNTAX     SEQUENCE OF BgpPeerConfiguredTimersEntry
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
            "Per peer management data on BGP session timers."
        ::= { bgpPeerTimers 2 }

    bgpPeerConfiguredTimersEntry OBJECT-TYPE
        SYNTAX     BgpPeerConfiguredTimersEntry
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
            "Each entry corresponds to the current state of BGP
                timers on a given peering session."
        INDEX { bgpPeerIndex }
        ::= { bgpPeerConfiguredTimersTable 1 }

    BgpPeerConfiguredTimersEntry ::= SEQUENCE {
        bgpPeerConnectRetryInterval
            Unsigned32,
        bgpPeerHoldTimeConfigured
            Unsigned32,
        bgpPeerKeepAliveConfigured
            Unsigned32,
        bgpPeerMinASOriginationInterval
            Unsigned32,
        bgpPeerMinRouteAdvertiseInterval
            Unsigned32
    }

    bgpPeerConnectRetryInterval OBJECT-TYPE
        SYNTAX     Unsigned32 (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."
            ::= { bgpPeerConfiguredTimersEntry 1 }

        bgpPeerHoldTimeConfigured OBJECT-TYPE
            SYNTAX   Unsigned32 (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."
            REFERENCE
                "RFC 1771, p. 9"
            ::= { bgpPeerConfiguredTimersEntry 2 }

        bgpPeerKeepAliveConfigured OBJECT-TYPE
            SYNTAX   Unsigned32 (0 | 1..21845)
            MAX-ACCESS read-write
            STATUS   current
            DESCRIPTION
                "Time interval in seconds for the KeepAlive
                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."
          REFERENCE
               "RFC 1771, pp. 17-18"
               ::= { bgpPeerConfiguredTimersEntry 3 }

     bgpPeerMinASOriginationInterval OBJECT-TYPE
          SYNTAX   Unsigned32 (1..65535)
          MAX-ACCESS read-write
          STATUS   current
          DESCRIPTION
               "Time interval in seconds for the
               timer. The suggested value for this timer is 15
               seconds."
          ::= { bgpPeerConfiguredTimersEntry 4 }

     bgpPeerMinRouteAdvertiseInterval OBJECT-TYPE
          SYNTAX   Unsigned32 (1..65535)
          MAX-ACCESS read-write
          STATUS   current
          DESCRIPTION
               "Time interval in seconds for the
               MinRouteAdvertisementInterval timer. The
               value for this timer is 30 seconds."
          ::= { bgpPeerConfiguredTimersEntry 5 }

     --
     -- Peer Negotiated Timers
     --

     bgpPeerNegotiatedTimersTable OBJECT-TYPE
          SYNTAX   SEQUENCE OF BgpPeerNegotiatedTimersEntry
          MAX-ACCESS not-accessible
          STATUS   current
          DESCRIPTION
               "Current values of per-peer timers which can be
                    dynamically set in the bgpPeerConfiguredTimersTable.
                    Values reflected in this table are the current
                operational values, after negotiation from values
                    derived from initial configuration or last set from
                    bgpPeerConfiguredTimersTable row instances."
               ::= { bgpPeerTimers 3 }

     bgpPeerNegotiatedTimersEntry OBJECT-TYPE
          SYNTAX   BgpPeerNegotiatedTimersEntry
          MAX-ACCESS not-accessible
          STATUS   current

```
            DESCRIPTION
                "Each entry reflects a value of the currently
                    operational, negotiated timers as reflected in the
                    BgpPeerNegotiatedTimersEntry."
            INDEX { bgpPeerIndex }
            ::= { bgpPeerNegotiatedTimersTable 1 }

        BgpPeerNegotiatedTimersEntry ::= SEQUENCE {
            bgpPeerHoldTime
                Integer32,
            bgpPeerKeepAlive
                Integer32
    }

        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
                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) in which case the Hold Timer has not
                been established with the peer, or, the value of
                bgpPeerHoldTimeConfigured is zero (0)."
-- +++wayne (from Tom Nadeau) would like to see enumerated cases of
-- description as this has too many subcases.
            ::= { bgpPeerNegotiatedTimersEntry 1 }

        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
                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)."
            ::= { bgpPeerNegotiatedTimersEntry 2 }
```

```
bgpPeerCapabilities
OBJECT IDENTIFIER ::= { bgpPeer 5 }


--
-- Peer Capabilities
--


--
-- Announced Capabilities
--

bgpPeerCapsAnnouncedTable OBJECT-TYPE
    SYNTAX     SEQUENCE OF BgpPeerCapsAnnouncedEntry
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
        "This table contains contains the capabilities
        that are supported for a given peer."
    ::= { bgpPeerCapabilities 1 }


bgpPeerCapsAnnouncedEntry OBJECT-TYPE
    SYNTAX     BgpPeerCapsAnnouncedEntry
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
        "These entries are keyed by a BGP-4 peer remote
        address and the BGP Capability Code"
    INDEX {
        bgpPeerIndex,
        bgpPeerCapAnnouncedCode,
        bgpPeerCapAnnouncedIndex
        }
    ::= { bgpPeerCapsAnnouncedTable 1 }


BgpPeerCapsAnnouncedEntry ::= SEQUENCE {
        bgpPeerCapAnnouncedCode
            Unsigned32,
        bgpPeerCapAnnouncedIndex
            Unsigned32,
        bgpPeerCapAnnouncedLength
            Unsigned32,
        bgpPeerCapAnnouncedValue
            OCTET STRING
        }
```

```
        bgpPeerCapAnnouncedCode OBJECT-TYPE
            SYNTAX     Unsigned32 (0..255)
            MAX-ACCESS read-only
            STATUS     current
            DESCRIPTION
                "The BGP Capability Advertisement Capability Code."
            ::= { bgpPeerCapsAnnouncedEntry 1 }


        bgpPeerCapAnnouncedIndex OBJECT-TYPE
            SYNTAX     Unsigned32 (1..128)
            MAX-ACCESS read-only
            STATUS     current
            DESCRIPTION
                "Multiple instances of a given capability may be sent
                bgp a BGP speaker.  This variable is used to index them."
            ::= { bgpPeerCapsAnnouncedEntry 2 }


        bgpPeerCapAnnouncedLength OBJECT-TYPE
            SYNTAX     Unsigned32
            MAX-ACCESS read-only
            STATUS     current
            DESCRIPTION
                "The length of the announced capability."
            ::= { bgpPeerCapsAnnouncedEntry 3 }


        bgpPeerCapAnnouncedValue OBJECT-TYPE
            SYNTAX     OCTET STRING (SIZE(0..255))
            MAX-ACCESS read-only
            STATUS     current
            DESCRIPTION
                "The value of the announced capability."
            ::= { bgpPeerCapsAnnouncedEntry 4 }



        --
        -- Received Capabilities
        --

        bgpPeerCapsReceivedTable OBJECT-TYPE
            SYNTAX     SEQUENCE OF Bgp4PeerCapsReceivedEntry
            MAX-ACCESS not-accessible
            STATUS     current
            DESCRIPTION
                "This table contains contains the capabilities
```

```
             that are supported for a given peer."
          ::= { bgpPeerCapabilities 2 }


      bgpPeerCapsReceivedEntry OBJECT-TYPE
          SYNTAX     Bgp4PeerCapsReceivedEntry
          MAX-ACCESS not-accessible
          STATUS     current
          DESCRIPTION
              "These entries are keyed by a BGP-4 peer remote
              address and the BGP Capability Code"
          INDEX {
              bgpPeerRemoteAddrType,
              bgpPeerRemoteAddr,
              bgpPeerCapReceivedCode,
              bgpPeerCapReceivedIndex
              }
          ::= { bgpPeerCapsReceivedTable 1 }


      Bgp4PeerCapsReceivedEntry ::= SEQUENCE {
              bgpPeerCapReceivedCode
                  Unsigned32,
              bgpPeerCapReceivedIndex
                  Unsigned32,
              bgpPeerCapReceivedLength
                  Unsigned32,
              bgpPeerCapReceivedValue
                  OCTET STRING
              }


      bgpPeerCapReceivedCode OBJECT-TYPE
          SYNTAX     Unsigned32 (0..255)
          MAX-ACCESS read-only
          STATUS     current
          DESCRIPTION
              "The BGP Capability Advertisement Capability Code."
          ::= { bgpPeerCapsReceivedEntry 1 }


      bgpPeerCapReceivedIndex OBJECT-TYPE
          SYNTAX     Unsigned32 (1..128)
          MAX-ACCESS read-only
          STATUS     current
          DESCRIPTION
              "Multiple instances of a given capability may be sent
              bgp a BGP speaker.  This variable is used to index them."
```

```
            ::= { bgpPeerCapsReceivedEntry 2 }


    bgpPeerCapReceivedLength OBJECT-TYPE
        SYNTAX      Unsigned32
        MAX-ACCESS read-only
        STATUS      current
        DESCRIPTION
            "The length of the announced capability."
        ::= { bgpPeerCapsReceivedEntry 3 }


    bgpPeerCapReceivedValue OBJECT-TYPE
        SYNTAX      OCTET STRING (SIZE(0..255))
        MAX-ACCESS read-only
        STATUS      current
        DESCRIPTION
            "The value of the announced capability."
        ::= { bgpPeerCapsReceivedEntry 4 }

    bgpPeerCounters
    OBJECT IDENTIFIER ::= { bgpPeer 6 }


    bgpPeerCountersTable OBJECT-TYPE
        SYNTAX      SEQUENCE OF BgpPeerCountersEntry
        MAX-ACCESS not-accessible
        STATUS      current
        DESCRIPTION
            "The counters associated with a BGP Peer."
        ::= { bgpPeerCounters 1 }


    bgpPeerCountersEntry OBJECT-TYPE
        SYNTAX      BgpPeerCountersEntry
        MAX-ACCESS not-accessible
        STATUS      current
        DESCRIPTION
            "Each entry contains counters of messsage transmissions
                and FSM transitions for a given BGP Peering session."
        INDEX { bgpPeerIndex }
        ::= { bgpPeerCountersTable 1 }


    BgpPeerCountersEntry ::= SEQUENCE {
            bgpPeerInUpdates
                Counter32,
            bgpPeerOutUpdates
```

```
                        Counter32,
                    bgpPeerInTotalMessages
                        Counter32,
                    bgpPeerOutTotalMessages
                        Counter32,
                    bgpPeerFsmEstablishedTransitions
                         Counter32
                    }

-- +++wayne need to describe what happens if connection is broken
-- and then reestablished. Does the prior counter value accumulate?

        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."
            ::= { bgpPeerCountersEntry 1 }


        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."
            ::= { bgpPeerCountersEntry 2 }


        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."
            ::= { bgpPeerCountersEntry 3 }


        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."
            ::= { bgpPeerCountersEntry 4 }


        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."
            ::= { bgpPeerCountersEntry 5 }

        --
        -- Per-Peer Prefix Counters
        --

        bgpPrefixCountersTable OBJECT-TYPE
            SYNTAX      SEQUENCE OF BgpPrefixCountersEntry
            MAX-ACCESS not-accessible
            STATUS      current
            DESCRIPTION
                "Additional per-peer, per AFI/SAFI counters for prefixes"
            ::= { bgpPeerCounters 2 }


        bgpPrefixCountersEntry OBJECT-TYPE
            SYNTAX      BgpPrefixCountersEntry
            MAX-ACCESS not-accessible
            STATUS      current
            DESCRIPTION
                "Entry containing information about a bgp-peer's prefix
                 counters."
            INDEX {
                bgpPeerIndex,
                bgpPrefixCountersAfi,
                bgpPrefixCountersSafi
                }
            ::= { bgpPrefixCountersTable 1 }


        BgpPrefixCountersEntry ::= SEQUENCE {
            -- JMH
```

```
                    -- do we really need AFI and safi in the table?
                       bgpPrefixCountersAfi
                           InetAddressType,
                       bgpPrefixCountersSafi
                           BgpSafi,
                       bgpPrefixInPrefixes
                           Gauge32,
                       bgpPrefixInPrefixesAccepted
                           Gauge32,
                       bgpPrefixInPrefixesRejected
                           Gauge32,
                       bgpPrefixOutPrefixes
                           Gauge32
                       }


          bgpPrefixCountersAfi OBJECT-TYPE
              SYNTAX      InetAddressType
              MAX-ACCESS read-only
              STATUS      current
              DESCRIPTION
                  "The AFI index of the per-peer, per prefix counters"
              ::= { bgpPrefixCountersEntry 1 }


          bgpPrefixCountersSafi OBJECT-TYPE
              SYNTAX      BgpSafi
              MAX-ACCESS read-only
              STATUS      current
              DESCRIPTION
                  "The SAFI index of the per-peer, per prefix counters"
              ::= { bgpPrefixCountersEntry 2 }


          bgpPrefixInPrefixes OBJECT-TYPE
              SYNTAX      Gauge32
              MAX-ACCESS read-only
              STATUS      current
              DESCRIPTION
                  "The number of prefixes received from a peer and are
                   stored in the Adj-Ribs-In for that peer."
                   -- jmh - note that we're allowing stuff to be discarded
              ::= { bgpPrefixCountersEntry 7 }


          bgpPrefixInPrefixesAccepted OBJECT-TYPE
              SYNTAX      Gauge32
              MAX-ACCESS read-only
```

```
        STATUS      current
        DESCRIPTION
            "The number of prefixes for a peer that are installed
             in the Adj-Ribs-In and are eligible to become active
             in the Loc-Rib."
        ::= { bgpPrefixCountersEntry 8 }


    bgpPrefixInPrefixesRejected OBJECT-TYPE
        SYNTAX      Gauge32
        MAX-ACCESS read-only
        STATUS      current
        DESCRIPTION
            "The number of prefixes for a peer that are installed
             in the Adj-Ribs-In and are NOT eligible to become active
             in the Loc-Rib."
        ::= { bgpPrefixCountersEntry 9 }

    bgpPrefixOutPrefixes OBJECT-TYPE
        SYNTAX      Gauge32
        MAX-ACCESS read-only
        STATUS      current
        DESCRIPTION
            "The number of prefixes for a peer that are installed
             in that peer's Adj-Ribs-Out."
        ::= { bgpPrefixCountersEntry 10 }

    bgpPeerExtensions
    OBJECT IDENTIFIER ::= { bgpPeer 7 }


    bgpPeerNonCapExts
        OBJECT IDENTIFIER ::= { bgpPeerExtensions 1 }


    bgpPeerCapExts
        OBJECT IDENTIFIER ::= { bgpPeerExtensions 2 }

    --
    -- Peer Route Reflection Extensions
    --

    bgpPeerRouteReflectionExts
        OBJECT IDENTIFIER ::= { bgpPeerNonCapExts 1966 }


    bgpPeerReflectorClient OBJECT-TYPE
        SYNTAX    INTEGER {
```

```
              nonClient(0),
              client(1),
              meshedClient(2)
          }
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
          "This value indicates whether the given peer is a
           reflector client of this router, or not.  A value of
           nonClient(0) indicates that this peer is not a reflector
           client.  A value of client(1) indicates that this peer is a
           reflector client that is not fully meshed with other
           reflector clients.  A value of meshedClient(2) indicates
           that the peer is a reflector client and is fully meshed
           with all other reflector clients."
      REFERENCE
          "RFC 2796 - BGP Route Reflection"
      ::= { bgpPeerRouteReflectionExts 1 }


  --
  -- Peer AS Confederations Extensions
  --

  bgpPeerASConfederationExts
      OBJECT IDENTIFIER ::= { bgpPeerNonCapExts 1965 }


  bgpPeerConfederationMember OBJECT-TYPE
      SYNTAX      TruthValue
      MAX-ACCESS  read-only
      STATUS      current
      DESCRIPTION
          "This value indicates whether the given peer is in our
           confederation or not."
      REFERENCE
          "RFC 3065 - BGP Confederations"
      ::= { bgpPeerASConfederationExts 1 }

  bgpRib
  OBJECT IDENTIFIER ::= { bgp 3 }


  --
  -- BGP NLRI Data
  --

  bgpNlriTable OBJECT-TYPE
```

```
            SYNTAX      SEQUENCE OF BgpNlriEntry
            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."
            ::= { bgpRib 1 }


        bgpNlriEntry OBJECT-TYPE
            SYNTAX      BgpNlriEntry
            MAX-ACCESS not-accessible
            STATUS      current
            DESCRIPTION
                "Information about a path to a network."
            INDEX {
                bgpPeerIndex,
                bgpNlriAfi,
                bgpNlriSafi,
                bgpNlriPrefixLen,
                bgpNlriPrefix
                }
            ::= { bgpNlriTable 1 }


        BgpNlriEntry ::= SEQUENCE {
                bgpNlriAfi
                    InetAddressType,
                bgpNlriSafi
                    BgpSafi,
                bgpNlriPrefixLen
                    Unsigned32,
                bgpNlriPrefix
                    InetAddress,
                bgpNlriBest
                    TruthValue,
                bgpPathAttrIndex
                    Unsigned32,
                bgpNlriASPathStr
                    DisplayString
                }


        bgpNlriAfi OBJECT-TYPE
            SYNTAX      InetAddressType
            MAX-ACCESS read-only
```

```
            STATUS      current
            DESCRIPTION
                "The address family of the prefix for this NLRI."
            ::= { bgpNlriEntry 1 }


        bgpNlriSafi OBJECT-TYPE
            SYNTAX      BgpSafi
            MAX-ACCESS read-only
            STATUS      current
            DESCRIPTION
                "The subsequent address family of the prefix for
                this NLRI"
            REFERENCE
                "RFC 2858 - Multiprotocol Extensions for BGP-4"
            ::= { bgpNlriEntry 2 }


        bgpNlriPrefixLen OBJECT-TYPE
            SYNTAX      Unsigned32 (1..128)
            MAX-ACCESS read-only
            STATUS      current
            DESCRIPTION
                "Length in bits of the IP address prefix in
                the Network Layer Reachability
                Information field."
            ::= { bgpNlriEntry 3 }


        -- JMH - this is going to vary based on AFI/SAFI !!!
        -- JMH - InetAddress is wrong now!
        bgpNlriPrefix OBJECT-TYPE
            SYNTAX      InetAddress  (SIZE (4..16))
            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
                bgpPathAttrAddrPrefixLen.
                Any bits beyond the length specified by
                bgpPathAttrAddrPrefixLen are zeroed."
            ::= { bgpNlriEntry 4 }


        bgpNlriBest OBJECT-TYPE
            SYNTAX      TruthValue
```

```
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "An indication of whether or not this route
            was chosen as the best BGP4 route."
        ::= { bgpNlriEntry 5 }


    bgpPathAttrIndex OBJECT-TYPE
        SYNTAX     Unsigned32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "This value is a unique index for the per-NLRI entry in the
            bgpPeerAttrTable.  It is assigned by the agent at the point
            of creation of the bgpPeerAttrTable row entry.  While its
            value is guaranteed to be unique at any time, it is
            otherwise opaque to the management application with
            respect to its value or the contiguity of bgpPeerAttrIndex
            row instance values across rows of the bgpPeerAttrTable.
            It is used to provide an index structure for other
            tables whose data is logically per-peer, per-NLRI."
        ::= { bgpNlriEntry 6 }

    bgpNlriASPathStr OBJECT-TYPE
        SYNTAX     DisplayString
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
            "This is a string depicting the autonomous system path
             to this network which was received from the peer which
             advertised it.  The format of the string is implementation-
             dependent, and should be designed for operator readability."
        ::= { bgpNlriEntry 7 }

    --
    -- BGP Rib Path Attributes Table
    --

    bgpPathAttrTable OBJECT-TYPE
        SYNTAX     SEQUENCE OF BgpPathAttrEntry
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
            "Provides per advertised network-prefix attribute data,
                as advertised over a peering session."
        ::= { bgpRib 2 }
```

```
         bgpPathAttrEntry OBJECT-TYPE
             SYNTAX     BgpPathAttrEntry
             MAX-ACCESS not-accessible
             STATUS     current
             DESCRIPTION
                 "Each entry contains data about a given network
                     prefix, per-prefix and per-advertising peer."
             INDEX { bgpPathAttrIndex }
             ::= { bgpPathAttrTable 1 }


         BgpPathAttrEntry ::= SEQUENCE {
                 bgpPathAttrOrigin
                     INTEGER,
                 bgpPathAttrNextHopAddrType
                     InetAddressType,
                 bgpPathAttrNextHop
                     InetAddress,
                 bgpPathAttrMultiExitDiscPresent
                     TruthValue,
                 bgpPathAttrMultiExitDisc
                     Unsigned32,
                 bgpPathAttrLocalPrefPresent
                     TruthValue,
                 bgpPathAttrLocalPref
                     Unsigned32,
                 bgpPathAttrAtomicAggregate
                     INTEGER,
                 bgpPathAttrAggregatorAS
                     BgpAutonomousSystemNumber,
                 bgpPathAttrAggregatorAddr
                     BgpIdentifier,
                 bgpPathAttrCalcLocalPref
                     Unsigned32
                 }


         bgpPathAttrOrigin OBJECT-TYPE
             SYNTAX     INTEGER {
                 igp(1),-- networks are interior
                 egp(2),-- networks learned
                         -- via EGP
                 incomplete(3) -- undetermined
                 }
             MAX-ACCESS read-only
             STATUS     current
             DESCRIPTION
                 "The ultimate origin of the path
```

```
        information."
    ::= { bgpPathAttrEntry 2 }


bgpPathAttrNextHopAddrType OBJECT-TYPE
    SYNTAX      InetAddressType
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The address family of the address for
         the border router that should be used
         to access the destination network."
    ::= { bgpPathAttrEntry 3 }


-- JMH - this is wrong for RFC2545!
bgpPathAttrNextHop OBJECT-TYPE
    SYNTAX      InetAddress
    MAX-ACCESS read-only
    STATUS      current
    DESCRIPTION
        "The address of the border router that
        should be used to access the destination
        network.  This address is the nexthop
        address received in the UPDATE packet.
        The address family of this object will be the
        same as that of the prefix in this row."
    ::= { bgpPathAttrEntry 4 }


bgpPathAttrMultiExitDiscPresent OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS read-only
    STATUS      current
    DESCRIPTION
        "Whether or not the MED value is present.
        If it is not present, the bgpPathAttrMultiExitDisc
        object has no useful value and should be set to 0."
    ::= { bgpPathAttrEntry 5 }


bgpPathAttrMultiExitDisc OBJECT-TYPE
    SYNTAX      Unsigned32
    MAX-ACCESS read-only
    STATUS      current
    DESCRIPTION
        "This metric is used to discriminate
        between multiple exit points to an
```

                    adjacent autonomous system."
               ::= { bgpPathAttrEntry 6 }

          bgpPathAttrLocalPrefPresent OBJECT-TYPE
              SYNTAX   TruthValue
              MAX-ACCESS read-only
              STATUS   current
              DESCRIPTION
                  "Whether or not the LOCAL_PREF value is present.
                  If it is not present, the bgpPathAttrLocalPref
                  object has no useful value and should be set to 0."
              ::= { bgpPathAttrEntry 7 }

          bgpPathAttrLocalPref OBJECT-TYPE
              SYNTAX   Unsigned32
              MAX-ACCESS read-only
              STATUS   current
              DESCRIPTION
                  "The originating BGP4 speaker's degree of
                  preference for an advertised route."
              ::= { bgpPathAttrEntry 8 }

-- JMH
-- See comment in v1 draft about this.

          bgpPathAttrAtomicAggregate 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."
              ::= { bgpPathAttrEntry 9 }

          bgpPathAttrAggregatorAS OBJECT-TYPE
              SYNTAX   BgpAutonomousSystemNumber
              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."
            ::= { bgpPathAttrEntry 10 }


        bgpPathAttrAggregatorAddr OBJECT-TYPE
            SYNTAX      BgpIdentifier
            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."
            ::= { bgpPathAttrEntry 11 }


        bgpPathAttrCalcLocalPref OBJECT-TYPE
            SYNTAX      Unsigned32
            MAX-ACCESS read-only
            STATUS      current
            DESCRIPTION
                "The degree of preference calculated by the
                receiving BGP4 speaker for an advertised
                route."
            ::= { bgpPathAttrEntry 12 }

        --    BGP 4 Path attribute AS Path Table.  There is one row in
        --    this table for each AS which is advertised for a given
        --    route as provided from a peer.

-- JMH
-- We need one of these for the NewAsPath for the 4byte draft

        bgpAsPathTable OBJECT-TYPE
            SYNTAX      SEQUENCE OF BgpAsPathEntry
            MAX-ACCESS not-accessible
            STATUS      current
            DESCRIPTION
                "The BGP-4 Path Attribute AS Path Table
                 contains the per network path (NLRI)
                 AS Path data recieved from the
                 advertising BGP peer."
            ::= { bgpRib 3 }
```

```
bgpAsPathTableEntry OBJECT-TYPE
    SYNTAX      BgpAsPathEntry
    MAX-ACCESS not-accessible
    STATUS      current
    DESCRIPTION
        "Information about an AS path segment
         provided with a path to a network."
    INDEX {
            bgpPathAttrIndex,
            bgpAsPathIndex,
            bgpAsPathElementValue
        }
    ::= { bgpAsPathTable 1 }


BgpAsPathEntry ::= SEQUENCE {
    bgpAsPathIndex
        Unsigned32,
    bgpAsPathType
        INTEGER,
    bgpAsPathElementValue
        BgpAutonomousSystemNumber
}


bgpAsPathIndex OBJECT-TYPE
    SYNTAX Unsigned32
    MAX-ACCESS read-only
    STATUS      current
    DESCRIPTION
        "A per-AS path index.  This will index a set of
         autonomous systems in an AS path that are part
         of the same sequence or set (as determined by
         the row value of bgpAsPathType, which
         should be the same value for each bgpAsPathTable
         entry indexed by the same <bgpPathAttrIndex,
         bgpAsPathIndex> pair)."
    ::= { bgpAsPathTableEntry 1 }


bgpAsPathType OBJECT-TYPE
    SYNTAX  INTEGER {
        asSet(1),
        asSequence(2),
        confedSequence(3),
        confedSet(4)
     }
     MAX-ACCESS  read-only
```

```
             STATUS      current
            DESCRIPTION
                "The type of sequence in which this asPath
                 was advertised as an attribute.  Note that
                 all asPath row instances for a given <bgpPathAttrIndex,
                 bgpAsPathIndex> index pair will have their
                 bgpAsPathType set to the same value.
                 The values for bgpAsPathType are
                 interpreted as defined in the base BGP document
                 and the BGP AS Confederations document."
            REFERENCE
                "draft-ietf-idr-bgp4-16
                 RFC 3065 - BGP AS Confederations"
            ::= { bgpAsPathTableEntry 2 }


        bgpAsPathElementValue OBJECT-TYPE
            SYNTAX      BgpAutonomousSystemNumber
            MAX-ACCESS read-only
            STATUS      current
            DESCRIPTION
                "An AS value for an AS the related NLRI traversed
                 in the propagation of its advertisement.  This
                 value is to be interpreted in the context of the
                 sequence implied by bgpAsPathIndex and
                 bgpAsPathType (and, in sequence of the
                 other table rows with the same value of
                 bgpPathAttrIndex and bgpAsPathIndex)."
            ::= { bgpAsPathTableEntry 3 }

        --    BGP 4 Path unknown attribute.  There is one row in
        --    this table for each attribute not known by this BGP
        --    implementation (or agent instrumentation), but provided
        --    from a peer.


        bgpPathAttrUnknownTable OBJECT-TYPE
            SYNTAX      SEQUENCE OF BgpPathAttrUnknownEntry
            MAX-ACCESS not-accessible
            STATUS      current
            DESCRIPTION
                "The BGP-4 Path Attribute Unknown Table
                contains the per network path (NLRI)
                data on the path attributes advertised
                with a route but not known to the local BGP implementation
                or not otherwise capable of being returned from this agent.

                The absence of row data for a given index value for
```

```
            bgpPathAttrIndex indicates a lack of such unknown
            attribute information for the indicated network path
            (as indexed by that bgpPathAttrIndex value in the
            bgpPathAttrTable)."
        ::= { bgpRib 4 }

    bgpPathAttrUnknownEntry OBJECT-TYPE
        SYNTAX      BgpPathAttrUnknownEntry
        MAX-ACCESS not-accessible
        STATUS      current
        DESCRIPTION
            "Information about an unknown attribute
            provided with a path to a network."
        INDEX {
            bgpPathAttrIndex,
            bgpPathAttrUnknownIndex
    }
        ::= { bgpPathAttrUnknownTable 1 }

    BgpPathAttrUnknownEntry ::= SEQUENCE {
            bgpPathAttrUnknownIndex
                Unsigned32,
            bgpPathAttrUnknownType
                Unsigned32,
            bgpPathAttrUnknownValue
                OCTET STRING
            }

    bgpPathAttrUnknownIndex OBJECT-TYPE
        SYNTAX Unsigned32
        MAX-ACCESS read-only
        STATUS      current
        DESCRIPTION
            "An integer index for a row in this table."
        ::= { bgpPathAttrUnknownEntry 1 }

    bgpPathAttrUnknownType OBJECT-TYPE
        SYNTAX Unsigned32
        MAX-ACCESS read-only
        STATUS      current
        DESCRIPTION
            "The attribute type advertised with this 'unnkown'
            attribute by the peer."
        ::= { bgpPathAttrUnknownEntry 2 }

    -- Maximum size of the following is derived as
    --     4096   max message size
    --   - 16     BGP message marker bytes
```

```
        --   -   2     BGP message size
        --   -   1     BGP message type (UPDATE with unknown attr)
        --   -   2     UPDATE routes length (even assuming no routes)
        --   -   2     UPDATE path attributes length
        --   -   1     path attribute flag octet
        --   -   2     unknown path attr type (in bgpPathAttrUnknownType)
        --   ---------
        --     4070 bytes maximum per-message attribute value data

-- +++wayne ideas as to how to make this a reliably smaller/more broken up
-- string eagerly solicited here

        bgpPathAttrUnknownValue OBJECT-TYPE
            SYNTAX     OCTET STRING (SIZE(0..4070))
            MAX-ACCESS read-only
            STATUS     current
            DESCRIPTION
                "Value of path attribute not understood
                 by the base BGP-4 document.

                Octets beyond the maximum size, if any,
                are not recorded by this row object. "
            ::= { bgpPathAttrUnknownEntry 3 }

        --
        -- Path Attribute Extensions
        --

    bgpPathAttrExtensions OBJECT IDENTIFIER ::=
        { bgpRib 5 }


        bgpPathAttrNonCapExts OBJECT IDENTIFIER ::=
            { bgpPathAttrExtensions 1 }


        bgpPathAttrCapExts OBJECT IDENTIFIER ::=
            { bgpPathAttrExtensions 2 }


        --
        -- Path Attribute Route Reflection Extensions
        --

        --
        -- Originator ID Table
        -- . This table is overkill, but seems to fit into
        -- . the current paradigm.
```

```
--

bgpPathAttrRouteReflectionExts OBJECT IDENTIFIER ::=
    { bgpPathAttrNonCapExts 1966 }

bgpPathAttrOriginatorIdTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF BgpPathAttrOriginatorIdEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "Per prefix data pertinent to advertisement of a
            network prefix through an originator."
    REFERENCE
        "RFC 2796 - BGP Route Reflection"
    ::= { bgpPathAttrRouteReflectionExts 1 }

bgpPathAttrOriginatorIdEntry OBJECT-TYPE
    SYNTAX      BgpPathAttrOriginatorIdEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
        "Each entry contains data pertinent to a network prefix
            as received through its originating BGP route reflector."
    REFERENCE
        "RFC 2796 - BGP Route Reflection"
    INDEX {
        bgpPathAttrIndex
}
    ::= { bgpPathAttrOriginatorIdTable 1 }

BgpPathAttrOriginatorIdEntry ::= SEQUENCE {
    bgpPathAttrOriginatorId
        BgpIdentifier
}

bgpPathAttrOriginatorId OBJECT-TYPE
    SYNTAX      BgpIdentifier
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The Originator-ID identifying the router that initially
         advertised this destination to a Route Reflector.  A
         value of 0.0.0.0 indicates the absence of this attribute."
    REFERENCE
        "This attribute is defined in [RFC2796]."
    ::= { bgpPathAttrOriginatorIdEntry 1 }

--
```

```
            -- Cluster table
            --

            bgpPathAttrClusterTable OBJECT-TYPE
                SYNTAX      SEQUENCE OF BgpPathAttrClusterEntry
                MAX-ACCESS not-accessible
                STATUS      current
                DESCRIPTION
                    "The BGP-4 Path Attribute Cluster Table
                     contains the per network path (NLRI)
                     data on the reflection path which a
                     route has traversed.  The absence of row
                     data for a given index value for bgpPathAttrIndex
                     indicates a lack of this attribute information
                     for the indicated network path (as indexed by
                     that bgpPathAttrIndex value in the bgpPathAttrTable)."
                ::= { bgpPathAttrRouteReflectionExts 2 }


            bgpPathAttrClusterEntry OBJECT-TYPE
                SYNTAX      BgpPathAttrClusterEntry
                MAX-ACCESS not-accessible
                STATUS      current
                DESCRIPTION
                    "Information about a cluster traversal
                     provided with a path to a network."
                INDEX {
                    bgpPathAttrIndex,
                    bgpPathAttrClusterIndex
                    }
                ::= { bgpPathAttrClusterTable 1 }


            BgpPathAttrClusterEntry ::= SEQUENCE {
                    bgpPathAttrClusterIndex
                        Unsigned32,
                    bgpPathAttrClusterValue
                        Unsigned32
                    }


            bgpPathAttrClusterIndex OBJECT-TYPE
                SYNTAX      Unsigned32
                MAX-ACCESS read-only
                STATUS      current
                DESCRIPTION
                    "An integral index for a row in this table."
                ::= { bgpPathAttrClusterEntry 1 }
```

-- +++wayne following changed from OCTET STRING/BgpIdentifier per tdn

          bgpPathAttrClusterValue OBJECT-TYPE
              SYNTAX   Unsigned32
              MAX-ACCESS read-only
              STATUS   current
              DESCRIPTION
                  "A four octet long value representing a part of the
                  reflection path that the route has passed. Each such four
                  octet long value represents the ID of a cluster that
                  the route has traversed. The sequence of this path as
                  received in the route advertisement will be preserved in
                  the sequence of bgpPathAttrClusterTable rows (and the
                  bgpPathAttrClusterValue's in each row) as returned for
                  a given bgpPathAttrIndex value, and the monotonically
                  increasing sequence of bgpPathAttrClusterIndex values
                  for that bgpPathAttrIndex."
              REFERENCE
                  "This attribute is defined in [RFC2796]."
              ::= { bgpPathAttrClusterEntry 2 }

          --
          -- BGP Communities
          --

          bgpPathAttrCommunityExts OBJECT IDENTIFIER ::=
              { bgpPathAttrNonCapExts 1997 }

          bgpPathAttrCommTable OBJECT-TYPE
              SYNTAX   SEQUENCE OF BgpPathAttrCommEntry
              MAX-ACCESS not-accessible
              STATUS   current
              DESCRIPTION
                  "The BGP-4 Path Attribute Community Table
                   contains the per network path (NLRI)
                   data on the community membership advertised
                   with a route. The absence of row
                   data for a given index value for bgpPathAttrIndex
                   indicates a lack of this attribute information
                   for the indicated network path (as indexed by
                   that bgpPathAttrIndex value in the bgpPathAttrTable)."
              ::= { bgpPathAttrCommunityExts 1 }

          bgpPathAttrCommEntry OBJECT-TYPE
              SYNTAX   BgpPathAttrCommEntry
              MAX-ACCESS not-accessible
              STATUS   current

                DESCRIPTION
                    "Information about a community association
                     provided with a path to a network."
                INDEX { bgpPathAttrIndex, bgpPathAttrCommIndex }
                ::= { bgpPathAttrCommTable 1 }

        BgpPathAttrCommEntry ::= SEQUENCE {
                bgpPathAttrCommIndex
                    Unsigned32,
                bgpPathAttrCommValue
                    OCTET STRING
                }

        bgpPathAttrCommIndex OBJECT-TYPE
            SYNTAX Unsigned32
            MAX-ACCESS read-only
            STATUS   current
            DESCRIPTION
                "An integer index for a row in this table."
            ::= { bgpPathAttrCommEntry 1 }

        -- JMH
        -- Should we be using a display hint for this object?

        bgpPathAttrCommValue OBJECT-TYPE
            SYNTAX   OCTET STRING (SIZE(4))
            MAX-ACCESS read-only
            STATUS   current
            DESCRIPTION
                "A value representing a community.   There are certain
                 4-octet long values which could be returned in this
                 columnar row data that carry additional semantics."
            REFERENCE
                "RFC 1997 - BGP Communities Attribute"
            ::= { bgpPathAttrCommEntry 2 }

        --
        -- BGP Extended Communities
        --

        bgpPathAttrExtCommTable OBJECT-TYPE
            SYNTAX   SEQUENCE OF BgpPathAttrExtCommEntry
            MAX-ACCESS not-accessible

```
            STATUS      current
            DESCRIPTION
                "The BGP-4 Path Attribute Community Table
                contains the per network path (NLRI)
                data on the extended community membership advertised
                with a route.  The absence of row
                data for a given index value for bgpPathAttrIndex
                indicates a lack of this attribute information
                for the indicated network path (as indexed by
                that bgpPathAttrIndex value in the bgpPathAttrTable).

                XXX JMH - can't assign the OID until an RFC is published."
            ::= { bgpPathAttrNonCapExts XXX }


        bgpPathAttrExtCommEntry OBJECT-TYPE
            SYNTAX      BgpPathAttrExtCommEntry
            MAX-ACCESS not-accessible
            STATUS      current
            DESCRIPTION
                "Information about an extended community association
                 provided with a path to a network."
            INDEX {
                bgpPathAttrIndex,
                bgpPathAttrExtCommIndex
                }
            ::= { bgpPathAttrExtCommTable 1 }


        BgpPathAttrExtCommEntry ::= SEQUENCE {
                bgpPathAttrExtCommIndex
                    Unsigned32,
                bgpPathAttrExtCommValue
                    OCTET STRING
                }


        bgpPathAttrExtCommIndex OBJECT-TYPE
            SYNTAX Unsigned32
            MAX-ACCESS read-only
            STATUS      current
            DESCRIPTION
                "An integral index for a row in this table."
            ::= { bgpPathAttrExtCommEntry 1 }


        -- JMH
        -- Again, do we want a display hint for this?
```

```
         bgpPathAttrExtCommValue  OBJECT-TYPE
             SYNTAX      OCTET STRING (SIZE(8))
             MAX-ACCESS  read-only
             STATUS      current
             DESCRIPTION
                 "A value representing an extended community which was
                 received with the route implied by the bgpPathAttr
                 Index value of this row data.   There are certain
                 8-octet long values which could be returned in this
                 columnar row data that carry additional semantics."
             REFERENCE
                 "BGP-EXTCOMM - BGP Extended Communities Attribute"
             ::= { bgpPathAttrExtCommEntry 2 }

         bgpConformance
         OBJECT IDENTIFIER ::= { bgp 4 }


            -- conformance information


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

         bgpMIBCompliance MODULE-COMPLIANCE
             STATUS   current
             DESCRIPTION
                 "The compliance statement for entities which
                 implement the BGP4 mib."
              MODULE  -- this module
              MANDATORY-GROUPS {
                 bgpTimersGroup,
                 bgpCountersGroup,
                 bgpAsPathGroup,
                 bgpAs4byteGroup,
                 bgpBaseGroup,
                 bgpErrorsGroup,
                 bgpPeerGroup,
                 bgpPathAttributesGroup
                 }

         GROUP bgpAuthenticationGroup
         DESCRIPTION
            "The authentication group is
             mandatory only for those implementations which
             support sending and receiving authentication
             information with peers in the BGP Authentication
             Field."
```

```
          GROUP bgpCommunitiesGroup
          DESCRIPTION
               "The communities group is mandatory only for those
              which support the BGP community attribute."
          GROUP bgpExtCommunitiesGroup
          DESCRIPTION
               "The communities group is mandatory only for those
              which support the BGP extended community attribute."
          GROUP bgpRouteReflectionGroup
          DESCRIPTION
               "The communities group is mandatory only for those
              which support the BGP route reflection relationships."
          GROUP bgpAsConfederationGroup
          DESCRIPTION
               "The communities group is mandatory only for those
              which support the BGP confederation membership."
            GROUP bgpTimersGroup
            DESCRIPTION
             "This group is mandatory for all agent implementations."
          GROUP bgpCountersGroup
          DESCRIPTION
            "This group is mandatory for all agent implementations."
          GROUP bgpCapabilitiesGroup
          DESCRIPTION
            "This group is mandatory for all agent implementations."
          GROUP bgpAsPathGroup
          DESCRIPTION
            "This group is mandatory for all agent implementations."
          GROUP bgpAs4byteGroup
          DESCRIPTION
            "This group is mandatory for all agent implementations."
          GROUP bgpBaseGroup
          DESCRIPTION
            "This group is mandatory for all agent implementations."
          GROUP bgpErrorsGroup
          DESCRIPTION
            "This group is mandatory for all agent implementations."
          GROUP bgpPeerGroup
          DESCRIPTION
            "This group is mandatory for all agent implementations."
          GROUP bgpPathAttributesGroup
          DESCRIPTION
            "This group is mandatory for all agent implementations."
          GROUP bgpPeerGroup
          DESCRIPTION
            "This group is mandatory for all agent implementations."
          ::= { bgpMIBCompliances 1 }
```

```
     bgpAuthenticationGroup OBJECT-GROUP
         OBJECTS {
                 bgpSupportedAuthCode,
                 bgpSupportedAuthValue,
                 bgpSupportedAuthCode,
                 bgpSupportedAuthValue,
                 bgpPeerAuthSent,
                 bgpPeerAuthSentCode,
                 bgpPeerAuthSentValue,
                 bgpPeerAuthRcvd,
                 bgpPeerAuthRcvdCode,
                 bgpPeerAuthRcvdValue
         }
         STATUS current
         DESCRIPTION
                 "Objects associated with BGP authentication."
         ::= { bgpMIBGroups 1 }

     bgpCommunitiesGroup OBJECT-GROUP
         OBJECTS {
                 bgpPathAttrCommIndex,
                 bgpPathAttrCommValue
         }
         STATUS current
         DESCRIPTION
                 "Objects associated with BGP communities."
         ::= { bgpMIBGroups 2 }

     bgpExtCommunitiesGroup OBJECT-GROUP
         OBJECTS {
                 bgpPathAttrExtCommIndex,
                 bgpPathAttrExtCommValue
         }
         STATUS current
         DESCRIPTION
                 "Objects associated with BGP extended communities."
         ::= { bgpMIBGroups 3 }

     bgpRouteReflectionGroup OBJECT-GROUP
         OBJECTS {
                 bgpClusterId,
                 bgpPeerReflectorClient,
                 bgpPathAttrOriginatorId,
                 bgpPathAttrClusterIndex,
                 bgpPathAttrClusterValue
         }
         STATUS current
         DESCRIPTION
```

```
                "Objects associated with BGP route reflection."
        ::= { bgpMIBGroups 4 }

bgpAsConfederationGroup OBJECT-GROUP
    OBJECTS {
            bgpConfederationId,
            bgpPeerConfederationMember
    }
    STATUS current
    DESCRIPTION
            "Objects associated with BGP confederation membership."
        ::= { bgpMIBGroups 5 }

bgpTimersGroup OBJECT-GROUP
    OBJECTS {
            bgpPeerFsmEstablishedTime,
            bgpPeerInUpdatesElapsedTime,
            bgpPeerConnectRetryInterval,
            bgpPeerHoldTimeConfigured,
            bgpPeerKeepAliveConfigured,
            bgpPeerMinASOriginationInterval,
            bgpPeerMinRouteAdvertiseInterval,
            bgpPeerHoldTime,
            bgpPeerKeepAlive
    }
    STATUS current
    DESCRIPTION
            "Objects associated with BGP peering timers."
        ::= { bgpMIBGroups 6 }

bgpCountersGroup OBJECT-GROUP
    OBJECTS {
            bgpPeerInUpdates,
            bgpPeerOutUpdates,
            bgpPeerInTotalMessages,
            bgpPeerOutTotalMessages,
            bgpPeerFsmEstablishedTransitions,
            bgpPrefixCountersAfi,
            bgpPrefixCountersSafi,
            bgpPrefixInPrefixes,
            bgpPrefixInPrefixesAccepted,
            bgpPrefixInPrefixesRejected,
            bgpPrefixOutPrefixes
    }
    STATUS current
    DESCRIPTION
            "Objects to count discrete events and exchanges on BGP
             sessions."
```

```
             ::= { bgpMIBGroups 7 }

    bgpCapabilitiesGroup OBJECT-GROUP
        OBJECTS {
                bgpCapabilitySupportAvailable,
                bgpSupportedCapabilityIndex,
                bgpSupportedCapability,
                bgpPeerCapAnnouncedCode,
                bgpPeerCapAnnouncedIndex,
                bgpPeerCapAnnouncedLength,
                bgpPeerCapAnnouncedValue,
                bgpPeerCapReceivedCode,
                bgpPeerCapReceivedIndex,
                bgpPeerCapReceivedLength,
                bgpPeerCapReceivedValue,
                bgpPeerCapAnnouncedCode,
                bgpPeerCapAnnouncedIndex,
                bgpPeerCapAnnouncedLength,
                bgpPeerCapAnnouncedValue,
                bgpPeerCapReceivedCode,
                bgpPeerCapReceivedIndex,
                bgpPeerCapReceivedLength,
                bgpPeerCapReceivedValue
        }
        STATUS current
        DESCRIPTION
                "Objects to report capabilities as received on BGP
                    sessions."
        ::= { bgpMIBGroups 8 }

    bgpAsPathGroup OBJECT-GROUP
        OBJECTS {
                bgpAsPathIndex,
                bgpAsPathType,
                bgpAsPathElementValue
        }
        STATUS current
        DESCRIPTION
                "Objects to report AS paths received on BGP
                    NLRIs."
        ::= { bgpMIBGroups 9 }

    bgpAs4byteGroup OBJECT-GROUP
        OBJECTS {
                bgpAsSize
        }
        STATUS current
        DESCRIPTION
```

```
                    "AS Size objects."
            ::= { bgpMIBGroups 10 }


    bgpBaseGroup OBJECT-GROUP
        OBJECTS {
                bgpLocalAs,
                bgpLocalIdentifier,
                bgpVersionIndex,
                bgpVersionSupported
        }
        STATUS current
        DESCRIPTION
                "Basic objects in local BGP implementation."
        ::= { bgpMIBGroups 11 }


    bgpErrorsGroup OBJECT-GROUP
        OBJECTS {
                bgpPeerLastError,
                bgpPeerLastErrorData
        }
        STATUS current
        DESCRIPTION
                "Errors received on BGP peering sessions."
        ::= { bgpMIBGroups 12 }


    bgpPeerGroup OBJECT-GROUP
        OBJECTS {
                bgpPeerIdentifier,
                bgpPeerState,
                bgpPeerAdminStatus,
                bgpPeerConfiguredVersion,
                bgpPeerNegotiatedVersion,
                bgpPeerLocalAddrType,
                bgpPeerLocalAddr,
                bgpPeerLocalPort,
                bgpPeerLocalAs,
                bgpPeerRemoteAddrType,
                bgpPeerRemoteAddr,
                bgpPeerRemotePort,
                bgpPeerRemoteAs,
                bgpPeerIndex,
                bgpPeerRowEntryStatus
        }
        STATUS current
        DESCRIPTION
                "Core object types on BGP peering sessions."
        ::= { bgpMIBGroups 13 }
```

     bgpPathAttributesGroup OBJECT-GROUP
         OBJECTS {
                 bgpNlriAfi,
                 bgpNlriSafi,
                 bgpNlriPrefixLen,
                 bgpNlriPrefix,
                 bgpNlriBest,
                 bgpPathAttrIndex,
                 bgpNlriASPathStr,
                 bgpPathAttrOrigin,
                 bgpPathAttrNextHopAddrType,
                 bgpPathAttrNextHop,
                 bgpPathAttrMultiExitDiscPresent,
                 bgpPathAttrMultiExitDisc,
                 bgpPathAttrLocalPrefPresent,
                 bgpPathAttrLocalPref,
                 bgpPathAttrAtomicAggregate,
                 bgpPathAttrAggregatorAS,
                 bgpPathAttrAggregatorAddr,
                 bgpPathAttrCalcLocalPref,
                 bgpAsPathIndex,
                 bgpAsPathType,
                 bgpAsPathElementValue,
                 bgpPathAttrUnknownIndex,
                 bgpPathAttrUnknownType,
                 bgpPathAttrUnknownValue
         }
         STATUS current
         DESCRIPTION
                 "Attributes recieved on BGP peering sessions."
         ::= { bgpMIBGroups 14 }

     bgpMIBNotificationsGroup NOTIFICATION-GROUP
         NOTIFICATIONS {
             bgpEstablished,
             bgpBackwardTransition
         }
         STATUS current
         DESCRIPTION
             "This group contains objects for notifications
             supported by this MIB module."
         ::= { bgpMIBGroups 15 }
END

5. Security Considerations

   This MIB module contains controls which relate to core services for
   interdomain routing using the Border Gateway Protocol. In particu-
   lar, this MIB allows configuration of operational elements for those
   services. If such configuration is done without consideration for
   the effects of such configuration activity, or malicious configura-
   tion activity is allowed on the managed elements, the effect could be
   denial of service to the processes and end users in the affected
   domain(s).

   SNMPv1 is not considered a sufficiently secure environment for the
   deployment of such configuration ability. Even if the management
   data path is secure at the network protocol layer (by the deployment
   of secure IP, for example), there are still points of exposure around
   such issues as to what operators and applications are allowed to
   access and modify the configuration as exposed through this MIB mod-
   ule.

   It is strongly recommended that the agent implementor considers the
   security features afforded by the SNMP Version 3 framework in expos-
   ing the configuration features of this MIB module. In particular,
   the availability and usage of the User-based Security Model [12]
   and/or the View-based Access Control Model [15] is highly recom-
   mended.

   It is then incumbent upon the customer deploying network management
   applications which make use of these configuration features to also
   consider and deploy a security discipline to make use of these SNMP
   Version 3 security features. In particular, the operational staff
   who have access to the configuration controls in their ability to
   create, set, and delete them, should be carefully considered.

6. Intellectual Property

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7. Acknowledgements

   Tom Nadeau, Cisco Systems, Inc.
   Jon Saperia, JDS Consulting, Inc.
   Bill Fenner, AT&T Research
   Mike McFaden, Riverstone Networks, Inc.
   Joel Krauska, Exodus Networks, Inc.
   Carl W. Kalbfleisch, Verio Networks, Inc.
   Joe Dupre, Gold Wire Technology

    others TBD...

8. Open Issues

   This section will be removed from the document prior to being issued
   to IDR working group last call (at the latest).

   *   Configuration is discussed, but not currently implemented in a
        thorough way in the MIB.

   *   Is 32 bits nearly enough indexing space for a row in the
        bgp4PathAttrTable? Row Pointers are a little more heavyweight
        for a management application to work with, but would a Row
        Pointer index type here be more appropriate regardless?

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