           OSPF Version 2 Management Information Base

Status of this Memo

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, it defines objects for managing the Open Shortest Path
    First Routing Protocol.

Table of Contents

1.   The SNMPv2 Network Management Framework

     The SNMPv2 Network Management Framework consists of four major
     components. They are:

        o RFC 1441 which defines the SMI, the mechanisms used for
          describing and naming objects for the purpose of
          management.

        o STD 17, RFC 1213 defines MIB-II, the core set of managed objects
          for the Internet suite of protocols.

        o RFC 1445 which defines the administrative and other
          architectural aspects of the framework.

        o RFC 1448 which defines the protocol used for network
          access to managed objects.

     The Framework permits new objects to be defined for the purpose of
     experimentation and evaluation.

1.1. Object Definitions

   Managed objects are accessed via a virtual information store, termed
   the Management Information Base or MIB. Objects in the MIB are
   defined using the subset of Abstract Syntax Notation One (ASN.1)
   defined in the SMI. In particular, each object object type is named
   by an OBJECT IDENTIFIER, an administratively assigned name. The
   object type together with an object instance serves to uniquely
   identify a specific instantiation of the object. For human
   convenience, we often use a textual string, termed the descriptor, to
   refer to the object type.

2. Overview

2.1. Changes from RFC 1253

   The changes from RFC 1253 are the following:

   (1) The textual convention PositiveInteger was changed from
        1..'FFFFFFFF'h to 1..'7FFFFFFF'h at the request of
        Marshall Rose.

   (2) The textual convention TOSType was changed to reflect the
        TOS values defined in the Router Requirements Draft, and
        in accordance with the IP Forwarding Table MIB's values.

   (3) The names of some objects were changed, conforming to the
        convention that an acronym (for example, LSA) is a single
        word ("Lsa") in most SNMP names.

   (4) textual changes were made to make the MIB readable by
        Dave Perkins' SMIC MIB Compiler in addition to Mosy.
        This involved changing the case of some characters in
        certain names and removing the DEFVAL clauses for
        Counters.

   (5) The variables ospfAreaStatus and ospfIfStatus were added,
        having been overlooked in the original MIB.

   (6) The range of the variable ospfLsdbType was extended to
        include multicastLink (Group-membership LSA) and
        nssaExternalLink (NSSA LSA).

   (7) The variable ospfIfMetricMetric was renamed
        ospfIfMetricValue, and the following text was removed
        from its description:

        "The value FFFF is distinguished to mean 'no route via

this TOS'."

(8) The variable ospfNbmaNbrPermanence was added, with the
     values 'dynamic' and 'permanent'; by this means,
     dynamically learned and configured neighbors can be
     distinguished.

(9) The DESCRIPTION of the variable ospfNbrIpAddr was changed
     from

     "The IP address of this neighbor."

     to

     "The IP address this neighbor is using in its IP Source
     Address. Note that, on addressless links, this will not
     be 0.0.0.0, but the address of another of the neighbor's
     interfaces."

     This is by way of clarification and does not change the
     specification.

(10) The OSPF External Link State Database was added. The
     OSPF Link State Database used to display all LSAs stored;
     in this MIB, it displays all but the AS External LSAs.
     This is because there are usually a large number of
     External LSAs, and they are relicated in all non-Stub
     Areas.

(11) The variable ospfAreaSummary was added to control the
     import of summary LSAs into stub areas. If it is
     noAreaSummary (default) the router will neither originate
     nor propagate summary LSAs into the stub area. It will
     rely entirely on its default route. If it is
     sendAreaSummary, the router will both summarize and
     propagate summary LSAs.

(12) The general variables ospfExtLsdbLimit and
     ExitOverflowInterval were introduced to help handle LSDB
     overflow.

(13) The use of the IP Forwarding Table is defined.

(14) The ospfAreaRangeTable was obsoleted and replaced with
     the ospfAreaAggregateTable to accommodate two additional
     indexes. The ospfAreaAggregateEntry keys now include a
     LsdbType (which can be used to differentiate between the
     traditional type-3 Aggregates and NSSA Aggregates) and an

ospfAreaAggregateMask (which will more clearly express
the range).

(15) The variable ospfAreaAggregateEffect was added. This
permits the network manager to hide a subnet within an
area.

(16) Normally, the border router of a stub area advertises a
default route as an OSPF network summary. An NSSA border
router will generate a type-7 LSA indicating a default
route, and import it into the NSSA. ospfStubMetricType
(ospf internal, type 1 external, or type 2 external)
indicates the type of the default metric advertised.

(17) ospfMulticastExtensions is added to the OSPF General
Group. This indicates the router's ability to forward IP
multicast (Class D) datagrams.

(18) ospfIfMulticastForwarding is added to the Interface
Group. It indicates whether, and if so, how, multicasts
should be forwarded on the interface.

(19) The MIB is converted to SNMP Version 2. Beyond simple
text changes and the addition of the MODULE-IDENTITY and
MODULE-COMPLIANCE macros, this involved trading the
TruthValue Textual Convention for SNMP Version 2's, which
has the same values, and trading the Validation Textual
Convention for SNMP Version 2's RowStatus.

(20) ospfAuthType (area authentication type) was changed to an
interface authentication type to match the key. It also
has an additional value, to indicate the use of MD5 for
authentication.

(21) ospfIfIntfType has a new value, pointToMultipoint.

(22) ospfIfDemand (read/write) is added, to permit control of
Demand OSPF features.

(23) ospfNbrHelloSuppressed and ospfVirtNbrHelloSuppressed
were added, (read only). They indicate whether Hellos are
being suppressed to the neighbor.

(24) ospfDemandExtensions was added to indicate whether the
Demand OSPF extensions have been implemented, and to
disable them if appropriate.

2.2. Textual Conventions

Several new data types are introduced as a textual convention in this
MIB document. These textual conventions enhance the readability of
the specification and can ease comparison with other specifications
if appropriate. It should be noted that the introduction of the
these textual conventions has no effect on either the syntax nor the
semantics of any managed objects. The use of these is merely an
artifact of the explanatory method used. Objects defined in terms of
one of these methods are always encoded by means of the rules that
define the primitive type. Hence, no changes to the SMI or the SNMP
are necessary to accommodate these textual conventions which are
adopted merely for the convenience of readers and writers in pursuit
of the elusive goal of clear, concise, and unambiguous MIB documents.

The new data types are AreaID, RouterID, TOSType, Metric, BigMetric,
Status, PositiveInteger, HelloRange, UpToMaxAge, InterfaceIndex, and
DesignatedRouterPriority.

2.3. Structure of MIB

The MIB is composed of the following sections:

    General Variables
    Area Data Structure
    Area Stub Metric Table
    Link State Database
    Address Range Table
    Host Table
    Interface Table
    Interface Metric Table
    Virtual Interface Table
    Neighbor Table
    Virtual Neighbor Table
    External Link State Database
    Aggregate Range Table

There exists a separate MIB for notifications ("traps"), which is
entirely optional.

2.3.1. General Variables

The General Variables are about what they sound like; variables which
are global to the OSPF Process.

2.3.2. Area Data Structure and Area Stub Metric Table

   The Area Data Structure describes the OSPF Areas that the router
   participates in. The Area Stub Metric Table describes the metrics
   advertised into a stub area by the default router(s).

2.3.3. Link State Database and External Link State Database

   The Link State Database is provided primarily to provide detailed
   information for network debugging.

2.3.4. Address Table and Host Tables

   The Address Range Table and Host Table are provided to view
   configured Network Summary and Host Route information.

2.3.5. Interface and Interface Metric Tables

   The Interface Table and the Interface Metric Table together describe
   the various IP interfaces to OSPF. The metrics are placed in
   separate tables in order to simplify dealing with multiple types of
   service, and to provide flexibility in the event that the IP TOS
   definition is changed in the future. A Default Value specification
   is supplied for the TOS 0 (default) metric.

2.3.6. Virtual Interface Table

   Likewise, the Virtual Interface Table describe virtual links to the
   OSPF Process.

2.3.7. Neighbor and Virtual Neighbor Tables

   The Neighbor Table and the Virtual Neighbor Table describe the
   neighbors to the OSPF Process.

2.4. Conceptual Row Creation

   For the benefit of row-creation in "conceptual" (see [9]) tables,
   DEFVAL (Default Value) clauses are included in the definitions in
   section 3, suggesting values which an agent should use for instances
   of variables which need to be created due to a Set-Request, but which
   are not specified in the Set-Request. DEFVAL clauses have not been
   specified for some objects which are read-only, implying that they
   are zeroed upon row creation. These objects are of the SYNTAX
   Counter32 or Gauge32.

   For those objects not having a DEFVAL clause, both management
   stations and agents should heed the Robustness Principle of the

Internet (see RFC-791):

   "be liberal in what you accept, conservative in what you
   send"

That is, management stations should include as many of these columnar
objects as possible (e.g., all read-write objects) in a Set-Request
when creating a conceptual row; agents should accept a Set-Request
with as few of these as they need (e.g., the minimum contents of a
row creating SET consists of those objects for which, as they cannot
be intuited, no default is specified.).

There are numerous read-write objects in this MIB, as it is designed
for SNMP management of the protocol, not just SNMP monitoring of its
state. However, in the absence of a standard SNMP Security
architecture, it is acceptable for implementations to implement these
as read-only with an alternative interface for their modification.

2.5. Default Configuration

OSPF is a powerful routing protocol, equipped with features to handle
virtually any configuration requirement that might reasonably be
found within an Autonomous System. With this power comes a fair
degree of complexity, which the sheer number of objects in the MIB
will attest to. Care has therefore been taken, in constructing this
MIB, to define default values for virtually every object, to minimize
the amount of parameterization required in the typical case. That
default configuration is as follows:

Given the following assumptions:

-     IP has already been configured

-     The ifTable has already been configured

-     ifSpeed is estimated by the interface drivers

-     The OSPF Process automatically discovers all IP
      Interfaces and creates corresponding OSPF Interfaces

-     The TOS 0 metrics are autonomously derived from ifSpeed

-     The OSPF Process automatically creates the Areas required
      for the Interfaces

The simplest configuration of an OSPF process requires that:

-     The OSPF Process be Enabled.

This can be accomplished with a single SET:

                    ospfAdminStat := enabled.

The configured system will have the following attributes:

-       The RouterID will be one of the IP addresses of the
        device

-       The device will be neither an Area Border Router nor an
        Autonomous System Border Router.

-       Every IP Interface, with or without an address, will be
        an OSPF Interface.

-       The AreaID of each interface will be 0.0.0.0, the
        Backbone.

-       Authentication will be disabled

-       All Broadcast and Point to Point interfaces will be
        operational. NBMA Interfaces require the configuration
        of at least one neighbor.

-       Timers on all direct interfaces will be:

          Hello Interval: 10 seconds
          Dead Timeout: 40 Seconds
          Retransmission: 5 Seconds
          Transit Delay: 1 Second
          Poll Interval: 120 Seconds

-       no direct links to hosts will be configured.

-       no addresses will be summarized

-       Metrics, being a measure of bit duration, are unambiguous
        and intelligent.

-       No Virtual Links will be configured.

3. Definitions

OSPF-MIB DEFINITIONS ::= BEGIN

        IMPORTS
                MODULE-IDENTITY, OBJECT-TYPE, Counter32, Gauge32,
                Integer32, IpAddress
                    FROM SNMPv2-SMI
                TEXTUAL-CONVENTION, TruthValue, RowStatus
                    FROM SNMPv2-TC
                MODULE-COMPLIANCE, OBJECT-GROUP   FROM SNMPv2-CONF
                mib-2   FROM RFC1213-MIB;

-- This MIB module uses the extended OBJECT-TYPE macro as
-- defined in [9].

ospf MODULE-IDENTITY
        LAST-UPDATED "9501201225Z" -- Fri Jan 20 12:25:50 PST 1995
         ORGANIZATION "IETF OSPF Working Group"
         CONTACT-INFO
        "   Fred Baker
        Postal: Cisco Systems
                519 Lado Drive
                Santa Barbara, California 93111
        Tel: +1 805 681 0115
        E-Mail: fred@cisco.com

                Rob Coltun
        Postal: RainbowBridge Communications
        Tel: (301) 340-9416
        E-Mail: rcoltun@rainbow-bridge.com"
        DESCRIPTION
          "The MIB module to describe the OSPF Version 2
          Protocol"
        ::= { mib-2 14 }

-- The Area ID, in OSPF, has the same format as an IP Address,
-- but has the function of defining a summarization point for
-- Link State Advertisements

AreaID ::= TEXTUAL-CONVENTION
        STATUS   current
        DESCRIPTION
          "An OSPF Area Identifier."
        SYNTAX   IpAddress

-- The Router ID, in OSPF, has the same format as an IP Address,

    --   but identifies the router independent of its IP Address.

    RouterID ::= TEXTUAL-CONVENTION
        STATUS   current
        DESCRIPTION
            "A OSPF Router Identifier."
        SYNTAX   IpAddress

    --   The OSPF Metric is defined as an unsigned value in the range

    Metric ::= TEXTUAL-CONVENTION
        STATUS   current
        DESCRIPTION
            "The OSPF Internal Metric."
        SYNTAX   Integer32 (0..'FFFF'h)

    BigMetric ::= TEXTUAL-CONVENTION
        STATUS   current
        DESCRIPTION
            "The OSPF External Metric."
        SYNTAX   Integer32 (0..'FFFFFF'h)

    --   Status Values

    Status ::= TEXTUAL-CONVENTION
        STATUS   current
        DESCRIPTION
            "The status of an interface: 'enabled' indicates that
            it is willing to communicate with other OSPF Routers,
            while 'disabled' indicates that it is not."
        SYNTAX   INTEGER { enabled (1), disabled (2) }

    --   Time Durations measured in seconds

    PositiveInteger ::= TEXTUAL-CONVENTION
        STATUS   current
        DESCRIPTION
            "A positive integer. Values in excess are precluded as
            unnecessary and prone to interoperability issues."
        SYNTAX   Integer32 (0..'7FFFFFFF'h)

    HelloRange ::= TEXTUAL-CONVENTION
        STATUS   current
        DESCRIPTION
            "The range of intervals on which hello messages are
            exchanged."
        SYNTAX   Integer32 (1..'FFFF'h)

```
UpToMaxAge ::= TEXTUAL-CONVENTION
    STATUS       current
    DESCRIPTION
      "The values that one might find or configure for
      variables bounded by the maximum age of an LSA."
    SYNTAX       Integer32 (0..3600)


-- The range of ifIndex

InterfaceIndex ::= TEXTUAL-CONVENTION
    STATUS       current
    DESCRIPTION
      "The range of ifIndex."
    SYNTAX       Integer32


-- Potential Priorities for the Designated Router Election

DesignatedRouterPriority ::= TEXTUAL-CONVENTION
    STATUS       current
    DESCRIPTION
      "The values defined for the priority of a system for
      becoming the designated router."
    SYNTAX       Integer32 (0..'FF'h)

TOSType ::= TEXTUAL-CONVENTION
    STATUS       current
    DESCRIPTION
      "Type of Service is defined as a mapping to the IP Type of
      Service Flags as defined in the IP Forwarding Table MIB

      +-----+-----+-----+-----+-----+-----+-----+-----+
      |                 |                       |     |
      |   PRECEDENCE    |    TYPE OF SERVICE    |  0  |
      |                 |                       |     |
      +-----+-----+-----+-----+-----+-----+-----+-----+

            IP TOS              IP TOS
         Field    Policy     Field    Policy

         Contents   Code     Contents   Code
         0 0 0 0  ==>   0     0 0 0 1  ==>   2
         0 0 1 0  ==>   4     0 0 1 1  ==>   6
         0 1 0 0  ==>   8     0 1 0 1  ==>  10
         0 1 1 0  ==>  12     0 1 1 1  ==>  14
         1 0 0 0  ==>  16     1 0 0 1  ==>  18
         1 0 1 0  ==>  20     1 0 1 1  ==>  22
```

```
              1 1 0 0  ==>  24      1 1 0 1  ==>  26
              1 1 1 0  ==>  28      1 1 1 1  ==>  30
```

        The remaining values are left for future definition."
    SYNTAX   Integer32 (0..30)

-- OSPF General Variables

--   These parameters apply globally to the Router's
--   OSPF Process.

ospfGeneralGroup OBJECT IDENTIFIER ::= { ospf 1 }

    ospfRouterId OBJECT-TYPE
        SYNTAX   RouterID
        MAX-ACCESS   read-write
        STATUS   current
        DESCRIPTION
          "A 32-bit integer uniquely identifying the
          router in the Autonomous System.

          By convention, to ensure uniqueness,   this
          should default to the value of one of the
          router's IP interface addresses."
        REFERENCE
          "OSPF Version 2, C.1 Global parameters"
      ::= { ospfGeneralGroup 1 }

    ospfAdminStat OBJECT-TYPE
        SYNTAX   Status
        MAX-ACCESS   read-write
        STATUS   current
        DESCRIPTION
          "The administrative status of OSPF in the
          router.   The value 'enabled' denotes that the
          OSPF Process is active on at least one inter-
          face; 'disabled' disables it on all inter-
          faces."
        ::= { ospfGeneralGroup 2 }

    ospfVersionNumber OBJECT-TYPE
        SYNTAX   INTEGER   { version2 (2) }
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
```

             "The current version number of the OSPF  proto-
             col is 2."
          REFERENCE
             "OSPF Version 2, Title"
        ::= { ospfGeneralGroup 3 }


     ospfAreaBdrRtrStatus OBJECT-TYPE
          SYNTAX   TruthValue
          MAX-ACCESS   read-only
          STATUS   current
          DESCRIPTION
             "A flag to note whether this router is an  area
             border router."
           REFERENCE
             "OSPF Version 2, Section 3 Splitting the AS into
             Areas"
        ::= { ospfGeneralGroup 4 }


     ospfASBdrRtrStatus OBJECT-TYPE
          SYNTAX   TruthValue
          MAX-ACCESS   read-write
          STATUS    current
          DESCRIPTION
             "A flag to note whether this router is  config-
             ured as an Autonomous System border router."
           REFERENCE
             "OSPF Version 2, Section 3.3  Classification  of
             routers"
        ::= { ospfGeneralGroup 5 }

     ospfExternLsaCount OBJECT-TYPE
          SYNTAX   Gauge32
          MAX-ACCESS   read-only
          STATUS    current
          DESCRIPTION
             "The number of external (LS type 5)  link-state
             advertisements in the link-state database."
           REFERENCE
             "OSPF Version 2, Appendix A.4.5 AS external link
             advertisements"
        ::= { ospfGeneralGroup 6 }


     ospfExternLsaCksumSum OBJECT-TYPE
          SYNTAX   Integer32
          MAX-ACCESS   read-only

```
        STATUS   current
        DESCRIPTION
          "The 32-bit unsigned sum of the LS checksums of
          the  external  link-state  advertisements  con-
          tained in the link-state  database.   This  sum
          can  be  used  to determine if there has been a
          change in a router's link state  database,  and
          to  compare  the  link-state database of  two
          routers."
     ::= { ospfGeneralGroup 7 }


  ospfTOSSupport OBJECT-TYPE
        SYNTAX   TruthValue
        MAX-ACCESS   read-write
        STATUS   current
        DESCRIPTION
          "The router's support for type-of-service rout-
          ing."
       REFERENCE
          "OSPF Version 2,  Appendix  F.1.2  Optional  TOS
          support"
     ::= { ospfGeneralGroup 8 }

  ospfOriginateNewLsas OBJECT-TYPE
        SYNTAX   Counter32
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
          "The number of  new  link-state  advertisements
          that  have been originated.  This number is in-
          cremented each time the router originates a new
          LSA."
     ::= { ospfGeneralGroup 9 }


  ospfRxNewLsas OBJECT-TYPE
        SYNTAX   Counter32
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
          "The number of  link-state  advertisements  re-
          ceived  determined  to  be  new instantiations.
          This number does not include  newer  instantia-
          tions  of self-originated link-state advertise-
          ments."
     ::= { ospfGeneralGroup 10 }
```

ospfExtLsdbLimit OBJECT-TYPE
    SYNTAX   Integer32 (-1..'7FFFFFFF'h)
    MAX-ACCESS   read-write
    STATUS   current
    DESCRIPTION
        "The maximum   number   of   non-default AS-
        external-LSAs entries that can be stored in the
        link-state database. If the value is -1, then
        there is no limit.

        When the number of non-default AS-external-LSAs
        in a router's link-state database reaches
        ospfExtLsdbLimit, the router enters Overflow-
        State.   The   router   never   holds   more than
        ospfExtLsdbLimit non-default AS-external-LSAs
        in its database. OspfExtLsdbLimit MUST be set
        identically in all routers attached to the OSPF
        backbone and/or any regular OSPF area. (i.e.,
        OSPF stub areas and NSSAs are excluded)."
    DEFVAL { -1 }
    ::= { ospfGeneralGroup 11 }

ospfMulticastExtensions OBJECT-TYPE
    SYNTAX   Integer32
    MAX-ACCESS   read-write
    STATUS   current
    DESCRIPTION
        "A Bit Mask indicating whether the router is
        forwarding IP multicast (Class D) datagrams
        based on the algorithms defined in the Multi-
        cast Extensions to OSPF.

        Bit 0, if set, indicates that the router can
        forward IP multicast datagrams in the router's
        directly attached areas (called intra-area mul-
        ticast routing).

        Bit 1, if set, indicates that the router can
        forward IP multicast datagrams between OSPF
        areas (called inter-area multicast routing).

        Bit 2, if set, indicates that the router can
        forward IP multicast datagrams between Auto-
        nomous Systems (called inter-AS multicast rout-
        ing).

        Only certain combinations of bit settings are
        allowed,   namely: 0 (no multicast forwarding is

```
                 enabled), 1 (intra-area multicasting  only),  3
                 (intra-area  and  inter-area  multicasting),  5
                 (intra-area and inter-AS  multicasting)  and  7
                 (multicasting  everywhere). By default, no mul-
                 ticast forwarding is enabled."
            DEFVAL { 0 }
            ::= { ospfGeneralGroup 12 }

        ospfExitOverflowInterval OBJECT-TYPE
            SYNTAX    PositiveInteger
            MAX-ACCESS    read-write
            STATUS    current
            DESCRIPTION
                 "The number of  seconds  that,  after  entering
                 OverflowState,  a  router will attempt to leave
                 OverflowState. This allows the router to   again
                 originate  non-default  AS-external-LSAs.  When
                 set to 0, the router will not  leave  Overflow-
                 State until restarted."
            DEFVAL { 0 }
            ::= { ospfGeneralGroup 13 }


        ospfDemandExtensions OBJECT-TYPE
            SYNTAX    TruthValue
            MAX-ACCESS    read-write
            STATUS    current
            DESCRIPTION
                 "The router's support for demand routing."
            REFERENCE
                 "OSPF Version 2, Appendix on Demand Routing"
           ::= { ospfGeneralGroup 14 }


--      The OSPF Area Data Structure contains information
--      regarding the various areas. The interfaces and
--      virtual links are configured as part of these areas.
--      Area 0.0.0.0, by definition, is the Backbone Area


        ospfAreaTable OBJECT-TYPE
            SYNTAX    SEQUENCE OF OspfAreaEntry
            MAX-ACCESS    not-accessible
            STATUS    current
            DESCRIPTION
                 "Information describing the configured  parame-
                 ters  and cumulative statistics of the router's
                 attached areas."
```

        REFERENCE
           "OSPF Version 2, Section 6 The Area Data Struc-
           ture"
        ::= { ospf 2 }

    ospfAreaEntry OBJECT-TYPE
        SYNTAX   OspfAreaEntry
        MAX-ACCESS   not-accessible
        STATUS   current
        DESCRIPTION
           "Information describing the configured parame-
           ters and cumulative statistics of one of the
           router's attached areas."
        INDEX { ospfAreaId }
        ::= { ospfAreaTable 1 }

OspfAreaEntry ::=
    SEQUENCE {
        ospfAreaId
            AreaID,
        ospfAuthType
            Integer32,
        ospfImportAsExtern
            INTEGER,
        ospfSpfRuns
            Counter32,
        ospfAreaBdrRtrCount
            Gauge32,
        ospfAsBdrRtrCount
            Gauge32,
        ospfAreaLsaCount
            Gauge32,
        ospfAreaLsaCksumSum
            Integer32,
        ospfAreaSummary
            INTEGER,
        ospfAreaStatus
            RowStatus
              }

    ospfAreaId OBJECT-TYPE
        SYNTAX   AreaID
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
           "A 32-bit integer uniquely identifying an area.
           Area ID 0.0.0.0 is used for the OSPF backbone."

```
       REFERENCE
          "OSPF Version 2, Appendix C.2 Area parameters"
       ::= { ospfAreaEntry 1 }


    ospfAuthType OBJECT-TYPE
        SYNTAX    Integer32
                    -- none (0),
                    -- simplePassword (1)
                    -- md5 (2)
                    -- reserved for specification by IANA (> 2)
        MAX-ACCESS   read-create
        STATUS    obsolete
        DESCRIPTION
           "The authentication type specified for an area.
           Additional authentication types may be assigned
           locally on a per Area basis."
         REFERENCE
           "OSPF Version 2, Appendix E Authentication"
       DEFVAL { 0 }           -- no authentication, by default
       ::= { ospfAreaEntry 2 }

    ospfImportAsExtern OBJECT-TYPE
        SYNTAX    INTEGER    {
                    importExternal (1),
                    importNoExternal (2),
                    importNssa (3)
                  }
        MAX-ACCESS   read-create
        STATUS    current
        DESCRIPTION
           "The area's support for importing  AS  external
           link- state advertisements."
         REFERENCE
           "OSPF Version 2, Appendix C.2 Area parameters"
       DEFVAL { importExternal }
       ::= { ospfAreaEntry 3 }


    ospfSpfRuns OBJECT-TYPE
        SYNTAX    Counter32
        MAX-ACCESS   read-only
        STATUS    current
        DESCRIPTION
           "The number of times that the intra-area  route
           table  has  been  calculated  using this area's
           link-state database. This  is  typically  done
           using Dijkstra's algorithm."
```

         ::= { ospfAreaEntry 4 }

     ospfAreaBdrRtrCount OBJECT-TYPE
         SYNTAX   Gauge32
         MAX-ACCESS   read-only
         STATUS   current
         DESCRIPTION
            "The total number of area border routers reach-
            able within this area. This is initially zero,
            and is calculated in each SPF Pass."
         ::= { ospfAreaEntry 5 }

     ospfAsBdrRtrCount OBJECT-TYPE
         SYNTAX   Gauge32
         MAX-ACCESS   read-only
         STATUS   current
         DESCRIPTION
            "The total number of Autonomous System border
            routers reachable within this area. This is
            initially zero, and is calculated in each SPF
            Pass."
         ::= { ospfAreaEntry 6 }

     ospfAreaLsaCount OBJECT-TYPE
         SYNTAX   Gauge32
         MAX-ACCESS   read-only
         STATUS   current
         DESCRIPTION
            "The total number of link-state advertisements
            in this area's link-state database, excluding
            AS External LSA's."
         ::= { ospfAreaEntry 7 }

     ospfAreaLsaCksumSum OBJECT-TYPE
         SYNTAX   Integer32
         MAX-ACCESS   read-only
         STATUS   current
         DESCRIPTION
            "The 32-bit unsigned sum of the link-state ad-
            vertisements' LS checksums contained in this
            area's link-state database. This sum excludes
            external (LS type 5) link-state advertisements.
            The sum can be used to determine if there has
            been a change in a router's link state data-
            base, and to compare the link-state database of

```
            two routers."
        DEFVAL    { 0 }
        ::= { ospfAreaEntry 8 }

    ospfAreaSummary OBJECT-TYPE
        SYNTAX    INTEGER    {
                noAreaSummary (1),
                sendAreaSummary (2)
              }
        MAX-ACCESS   read-create
        STATUS    current
        DESCRIPTION
            "The variable ospfAreaSummary controls the  im-
            port  of  summary LSAs into stub areas.  It has
            no effect on  other areas.

            If it is noAreaSummary, the router will neither
            originate  nor  propagate summary LSAs into the
            stub area.  It will rely entirely  on  its  de-
            fault route.

            If it is sendAreaSummary, the router will  both
            summarize and propagate summary LSAs."
        DEFVAL    { noAreaSummary }
        ::= { ospfAreaEntry 9 }


    ospfAreaStatus OBJECT-TYPE
        SYNTAX    RowStatus
        MAX-ACCESS    read-create
        STATUS    current
        DESCRIPTION
            "This variable displays the status of  the  en-
            try.  Setting it to 'invalid' has the effect of
            rendering it inoperative.  The internal  effect
            (row removal) is implementation dependent."
        ::= { ospfAreaEntry 10 }


-- OSPF Area Default Metric Table

--      The OSPF Area Default Metric Table describes the metrics
--      that a default Area Border Router will advertise into a
--      Stub area.


    ospfStubAreaTable OBJECT-TYPE
        SYNTAX    SEQUENCE OF OspfStubAreaEntry
```

```
        MAX-ACCESS    not-accessible
        STATUS    current
        DESCRIPTION
           "The set of metrics that will be advertised  by
           a default Area Border Router into a stub area."
         REFERENCE
           "OSPF Version 2, Appendix C.2, Area Parameters"
        ::= { ospf 3 }


    ospfStubAreaEntry OBJECT-TYPE
        SYNTAX    OspfStubAreaEntry
        MAX-ACCESS    not-accessible
        STATUS    current
        DESCRIPTION
           "The metric for a given Type  of  Service  that
           will  be  advertised  by  a default Area Border
           Router into a stub area."
         REFERENCE
           "OSPF Version 2, Appendix C.2, Area Parameters"
        INDEX { ospfStubAreaId, ospfStubTOS }
        ::= { ospfStubAreaTable 1 }

OspfStubAreaEntry ::=
    SEQUENCE {
        ospfStubAreaId
           AreaID,
        ospfStubTOS
           TOSType,
        ospfStubMetric
           BigMetric,
        ospfStubStatus
           RowStatus,
        ospfStubMetricType
           INTEGER
             }

    ospfStubAreaId OBJECT-TYPE
        SYNTAX    AreaID
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
           "The 32 bit identifier for the Stub  Area.   On
           creation,  this  can  be  derived  from the in-
           stance."
        ::= { ospfStubAreaEntry 1 }
```

```
    ospfStubTOS OBJECT-TYPE
        SYNTAX    TOSType
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
          "The Type of Service associated with the
          metric.  On creation, this can be derived from
          the instance."
      ::= { ospfStubAreaEntry 2 }


    ospfStubMetric OBJECT-TYPE
        SYNTAX    BigMetric
        MAX-ACCESS    read-create
        STATUS    current
        DESCRIPTION
          "The metric value applied at the indicated type
          of  service.  By default, this equals the least
          metric at the type of service among the  inter-
          faces to other areas."
      ::= { ospfStubAreaEntry 3 }


    ospfStubStatus OBJECT-TYPE
        SYNTAX    RowStatus
        MAX-ACCESS    read-create
        STATUS    current
        DESCRIPTION
          "This variable displays the status of  the  en-
          try.  Setting it to 'invalid' has the effect of
          rendering it inoperative.  The internal  effect
          (row removal) is implementation dependent."
      ::= { ospfStubAreaEntry 4 }

    ospfStubMetricType OBJECT-TYPE
        SYNTAX    INTEGER    {
                  ospfMetric (1),             -- OSPF Metric
                  comparableCost (2),    -- external type 1
                  nonComparable  (3)     -- external type 2
              }
        MAX-ACCESS    read-create
        STATUS    current
        DESCRIPTION
          "This variable displays the type of metric  ad-
          vertised as a default route."
       DEFVAL    { ospfMetric }
      ::= { ospfStubAreaEntry 5 }
```

-- OSPF Link State Database

--   The Link State Database contains the Link State
--   Advertisements from throughout the areas that the
--   device is attached to.

     ospfLsdbTable OBJECT-TYPE
         SYNTAX   SEQUENCE OF OspfLsdbEntry
         MAX-ACCESS   not-accessible
         STATUS   current
         DESCRIPTION
            "The OSPF Process's Link State Database."
          REFERENCE
            "OSPF Version 2, Section 12 Link State Adver-
            tisements"
         ::= { ospf 4 }

     ospfLsdbEntry OBJECT-TYPE
         SYNTAX   OspfLsdbEntry
         MAX-ACCESS   not-accessible
         STATUS   current
         DESCRIPTION
            "A single Link State Advertisement."
         INDEX { ospfLsdbAreaId, ospfLsdbType,
                 ospfLsdbLsid, ospfLsdbRouterId }
         ::= { ospfLsdbTable 1 }

OspfLsdbEntry ::=
     SEQUENCE {
         ospfLsdbAreaId
             AreaID,
         ospfLsdbType
             INTEGER,
         ospfLsdbLsid
             IpAddress,
         ospfLsdbRouterId
             RouterID,
         ospfLsdbSequence
             Integer32,
         ospfLsdbAge
             Integer32,
         ospfLsdbChecksum
             Integer32,
         ospfLsdbAdvertisement
             OCTET STRING
               }

```
   ospfLsdbAreaId OBJECT-TYPE
       SYNTAX    AreaID
       MAX-ACCESS   read-only
       STATUS    current
       DESCRIPTION
          "The 32 bit identifier of the Area  from  which
          the LSA was received."
      REFERENCE
          "OSPF Version 2, Appendix C.2 Area parameters"
       ::= { ospfLsdbEntry 1 }

-- External Link State Advertisements are permitted
-- for backward compatibility, but should be displayed in
-- the ospfExtLsdbTable rather than here.

   ospfLsdbType OBJECT-TYPE
       SYNTAX    INTEGER    {
               routerLink (1),
               networkLink (2),
               summaryLink (3),
               asSummaryLink (4),
               asExternalLink (5), -- but see ospfExtLsdbTable
               multicastLink (6),
               nssaExternalLink (7)
              }
      MAX-ACCESS   read-only
      STATUS    current
      DESCRIPTION
          "The type  of  the  link  state  advertisement.
          Each  link state type has a separate advertise-
          ment format."
      REFERENCE
          "OSPF Version 2, Appendix A.4.1 The  Link  State
          Advertisement header"
       ::= { ospfLsdbEntry 2 }

   ospfLsdbLsid OBJECT-TYPE
       SYNTAX    IpAddress
       MAX-ACCESS   read-only
       STATUS    current
       DESCRIPTION
          "The Link State ID is an LS Type Specific field
          containing either a Router ID or an IP Address;
          it identifies the piece of the  routing  domain
          that is being described by the advertisement."
      REFERENCE
          "OSPF Version 2, Section 12.1.4 Link State ID"
       ::= { ospfLsdbEntry 3 }
```

```
    ospfLsdbRouterId OBJECT-TYPE
        SYNTAX    RouterID
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
           "The 32 bit number that uniquely identifies the
           originating router in the Autonomous System."
        REFERENCE
           "OSPF Version 2, Appendix C.1 Global parameters"
      ::= { ospfLsdbEntry 4 }

-- Note that the OSPF Sequence Number is a 32 bit signed
-- integer.  It starts with the value '80000001'h,
-- or -'7FFFFFFF'h, and increments until '7FFFFFFF'h
-- Thus, a typical sequence number will be very negative.

    ospfLsdbSequence OBJECT-TYPE
        SYNTAX    Integer32
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
           "The sequence number field is a  signed  32-bit
           integer.   It  is used to detect old and dupli-
           cate link state advertisements.  The   space  of
           sequence  numbers  is  linearly  ordered.   The
           larger the sequence number the more recent  the
           advertisement."
         REFERENCE
           "OSPF Version  2,  Section  12.1.6  LS  sequence
           number"
      ::= { ospfLsdbEntry 5 }


    ospfLsdbAge OBJECT-TYPE
        SYNTAX    Integer32    -- Should be 0..MaxAge
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
           "This field is the age of the link state adver-
           tisement in seconds."
         REFERENCE
           "OSPF Version 2, Section 12.1.1 LS age"
      ::= { ospfLsdbEntry 6 }

    ospfLsdbChecksum OBJECT-TYPE
        SYNTAX    Integer32
        MAX-ACCESS    read-only
        STATUS    current
```

        DESCRIPTION
          "This field is the checksum of the complete
          contents of the advertisement, excepting the
          age field. The age field is excepted so that
          an   advertisement's age can be incremented
          without updating the checksum.   The checksum
          used is the same that is used for ISO connec-
          tionless datagrams; it is commonly referred to
          as the Fletcher checksum."
        REFERENCE
          "OSPF Version 2, Section 12.1.7 LS checksum"
      ::= { ospfLsdbEntry 7 }

    ospfLsdbAdvertisement OBJECT-TYPE
        SYNTAX   OCTET STRING (SIZE (1..65535))
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
          "The entire Link State Advertisement, including
          its header."
        REFERENCE
          "OSPF Version 2, Section 12 Link State Adver-
          tisements"
      ::= { ospfLsdbEntry 8 }

--   Address Range Table

--   The Address Range Table acts as an adjunct to the Area
--   Table; It describes those Address Range Summaries that
--   are configured to be propagated from an Area to reduce
--   the amount of information about it which is known beyond
--   its borders.

    ospfAreaRangeTable OBJECT-TYPE
        SYNTAX   SEQUENCE OF OspfAreaRangeEntry
        MAX-ACCESS   not-accessible
        STATUS   obsolete
        DESCRIPTION
          "A range if IP addresses specified by an IP
          address/IP network mask pair. For example,
          class B address range of X.X.X.X with a network
          mask of 255.255.0.0 includes all IP addresses
          from X.X.0.0 to X.X.255.255"
        REFERENCE
          "OSPF Version 2, Appendix C.2 Area parameters"
      ::= { ospf 5 }

```
    ospfAreaRangeEntry OBJECT-TYPE
        SYNTAX    OspfAreaRangeEntry
        MAX-ACCESS    not-accessible
        STATUS    obsolete
        DESCRIPTION
           "A range if IP addresses  specified  by  an  IP
           address/IP  network  mask  pair.   For example,
           class B address range of X.X.X.X with a network
           mask  of  255.255.0.0 includes all IP addresses
           from X.X.0.0 to X.X.255.255"
         REFERENCE
           "OSPF Version 2, Appendix C.2  Area parameters"
        INDEX { ospfAreaRangeAreaId, ospfAreaRangeNet }
        ::= { ospfAreaRangeTable 1 }

OspfAreaRangeEntry ::=
    SEQUENCE {
        ospfAreaRangeAreaId
            AreaID,
        ospfAreaRangeNet
            IpAddress,
        ospfAreaRangeMask
            IpAddress,
        ospfAreaRangeStatus
            RowStatus,
        ospfAreaRangeEffect
            INTEGER
             }

    ospfAreaRangeAreaId OBJECT-TYPE
        SYNTAX    AreaID
        MAX-ACCESS    read-only
        STATUS    obsolete
        DESCRIPTION
           "The Area the Address  Range  is  to  be  found
           within."
         REFERENCE
           "OSPF Version 2, Appendix C.2 Area parameters"
        ::= { ospfAreaRangeEntry 1 }


    ospfAreaRangeNet OBJECT-TYPE
        SYNTAX    IpAddress
        MAX-ACCESS    read-only
        STATUS    obsolete
        DESCRIPTION
           "The IP Address of the Net or Subnet  indicated
           by the range."
```

```
        REFERENCE
            "OSPF Version 2, Appendix C.2 Area parameters"
        ::= { ospfAreaRangeEntry 2 }


    ospfAreaRangeMask OBJECT-TYPE
        SYNTAX    IpAddress
        MAX-ACCESS    read-create
        STATUS    obsolete
        DESCRIPTION
            "The Subnet Mask that pertains to  the  Net  or
            Subnet."
         REFERENCE
            "OSPF Version 2, Appendix C.2 Area parameters"
        ::= { ospfAreaRangeEntry 3 }

    ospfAreaRangeStatus OBJECT-TYPE
        SYNTAX    RowStatus
        MAX-ACCESS    read-create
        STATUS    obsolete
        DESCRIPTION
            "This variable displays the status of  the  en-
            try.  Setting it to 'invalid' has the effect of
            rendering it inoperative.  The internal  effect
            (row removal) is implementation dependent."
        ::= { ospfAreaRangeEntry 4 }


    ospfAreaRangeEffect OBJECT-TYPE
        SYNTAX    INTEGER    {
                advertiseMatching (1),
                doNotAdvertiseMatching (2)
              }
        MAX-ACCESS    read-create
        STATUS    obsolete
        DESCRIPTION
            "Subnets subsumed by ranges either trigger  the
            advertisement  of the indicated summary (adver-
            tiseMatching), or result in  the  subnet's  not
            being advertised at all outside the area."
        DEFVAL    { advertiseMatching }
        ::= { ospfAreaRangeEntry 5 }



-- OSPF Host Table

--       The Host/Metric Table indicates what hosts are directly
```

```
--        attached to the Router, and what metrics and types of
--        service should be advertised for them.

    ospfHostTable OBJECT-TYPE
        SYNTAX    SEQUENCE OF OspfHostEntry
        MAX-ACCESS    not-accessible
        STATUS    current
        DESCRIPTION
          "The list of Hosts, and their metrics, that the
          router will advertise as host routes."
       REFERENCE
          "OSPF Version 2, Appendix C.6  Host route param-
          eters"
      ::= { ospf 6 }


    ospfHostEntry OBJECT-TYPE
        SYNTAX    OspfHostEntry
        MAX-ACCESS    not-accessible
        STATUS    current
        DESCRIPTION
          "A metric to be advertised, for a given type of
          service, when a given host is reachable."
        INDEX { ospfHostIpAddress, ospfHostTOS }
        ::= { ospfHostTable 1 }

OspfHostEntry ::=
    SEQUENCE {
        ospfHostIpAddress
            IpAddress,
        ospfHostTOS
            TOSType,
        ospfHostMetric
            Metric,
        ospfHostStatus
            RowStatus,
        ospfHostAreaID
            AreaID
              }

    ospfHostIpAddress OBJECT-TYPE
        SYNTAX    IpAddress
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
          "The IP Address of the Host."
        REFERENCE
          "OSPF Version 2, Appendix C.6 Host route parame-
```

                   ters"
           ::= { ospfHostEntry 1 }

       ospfHostTOS OBJECT-TYPE
           SYNTAX   TOSType
           MAX-ACCESS   read-only
           STATUS   current
           DESCRIPTION
              "The Type of Service of the route being config-
              ured."
            REFERENCE
              "OSPF Version 2, Appendix C.6 Host route parame-
              ters"
           ::= { ospfHostEntry 2 }

       ospfHostMetric OBJECT-TYPE
           SYNTAX   Metric
           MAX-ACCESS   read-create
           STATUS   current
           DESCRIPTION
              "The Metric to be advertised."
            REFERENCE
              "OSPF Version 2, Appendix C.6 Host route parame-
              ters"
           ::= { ospfHostEntry 3 }

       ospfHostStatus OBJECT-TYPE
           SYNTAX   RowStatus
           MAX-ACCESS   read-create
           STATUS   current
           DESCRIPTION
              "This variable displays the status of the en-
              try. Setting it to 'invalid' has the effect of
              rendering it inoperative. The internal effect
              (row removal) is implementation dependent."
           ::= { ospfHostEntry 4 }

       ospfHostAreaID OBJECT-TYPE
           SYNTAX   AreaID
           MAX-ACCESS   read-only
           STATUS   current
           DESCRIPTION
              "The Area the Host Entry is to be found within.
              By default, the area that a subsuming OSPF in-
              terface is in, or 0.0.0.0"

```
        REFERENCE
           "OSPF Version 2, Appendix C.2 Area parameters"
        ::= { ospfHostEntry 5 }


--   OSPF Interface Table

--       The OSPF Interface Table augments the ipAddrTable
--              with OSPF specific information.

     ospfIfTable OBJECT-TYPE
         SYNTAX    SEQUENCE OF OspfIfEntry
         MAX-ACCESS    not-accessible
         STATUS    current
         DESCRIPTION
            "The OSPF Interface Table describes the  inter-
            faces from the viewpoint of OSPF."
         REFERENCE
            "OSPF Version 2, Appendix C.3  Router  interface
            parameters"
        ::= { ospf 7 }


     ospfIfEntry OBJECT-TYPE
         SYNTAX    OspfIfEntry
         MAX-ACCESS    not-accessible
         STATUS    current
         DESCRIPTION
            "The OSPF Interface Entry describes one  inter-
            face from the viewpoint of OSPF."
         INDEX { ospfIfIpAddress, ospfAddressLessIf }
         ::= { ospfIfTable 1 }

OspfIfEntry ::=
     SEQUENCE {
         ospfIfIpAddress
             IpAddress,
         ospfAddressLessIf
             Integer32,
         ospfIfAreaId
             AreaID,
         ospfIfType
             INTEGER,
         ospfIfAdminStat
             Status,
         ospfIfRtrPriority
             DesignatedRouterPriority,
         ospfIfTransitDelay
```

```
            UpToMaxAge,
        ospfIfRetransInterval
            UpToMaxAge,
        ospfIfHelloInterval
            HelloRange,
        ospfIfRtrDeadInterval
            PositiveInteger,
        ospfIfPollInterval
            PositiveInteger,
        ospfIfState
            INTEGER,
        ospfIfDesignatedRouter
            IpAddress,
        ospfIfBackupDesignatedRouter
            IpAddress,
        ospfIfEvents
            Counter32,
        ospfIfAuthType
            INTEGER,
        ospfIfAuthKey
            OCTET STRING,
        ospfIfStatus
            RowStatus,
        ospfIfMulticastForwarding
            INTEGER,
        ospfIfDemand
            TruthValue
              }

    ospfIfIpAddress OBJECT-TYPE
        SYNTAX    IpAddress
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
            "The IP address of this OSPF interface."
        ::= { ospfIfEntry 1 }

    ospfAddressLessIf OBJECT-TYPE
        SYNTAX    Integer32
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
            "For the purpose of easing  the  instancing  of
            addressed   and   addressless  interfaces; This
            variable takes the value 0 on  interfaces  with
            IP  Addresses,  and  the corresponding value of
            ifIndex for interfaces having no IP Address."
        ::= { ospfIfEntry 2 }
```

```
ospfIfAreaId OBJECT-TYPE
    SYNTAX    AreaID
    MAX-ACCESS    read-create
    STATUS    current
    DESCRIPTION
       "A 32-bit integer uniquely identifying the area
       to  which  the  interface  connects.   Area  ID
       0.0.0.0 is used for the OSPF backbone."
    DEFVAL   { '00000000'H }    -- 0.0.0.0
    ::= { ospfIfEntry 3 }

ospfIfType OBJECT-TYPE
    SYNTAX   INTEGER    {
            broadcast (1),
            nbma (2),
            pointToPoint (3),
            pointToMultipoint (5)
          }
    MAX-ACCESS    read-create
    STATUS    current
    DESCRIPTION
       "The OSPF interface type.

       By way of a default, this field may be intuited
       from the corresponding value of ifType.  Broad-
       cast LANs, such as  Ethernet  and  IEEE  802.5,
       take   the  value  'broadcast', X.25 and similar
       technologies take the value 'nbma',  and  links
       that  are  definitively point to point take the
       value 'pointToPoint'."
    ::= { ospfIfEntry 4 }


ospfIfAdminStat OBJECT-TYPE
    SYNTAX    Status
    MAX-ACCESS    read-create
    STATUS    current
    DESCRIPTION
       "The OSPF  interface's  administrative  status.
       The  value formed on the interface, and the in-
       terface will be advertised as an internal route
       to  some  area.   The  value 'disabled' denotes
       that the interface is external to OSPF."
    DEFVAL { enabled }
    ::= { ospfIfEntry 5 }

ospfIfRtrPriority OBJECT-TYPE
    SYNTAX   DesignatedRouterPriority
```

          MAX-ACCESS   read-create
          STATUS   current
          DESCRIPTION
             "The priority of this interface.   Used in
             multi-access networks, this field is used in
             the designated router election algorithm.   The
             value 0 signifies that the router is not eligi-
             ble to become the designated router on this
             particular network.   In the event of a tie in
             this value, routers will use their Router ID as
             a tie breaker."
       DEFVAL { 1 }
       ::= { ospfIfEntry 6 }

    ospfIfTransitDelay OBJECT-TYPE
          SYNTAX   UpToMaxAge
          MAX-ACCESS   read-create
          STATUS   current
          DESCRIPTION
             "The estimated number of seconds it takes to
             transmit a link state update packet over this
             interface."
       DEFVAL { 1 }
       ::= { ospfIfEntry 7 }

    ospfIfRetransInterval OBJECT-TYPE
          SYNTAX   UpToMaxAge
          MAX-ACCESS   read-create
          STATUS   current
          DESCRIPTION
             "The number of seconds between link-state ad-
             vertisement retransmissions, for adjacencies
             belonging to this interface.   This value is
             also used when retransmitting database descrip-
             tion and link-state request packets."
       DEFVAL { 5 }
       ::= { ospfIfEntry 8 }

    ospfIfHelloInterval OBJECT-TYPE
          SYNTAX   HelloRange
          MAX-ACCESS   read-create
          STATUS   current
          DESCRIPTION
             "The length of time, in seconds, between the
             Hello packets that the router sends on the in-

                terface. This value must be the same for all
                routers attached to a common network."
            DEFVAL { 10 }
            ::= { ospfIfEntry 9 }

        ospfIfRtrDeadInterval OBJECT-TYPE
            SYNTAX   PositiveInteger
            MAX-ACCESS   read-create
            STATUS   current
            DESCRIPTION
                "The number of seconds that a router's Hello
                packets have not been seen before it's neigh-
                bors declare the router down. This should be
                some multiple of the Hello interval. This
                value must be the same for all routers attached
                to a common network."
            DEFVAL { 40 }
            ::= { ospfIfEntry 10 }

        ospfIfPollInterval OBJECT-TYPE
            SYNTAX   PositiveInteger
            MAX-ACCESS   read-create
            STATUS   current
            DESCRIPTION
                "The larger time interval, in seconds, between
                the Hello packets sent to an inactive non-
                broadcast multi- access neighbor."
            DEFVAL { 120 }
            ::= { ospfIfEntry 11 }

        ospfIfState OBJECT-TYPE
            SYNTAX   INTEGER   {
                        down (1),
                        loopback (2),
                        waiting (3),
                        pointToPoint (4),
                        designatedRouter (5),
                        backupDesignatedRouter (6),
                        otherDesignatedRouter (7)
                    }
            MAX-ACCESS   read-only
            STATUS   current
            DESCRIPTION
                "The OSPF Interface State."
            DEFVAL { down }

```
        ::= { ospfIfEntry 12 }


    ospfIfDesignatedRouter OBJECT-TYPE
        SYNTAX    IpAddress
        MAX-ACCESS   read-only
        STATUS    current
        DESCRIPTION
          "The IP Address of the Designated Router."
      DEFVAL   { '00000000'H }    -- 0.0.0.0
      ::= { ospfIfEntry 13 }


    ospfIfBackupDesignatedRouter OBJECT-TYPE
        SYNTAX    IpAddress
        MAX-ACCESS   read-only
        STATUS    current
        DESCRIPTION
          "The  IP  Address  of  the  Backup   Designated
          Router."
      DEFVAL   { '00000000'H }    -- 0.0.0.0
      ::= { ospfIfEntry 14 }

    ospfIfEvents OBJECT-TYPE
        SYNTAX    Counter32
        MAX-ACCESS   read-only
        STATUS    current
        DESCRIPTION
          "The number of times this  OSPF  interface  has
          changed its state, or an error has occurred."
      ::= { ospfIfEntry 15 }


    ospfIfAuthKey OBJECT-TYPE
        SYNTAX    OCTET STRING (SIZE (0..256))
        MAX-ACCESS   read-create
        STATUS    current
        DESCRIPTION
          "The Authentication Key.  If the Area's Author-
          ization Type  is  simplePassword,  and the key
          length is shorter than 8 octets, the agent will
          left adjust and zero fill to 8 octets.

          Note that unauthenticated  interfaces  need  no
          authentication key, and simple password authen-
          tication cannot use a key of more  than  8  oc-
          tets.  Larger keys are useful only with authen-
          tication mechanisms not specified in this docu-
```

          ment.

          When read, ospfIfAuthKey always returns an Oc-
          tet String of length zero."
       REFERENCE
          "OSPF Version 2, Section 9 The Interface Data
          Structure"
     DEFVAL   { '0000000000000000'H }   -- 0.0.0.0.0.0.0.0
     ::= { ospfIfEntry 16 }

     ospfIfStatus OBJECT-TYPE
         SYNTAX   RowStatus
         MAX-ACCESS   read-create
         STATUS   current
         DESCRIPTION
           "This variable displays the status of the en-
           try. Setting it to 'invalid' has the effect of
           rendering it inoperative. The internal effect
           (row removal) is implementation dependent."
         ::= { ospfIfEntry 17 }

     ospfIfMulticastForwarding OBJECT-TYPE
         SYNTAX   INTEGER   {
                         blocked (1),   -- no multicast forwarding
                         multicast (2),   -- using multicast address
                         unicast (3)   -- to each OSPF neighbor
                 }
         MAX-ACCESS   read-create
         STATUS   current
         DESCRIPTION
           "The way multicasts should forwarded on this
           interface; not forwarded, forwarded as data
           link multicasts, or forwarded as data link uni-
           casts.   Data link multicasting is not meaning-
           ful on point to point and NBMA interfaces, and
           setting ospfMulticastForwarding to 0 effective-
           ly disables all multicast forwarding."
        DEFVAL { blocked }
        ::= { ospfIfEntry 18 }

     ospfIfDemand OBJECT-TYPE
         SYNTAX   TruthValue
         MAX-ACCESS   read-create
         STATUS   current
         DESCRIPTION
           "Indicates whether Demand OSPF procedures (hel-

          lo supression to FULL neighbors and setting the
          DoNotAge flag on proogated LSAs) should be per-
          formed on this interface."
        DEFVAL { false }
        ::= { ospfIfEntry 19 }

    ospfIfAuthType OBJECT-TYPE
        SYNTAX   INTEGER (0..255)
                  -- none (0),
                  -- simplePassword (1)
                  -- md5 (2)
                  -- reserved for specification by IANA (> 2)
        MAX-ACCESS   read-create
        STATUS   current
        DESCRIPTION
          "The authentication type specified for an in-
          terface.   Additional authentication types may
          be assigned locally."
         REFERENCE
          "OSPF Version 2, Appendix E Authentication"
        DEFVAL { 0 }   -- no authentication, by default
        ::= { ospfIfEntry 20 }

-- OSPF Interface Metric Table

--   The Metric Table describes the metrics to be advertised
--   for a specified interface at the various types of service.
--   As such, this table is an adjunct of the OSPF Interface
--   Table.

-- Types of service, as defined by RFC 791, have the ability
-- to request low delay, high bandwidth, or reliable linkage.

-- For the purposes of this specification, the measure of
-- bandwidth

--   Metric = 10^8 / ifSpeed

-- is the default value. For multiple link interfaces, note
-- that ifSpeed is the sum of the individual link speeds.
-- This yields a number having the following typical values:

--   Network Type/bit rate   Metric

--   >= 100 MBPS   1
--   Ethernet/802.3   10

```
--       E1                          48
--       T1 (ESF)                    65
--        64 KBPS                  1562
--        56 KBPS                  1785
--        19.2 KBPS                5208
--         9.6 KBPS               10416

-- Routes that are not specified use the default (TOS 0) metric

    ospfIfMetricTable OBJECT-TYPE
        SYNTAX    SEQUENCE OF OspfIfMetricEntry
        MAX-ACCESS    not-accessible
        STATUS    current
        DESCRIPTION
          "The TOS metrics for  a  non-virtual  interface
          identified by the interface index."
        REFERENCE
          "OSPF Version 2, Appendix C.3  Router  interface
          parameters"
      ::= { ospf 8 }

    ospfIfMetricEntry OBJECT-TYPE
        SYNTAX    OspfIfMetricEntry
        MAX-ACCESS    not-accessible
        STATUS    current
        DESCRIPTION
          "A particular TOS metric for a non-virtual  in-
          terface identified by the interface index."
        REFERENCE
          "OSPF Version 2, Appendix C.3  Router  interface
          parameters"
      INDEX { ospfIfMetricIpAddress,
  ospfIfMetricAddressLessIf,
  ospfIfMetricTOS }
      ::= { ospfIfMetricTable 1 }

OspfIfMetricEntry ::=
    SEQUENCE {
        ospfIfMetricIpAddress
            IpAddress,
        ospfIfMetricAddressLessIf
            Integer32,
        ospfIfMetricTOS
            TOSType,
        ospfIfMetricValue
            Metric,
        ospfIfMetricStatus
            RowStatus
```

```
            }

    ospfIfMetricIpAddress OBJECT-TYPE
        SYNTAX    IpAddress
        MAX-ACCESS   read-only
        STATUS    current
        DESCRIPTION
          "The IP address of this OSPF interface.  On row
          creation,  this  can  be  derived  from the in-
          stance."
     ::= { ospfIfMetricEntry 1 }

    ospfIfMetricAddressLessIf OBJECT-TYPE
        SYNTAX    Integer32
        MAX-ACCESS   read-only
        STATUS    current
        DESCRIPTION
          "For the purpose of easing  the  instancing  of
          addressed   and  addressless  interfaces;  This
          variable takes the value 0 on  interfaces  with
          IP  Addresses, and the value of ifIndex for in-
          terfaces having no IP Address.   On  row  crea-
          tion, this can be derived from the instance."
     ::= { ospfIfMetricEntry 2 }


    ospfIfMetricTOS OBJECT-TYPE
        SYNTAX    TOSType
        MAX-ACCESS   read-only
        STATUS    current
        DESCRIPTION
          "The type of service metric  being  referenced.
          On  row  creation, this can be derived from the
          instance."
     ::= { ospfIfMetricEntry 3 }


    ospfIfMetricValue OBJECT-TYPE
        SYNTAX    Metric
        MAX-ACCESS   read-create
        STATUS    current
        DESCRIPTION
          "The metric of using this type  of  service  on
          this interface.  The default value of the TOS 0
          Metric is 10^8 / ifSpeed."
     ::= { ospfIfMetricEntry 4 }

    ospfIfMetricStatus OBJECT-TYPE
```

```
        SYNTAX    RowStatus
        MAX-ACCESS    read-create
        STATUS    current
        DESCRIPTION
           "This variable displays the status of  the  en-
           try.  Setting it to 'invalid' has the effect of
           rendering it inoperative.  The internal  effect
           (row removal) is implementation dependent."
        ::= { ospfIfMetricEntry 5 }


-- OSPF Virtual Interface Table

--      The Virtual Interface Table describes the virtual
--      links that the OSPF Process is configured to
--      carry on.

    ospfVirtIfTable OBJECT-TYPE
        SYNTAX    SEQUENCE OF OspfVirtIfEntry
        MAX-ACCESS    not-accessible
        STATUS    current
        DESCRIPTION
           "Information about this router's virtual inter-
           faces."
       REFERENCE
           "OSPF Version  2,  Appendix  C.4   Virtual  link
           parameters"
        ::= { ospf 9 }


    ospfVirtIfEntry OBJECT-TYPE
        SYNTAX    OspfVirtIfEntry
        MAX-ACCESS    not-accessible
        STATUS    current
        DESCRIPTION
           "Information about a single Virtual Interface."
       INDEX { ospfVirtIfAreaId, ospfVirtIfNeighbor }
        ::= { ospfVirtIfTable 1 }

OspfVirtIfEntry ::=
    SEQUENCE {
        ospfVirtIfAreaId
            AreaID,
        ospfVirtIfNeighbor
            RouterID,
        ospfVirtIfTransitDelay
            UpToMaxAge,
        ospfVirtIfRetransInterval
```

```
            UpToMaxAge,
        ospfVirtIfHelloInterval
            HelloRange,
        ospfVirtIfRtrDeadInterval
            PositiveInteger,
        ospfVirtIfState
            INTEGER,
        ospfVirtIfEvents
            Counter32,
        ospfVirtIfAuthType
            INTEGER,
        ospfVirtIfAuthKey
            OCTET STRING,
        ospfVirtIfStatus
            RowStatus
                }

    ospfVirtIfAreaId OBJECT-TYPE
        SYNTAX    AreaID
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
            "The  Transit  Area  that  the   Virtual   Link
            traverses.  By definition, this is not 0.0.0.0"
        ::= { ospfVirtIfEntry 1 }


    ospfVirtIfNeighbor OBJECT-TYPE
        SYNTAX    RouterID
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
            "The Router ID of the Virtual Neighbor."
        ::= { ospfVirtIfEntry 2 }


    ospfVirtIfTransitDelay OBJECT-TYPE
        SYNTAX    UpToMaxAge
        MAX-ACCESS    read-create
        STATUS    current
        DESCRIPTION
            "The estimated number of seconds  it  takes  to
            transmit  a link- state update packet over this
            interface."
        DEFVAL { 1 }
        ::= { ospfVirtIfEntry 3 }
```

```
ospfVirtIfRetransInterval OBJECT-TYPE
    SYNTAX    UpToMaxAge
    MAX-ACCESS    read-create
    STATUS    current
    DESCRIPTION
       "The number of seconds between link-state  ad-
       vertisement  retransmissions,  for  adjacencies
       belonging to this  interface.   This  value  is
       also used when retransmitting database descrip-
       tion  and  link-state  request  packets.   This
       value  should  be well over the expected round-
       trip time."
    DEFVAL { 5 }
    ::= { ospfVirtIfEntry 4 }


ospfVirtIfHelloInterval OBJECT-TYPE
    SYNTAX    HelloRange
    MAX-ACCESS    read-create
    STATUS    current
    DESCRIPTION
       "The length of time, in  seconds,  between  the
       Hello  packets that the router sends on the in-
       terface.  This value must be the same  for  the
       virtual neighbor."
    DEFVAL { 10 }
    ::= { ospfVirtIfEntry 5 }


ospfVirtIfRtrDeadInterval OBJECT-TYPE
    SYNTAX    PositiveInteger
    MAX-ACCESS    read-create
    STATUS    current
    DESCRIPTION
       "The number of seconds that  a  router's  Hello
       packets  have  not been seen before it's neigh-
       bors declare the router down.  This  should  be
       some  multiple  of  the  Hello  interval.  This
       value must be the same for the  virtual  neigh-
       bor."
    DEFVAL { 60 }
    ::= { ospfVirtIfEntry 6 }


ospfVirtIfState OBJECT-TYPE
    SYNTAX    INTEGER    {
                down (1),            -- these use the same encoding
                pointToPoint (4)     -- as the ospfIfTable
```

```
                   }
         MAX-ACCESS   read-only
         STATUS    current
         DESCRIPTION
           "OSPF virtual interface states."
       DEFVAL   { down }
       ::= { ospfVirtIfEntry 7 }


     ospfVirtIfEvents OBJECT-TYPE
         SYNTAX    Counter32
         MAX-ACCESS   read-only
         STATUS    current
         DESCRIPTION
           "The number of state changes or error events on
           this Virtual Link"
       ::= { ospfVirtIfEntry 8 }


     ospfVirtIfAuthKey OBJECT-TYPE
         SYNTAX    OCTET STRING (SIZE(0..256))
         MAX-ACCESS   read-create
         STATUS    current
         DESCRIPTION
           "If Authentication Type is simplePassword,  the
           device  will left adjust and zero fill to 8 oc-
           tets.

           Note that unauthenticated  interfaces  need  no
           authentication key, and simple password authen-
           tication cannot use a key of more  than  8  oc-
           tets.  Larger keys are useful only with authen-
           tication mechanisms not specified in this docu-
           ment.

           When  read,  ospfVifAuthKey  always  returns  a
           string of length zero."
        REFERENCE
           "OSPF Version 2, Section 9  The  Interface  Data
           Structure"
       DEFVAL   { '0000000000000000'H }    -- 0.0.0.0.0.0.0.0
      ::= { ospfVirtIfEntry 9 }


     ospfVirtIfStatus OBJECT-TYPE
         SYNTAX    RowStatus
         MAX-ACCESS   read-create
         STATUS    current
```

          DESCRIPTION
             "This variable displays the status of the en-
             try. Setting it to 'invalid' has the effect of
             rendering it inoperative. The internal effect
             (row removal) is implementation dependent."
          ::= { ospfVirtIfEntry 10 }

      ospfVirtIfAuthType OBJECT-TYPE
          SYNTAX   INTEGER (0..255)
                       -- none (0),
                       -- simplePassword (1)
                       -- md5 (2)
                       -- reserved for specification by IANA (> 2)
          MAX-ACCESS   read-create
          STATUS   current
          DESCRIPTION
             "The authentication type specified for a virtu-
             al interface. Additional authentication types
             may be assigned locally."
           REFERENCE
             "OSPF Version 2, Appendix E Authentication"
          DEFVAL { 0 }   -- no authentication, by default
          ::= { ospfVirtIfEntry 11 }

   --   OSPF Neighbor Table

   --   The OSPF Neighbor Table describes all neighbors in
   --   the locality of the subject router.

      ospfNbrTable OBJECT-TYPE
          SYNTAX   SEQUENCE OF OspfNbrEntry
          MAX-ACCESS   not-accessible
          STATUS   current
          DESCRIPTION
             "A table of non-virtual neighbor information."
           REFERENCE
             "OSPF Version 2, Section 10 The Neighbor Data
             Structure"
          ::= { ospf 10 }

      ospfNbrEntry OBJECT-TYPE
          SYNTAX   OspfNbrEntry
          MAX-ACCESS   not-accessible
          STATUS   current
          DESCRIPTION

```
                "The information regarding a single neighbor."
            REFERENCE
               "OSPF Version 2, Section 10  The  Neighbor  Data
               Structure"
         INDEX { ospfNbrIpAddr, ospfNbrAddressLessIndex }
         ::= { ospfNbrTable 1 }

OspfNbrEntry ::=
     SEQUENCE {
        ospfNbrIpAddr
            IpAddress,
        ospfNbrAddressLessIndex
            InterfaceIndex,
        ospfNbrRtrId
            RouterID,
        ospfNbrOptions
            Integer32,
        ospfNbrPriority
            DesignatedRouterPriority,
        ospfNbrState
            INTEGER,
        ospfNbrEvents
            Counter32,
        ospfNbrLsRetransQLen
            Gauge32,
        ospfNbmaNbrStatus
            RowStatus,
        ospfNbmaNbrPermanence
            INTEGER,
        ospfNbrHelloSuppressed
            TruthValue
               }

     ospfNbrIpAddr OBJECT-TYPE
        SYNTAX    IpAddress
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
           "The IP address this neighbor is using  in  its
           IP  Source  Address.  Note that, on addressless
           links, this will not be 0.0.0.0,  but  the  ad-
           dress of another of the neighbor's interfaces."
        ::= { ospfNbrEntry 1 }


     ospfNbrAddressLessIndex OBJECT-TYPE
        SYNTAX    InterfaceIndex
        MAX-ACCESS    read-only
```

        STATUS   current
        DESCRIPTION
           "On an interface having an IP Address, zero.
           On addressless interfaces, the corresponding
           value of ifIndex in the Internet Standard MIB.
           On row creation, this can be derived from the
           instance."
        ::= { ospfNbrEntry 2 }

    ospfNbrRtrId OBJECT-TYPE
        SYNTAX   RouterID
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
           "A 32-bit integer (represented as a type IpAd-
           dress) uniquely identifying the neighboring
           router in the Autonomous System."
        DEFVAL   { '00000000'H }   -- 0.0.0.0
        ::= { ospfNbrEntry 3 }

    ospfNbrOptions OBJECT-TYPE
        SYNTAX   Integer32
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
           "A Bit Mask corresponding to the neighbor's op-
           tions field.

           Bit 0, if set, indicates that the system will
           operate on Type of Service metrics other than
           TOS 0. If zero, the neighbor will ignore all
           metrics except the TOS 0 metric.

           Bit 1, if set, indicates that the associated
           area accepts and operates on external informa-
           tion; if zero, it is a stub area.

           Bit 2, if set, indicates that the system is ca-
           pable of routing IP Multicast datagrams; i.e.,
           that it implements the Multicast Extensions to
           OSPF.

           Bit 3, if set, indicates that the associated
           area is an NSSA. These areas are capable of
           carrying type 7 external advertisements, which
           are translated into type 5 external advertise-

          ments at NSSA borders."
        REFERENCE
           "OSPF Version 2, Section 12.1.2 Options"
      DEFVAL { 0 }
      ::= { ospfNbrEntry 4 }

      ospfNbrPriority OBJECT-TYPE
          SYNTAX   DesignatedRouterPriority
          MAX-ACCESS   read-create
          STATUS   current
          DESCRIPTION
             "The priority of this neighbor in the designat-
             ed router election algorithm. The value 0 sig-
             nifies that the neighbor is not eligible to be-
             come the designated router on this particular
             network."
      DEFVAL { 1 }
      ::= { ospfNbrEntry 5 }

      ospfNbrState OBJECT-TYPE
          SYNTAX   INTEGER   {
                     down (1),
                     attempt (2),
                     init (3),
                     twoWay (4),
                     exchangeStart (5),
                     exchange (6),
                     loading (7),
                     full (8)
                   }
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
           "The State of the relationship with this Neigh-
           bor."
        REFERENCE
           "OSPF Version 2, Section 10.1 Neighbor States"
      DEFVAL   { down }
      ::= { ospfNbrEntry 6 }

      ospfNbrEvents OBJECT-TYPE
          SYNTAX   Counter32
          MAX-ACCESS   read-only
          STATUS   current
          DESCRIPTION

```
                "The number of times this neighbor relationship
                has changed state, or an error has occurred."
           ::= { ospfNbrEntry 7 }


       ospfNbrLsRetransQLen OBJECT-TYPE
           SYNTAX    Gauge32
           MAX-ACCESS   read-only
           STATUS    current
           DESCRIPTION
                "The   current  length  of  the   retransmission
                queue."
           ::= { ospfNbrEntry 8 }


       ospfNbmaNbrStatus OBJECT-TYPE
           SYNTAX    RowStatus
           MAX-ACCESS   read-create
           STATUS    current
           DESCRIPTION
                "This variable displays the status of  the  en-
                try.  Setting it to 'invalid' has the effect of
                rendering it inoperative.  The internal  effect
                (row removal) is implementation dependent."
           ::= { ospfNbrEntry 9 }


       ospfNbmaNbrPermanence OBJECT-TYPE
           SYNTAX    INTEGER    {
                        dynamic (1),        -- learned through protocol
                        permanent (2)       -- configured address
                     }
           MAX-ACCESS   read-only
           STATUS    current
           DESCRIPTION
                "This variable displays the status of  the  en-
                try.  'dynamic'  and  'permanent' refer to how
                the neighbor became known."
         DEFVAL { permanent }
           ::= { ospfNbrEntry 10 }


       ospfNbrHelloSuppressed OBJECT-TYPE
           SYNTAX    TruthValue
           MAX-ACCESS   read-only
           STATUS    current
           DESCRIPTION
                "Indicates whether Hellos are being  suppressed
```

```
            to the neighbor"
        ::= { ospfNbrEntry 11 }


--   OSPF Virtual Neighbor Table

--       This table describes all virtual neighbors.
--       Since Virtual Links are configured in the
--       virtual interface table, this table is read-only.

     ospfVirtNbrTable OBJECT-TYPE
         SYNTAX    SEQUENCE OF OspfVirtNbrEntry
         MAX-ACCESS    not-accessible
         STATUS    current
         DESCRIPTION
            "A table of virtual neighbor information."
        REFERENCE
            "OSPF Version 2, Section 15  Virtual Links"
        ::= { ospf 11 }


     ospfVirtNbrEntry OBJECT-TYPE
         SYNTAX    OspfVirtNbrEntry
         MAX-ACCESS    not-accessible
         STATUS     current
         DESCRIPTION
            "Virtual neighbor information."
         INDEX { ospfVirtNbrArea, ospfVirtNbrRtrId }
         ::= { ospfVirtNbrTable 1 }

OspfVirtNbrEntry ::=
     SEQUENCE {
         ospfVirtNbrArea
             AreaID,
         ospfVirtNbrRtrId
             RouterID,
         ospfVirtNbrIpAddr
             IpAddress,
         ospfVirtNbrOptions
             Integer32,
         ospfVirtNbrState
             INTEGER,
         ospfVirtNbrEvents
             Counter32,
         ospfVirtNbrLsRetransQLen
             Gauge32,
         ospfVirtNbrHelloSuppressed
                 TruthValue
```

```
             }

    ospfVirtNbrArea OBJECT-TYPE
        SYNTAX    AreaID
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
          "The Transit Area Identifier."
        ::= { ospfVirtNbrEntry 1 }


    ospfVirtNbrRtrId OBJECT-TYPE
        SYNTAX    RouterID
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
          "A  32-bit  integer  uniquely  identifying  the
          neighboring router in the Autonomous System."
        ::= { ospfVirtNbrEntry 2 }


    ospfVirtNbrIpAddr OBJECT-TYPE
        SYNTAX    IpAddress
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
          "The IP address this Virtual  Neighbor  is  us-
          ing."
        ::= { ospfVirtNbrEntry 3 }


    ospfVirtNbrOptions OBJECT-TYPE
        SYNTAX    Integer32
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
          "A Bit Mask corresponding to the neighbor's op-
          tions field.

          Bit 1, if set, indicates that the  system  will
          operate  on  Type of Service metrics other than
          TOS 0.  If zero, the neighbor will  ignore  all
          metrics except the TOS 0 metric.

          Bit 2, if set, indicates  that  the  system  is
          Network  Multicast  capable; ie, that it imple-
          ments OSPF Multicast Routing."
        ::= { ospfVirtNbrEntry 4 }
```

```
ospfVirtNbrState OBJECT-TYPE
    SYNTAX   INTEGER    {
            down (1),
            attempt (2),
            init (3),
            twoWay (4),
            exchangeStart (5),
            exchange (6),
            loading (7),
            full (8)
         }
   MAX-ACCESS   read-only
   STATUS   current
   DESCRIPTION
      "The state of the  Virtual  Neighbor  Relation-
      ship."
   ::= { ospfVirtNbrEntry 5 }


ospfVirtNbrEvents OBJECT-TYPE
    SYNTAX   Counter32
    MAX-ACCESS   read-only
    STATUS   current
    DESCRIPTION
      "The number of  times  this  virtual  link  has
      changed its state, or an error has occurred."
   ::= { ospfVirtNbrEntry 6 }


ospfVirtNbrLsRetransQLen OBJECT-TYPE
    SYNTAX   Gauge32
    MAX-ACCESS   read-only
    STATUS   current
    DESCRIPTION
      "The  current  length  of  the   retransmission
      queue."
   ::= { ospfVirtNbrEntry 7 }


ospfVirtNbrHelloSuppressed OBJECT-TYPE
    SYNTAX   TruthValue
    MAX-ACCESS   read-only
    STATUS   current
    DESCRIPTION
      "Indicates whether Hellos are being  suppressed
      to the neighbor"
   ::= { ospfVirtNbrEntry 8 }
```

```
--   OSPF Link State Database, External

--        The Link State Database contains the Link State
--        Advertisements from throughout the areas that the
--        device is attached to.

--                This table is identical to the OSPF LSDB Table in
--        format, but contains only External Link State
--                Advertisements.  The purpose is to allow external
--        LSAs to be displayed once for the router rather
--        than once in each non-stub area.

     ospfExtLsdbTable OBJECT-TYPE
         SYNTAX    SEQUENCE OF OspfExtLsdbEntry
         MAX-ACCESS    not-accessible
         STATUS    current
         DESCRIPTION
            "The OSPF Process's Links State Database."
          REFERENCE
            "OSPF Version 2, Section 12  Link  State  Adver-
            tisements"
        ::= { ospf 12 }


     ospfExtLsdbEntry OBJECT-TYPE
         SYNTAX    OspfExtLsdbEntry
         MAX-ACCESS    not-accessible
         STATUS    current
         DESCRIPTION
            "A single Link State Advertisement."
         INDEX { ospfExtLsdbType, ospfExtLsdbLsid, ospfExtLsdbRouterId }
         ::= { ospfExtLsdbTable 1 }

OspfExtLsdbEntry ::=
     SEQUENCE {
         ospfExtLsdbType
             INTEGER,
         ospfExtLsdbLsid
             IpAddress,
         ospfExtLsdbRouterId
             RouterID,
         ospfExtLsdbSequence
             Integer32,
         ospfExtLsdbAge
             Integer32,
         ospfExtLsdbChecksum
             Integer32,
         ospfExtLsdbAdvertisement
```

```
              OCTET STRING
                }

      ospfExtLsdbType OBJECT-TYPE
          SYNTAX    INTEGER    {
                       asExternalLink (5)
                    }
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
           "The type  of  the  link  state  advertisement.
            Each  link state type has a separate advertise-
            ment format."
         REFERENCE
           "OSPF Version 2, Appendix A.4.1 The  Link  State
            Advertisement header"
        ::= { ospfExtLsdbEntry 1 }


      ospfExtLsdbLsid OBJECT-TYPE
          SYNTAX    IpAddress
          MAX-ACCESS    read-only
          STATUS     current
          DESCRIPTION
             "The Link State ID is an LS Type Specific field
              containing either a Router ID or an IP Address;
              it identifies the piece of the  routing  domain
              that is being described by the advertisement."
          REFERENCE
             "OSPF Version 2, Section 12.1.4 Link State ID"
        ::= { ospfExtLsdbEntry 2 }


      ospfExtLsdbRouterId OBJECT-TYPE
          SYNTAX    RouterID
          MAX-ACCESS    read-only
          STATUS     current
          DESCRIPTION
             "The 32 bit number that uniquely identifies the
              originating router in the Autonomous System."
          REFERENCE
             "OSPF Version 2, Appendix C.1 Global parameters"
        ::= { ospfExtLsdbEntry 3 }

-- Note that the OSPF Sequence Number is a 32 bit signed
-- integer.  It starts with the value '80000001'h,
-- or -'7FFFFFFF'h, and increments until '7FFFFFFF'h
-- Thus, a typical sequence number will be very negative.
```

        ospfExtLsdbSequence OBJECT-TYPE
            SYNTAX   Integer32
            MAX-ACCESS   read-only
            STATUS   current
            DESCRIPTION
                "The sequence number field is a signed 32-bit
                integer. It is used to detect old and dupli-
                cate link state advertisements. The   space of
                sequence numbers is linearly ordered.   The
                larger the sequence number the more recent the
                advertisement."
          REFERENCE
                "OSPF Version 2, Section 12.1.6 LS sequence
                number"
          ::= { ospfExtLsdbEntry 4 }

        ospfExtLsdbAge OBJECT-TYPE
            SYNTAX   Integer32   -- Should be 0..MaxAge
            MAX-ACCESS   read-only
            STATUS   current
            DESCRIPTION
                "This field is the age of the link state adver-
                tisement in seconds."
          REFERENCE
                "OSPF Version 2, Section 12.1.1 LS age"
          ::= { ospfExtLsdbEntry 5 }

        ospfExtLsdbChecksum OBJECT-TYPE
            SYNTAX   Integer32
            MAX-ACCESS   read-only
            STATUS   current
            DESCRIPTION
                "This field is the checksum of the complete
                contents of the advertisement, excepting the
                age field. The age field is excepted so that
                an   advertisement's age can be incremented
                without updating the checksum.   The checksum
                used is the same that is used for ISO connec-
                tionless datagrams; it is commonly referred to
                as the Fletcher checksum."
          REFERENCE
                "OSPF Version 2, Section 12.1.7 LS checksum"
          ::= { ospfExtLsdbEntry 6 }

        ospfExtLsdbAdvertisement OBJECT-TYPE

```
        SYNTAX    OCTET STRING (SIZE(36))
        MAX-ACCESS    read-only
        STATUS    current
        DESCRIPTION
           "The entire Link State Advertisement, including
            its header."
       REFERENCE
           "OSPF Version 2, Section 12  Link  State  Adver-
            tisements"
      ::= { ospfExtLsdbEntry 7 }
```

-- OSPF Use of the CIDR Route Table

```
ospfRouteGroup            OBJECT IDENTIFIER ::= { ospf 13 }
```

-- The IP Forwarding Table defines a number of objects for use by
-- the routing protocol to externalize its information. Most of
-- the variables (ipForwardDest, ipForwardMask, ipForwardPolicy,
-- ipForwardNextHop, ipForwardIfIndex, ipForwardType,
-- ipForwardProto, ipForwardAge, and ipForwardNextHopAS) are
-- defined there.

-- Those that leave some discretion are defined here.

-- ipCidrRouteProto is, of course, ospf (13).

-- ipCidrRouteAge is the time since the route was first calculated,
-- as opposed to the time since the last SPF run.

-- ipCidrRouteInfo is an OBJECT IDENTIFIER for use by the routing
-- protocol. The following values shall be found there depending
-- on the way the route was calculated.

```
ospfIntraArea       OBJECT IDENTIFIER ::= { ospfRouteGroup 1 }
ospfInterArea       OBJECT IDENTIFIER ::= { ospfRouteGroup 2 }
ospfExternalType1   OBJECT IDENTIFIER ::= { ospfRouteGroup 3 }
ospfExternalType2   OBJECT IDENTIFIER ::= { ospfRouteGroup 4 }
```

-- ipCidrRouteMetric1 is, by definition, the primary routing
-- metric. Therefore, it should be the metric that route
-- selection is based on. For intra-area and inter-area routes,
-- it is an OSPF metric. For External Type 1 (comparable value)
-- routes, it is an OSPF metric plus the External Metric. For
-- external Type 2 (non-comparable value) routes, it is the
-- external metric.

-- ipCidrRouteMetric2 is, by definition, a secondary routing

```
-- metric.  Therefore, it should be the metric that breaks a tie
-- among routes having equal metric1 values and the same
-- calculation rule.  For intra-area, inter-area routes, and
-- External Type 1 (comparable value) routes, it is unused.  For
-- external Type 2 (non-comparable value) routes, it is the metric
-- to the AS border router.

-- ipCidrRouteMetric3, ipCidrRouteMetric4, and ipCidrRouteMetric5 are
-- unused.


--
--        The OSPF Area Aggregate Table
--
--        This table replaces the OSPF Area Summary Table, being an
--        extension of that for CIDR routers.

    ospfAreaAggregateTable OBJECT-TYPE
        SYNTAX    SEQUENCE OF OspfAreaAggregateEntry
        MAX-ACCESS    not-accessible
        STATUS    current
        DESCRIPTION
           "A range of IP addresses  specified  by  an  IP
           address/IP  network  mask  pair.  For example,
           class B address range of X.X.X.X with a network
           mask  of  255.255.0.0 includes all IP addresses
           from X.X.0.0  to  X.X.255.255.   Note   that   if
           ranges  are configured such that one range sub-
           sumes  another  range  (e.g.,   10.0.0.0   mask
           255.0.0.0  and  10.1.0.0 mask 255.255.0.0), the
           most specific match is the preferred one."
         REFERENCE
           "OSPF Version 2, Appendix C.2  Area parameters"
       ::= { ospf 14 }


    ospfAreaAggregateEntry OBJECT-TYPE
        SYNTAX    OspfAreaAggregateEntry
        MAX-ACCESS    not-accessible
        STATUS    current
        DESCRIPTION
           "A range of IP addresses  specified  by  an  IP
           address/IP  network  mask  pair.  For example,
           class B address range of X.X.X.X with a network
           mask  of  255.255.0.0 includes all IP addresses
           from X.X.0.0  to  X.X.255.255.   Note   that   if
           ranges are range configured such that one range
           subsumes another  range  (e.g.,   10.0.0.0   mask
           255.0.0.0  and  10.1.0.0 mask 255.255.0.0), the
```

```
            most specific match is the preferred one."
         REFERENCE
            "OSPF Version 2, Appendix C.2  Area parameters"
        INDEX { ospfAreaAggregateAreaID, ospfAreaAggregateLsdbType,
                ospfAreaAggregateNet, ospfAreaAggregateMask }
        ::= { ospfAreaAggregateTable 1 }


OspfAreaAggregateEntry ::=
        SEQUENCE {
            ospfAreaAggregateAreaID
                AreaID,
            ospfAreaAggregateLsdbType
                INTEGER,
            ospfAreaAggregateNet
                IpAddress,
            ospfAreaAggregateMask
                IpAddress,
            ospfAreaAggregateStatus
                RowStatus,
            ospfAreaAggregateEffect
                INTEGER
                  }

        ospfAreaAggregateAreaID OBJECT-TYPE
            SYNTAX    AreaID
            MAX-ACCESS    read-only
            STATUS    current
            DESCRIPTION
                "The Area the Address Aggregate is to be  found
                within."
             REFERENCE
                "OSPF Version 2, Appendix C.2 Area parameters"
            ::= { ospfAreaAggregateEntry 1 }


        ospfAreaAggregateLsdbType OBJECT-TYPE
            SYNTAX    INTEGER    {
                        summaryLink (3),
                        nssaExternalLink (7)
                      }
            MAX-ACCESS    read-only
            STATUS    current
            DESCRIPTION
                "The type of the Address Aggregate.  This field
                specifies  the  Lsdb type that this Address Ag-
                gregate applies to."
             REFERENCE
```

                "OSPF Version 2, Appendix A.4.1 The Link State
                Advertisement header"
            ::= { ospfAreaAggregateEntry 2 }

        ospfAreaAggregateNet OBJECT-TYPE
            SYNTAX   IpAddress
            MAX-ACCESS   read-only
            STATUS   current
            DESCRIPTION
                "The IP Address of the Net or Subnet indicated
                by the range."
             REFERENCE
                "OSPF Version 2, Appendix C.2 Area parameters"
            ::= { ospfAreaAggregateEntry 3 }

        ospfAreaAggregateMask OBJECT-TYPE
            SYNTAX   IpAddress
            MAX-ACCESS   read-only
            STATUS   current
            DESCRIPTION
                "The Subnet Mask that pertains to the Net or
                Subnet."
             REFERENCE
                "OSPF Version 2, Appendix C.2 Area parameters"
            ::= { ospfAreaAggregateEntry 4 }

        ospfAreaAggregateStatus OBJECT-TYPE
            SYNTAX   RowStatus
            MAX-ACCESS   read-create
            STATUS   current
            DESCRIPTION
                "This variable displays the status of the en-
                try. Setting it to 'invalid' has the effect of
                rendering it inoperative. The internal effect
                (row removal) is implementation dependent."
            ::= { ospfAreaAggregateEntry 5 }

        ospfAreaAggregateEffect OBJECT-TYPE
            SYNTAX   INTEGER   {
                        advertiseMatching (1),
                        doNotAdvertiseMatching (2)
                      }
            MAX-ACCESS   read-create
            STATUS   current

```
        DESCRIPTION
            "Subnets subsumed by ranges either trigger  the
            advertisement  of  the indicated aggregate (ad-
            vertiseMatching), or result in the subnet's not
            being advertised at all outside the area."
        DEFVAL   { advertiseMatching }
        ::= { ospfAreaAggregateEntry 6 }


-- conformance information

ospfConformance OBJECT IDENTIFIER ::= { ospf 15 }

ospfGroups      OBJECT IDENTIFIER ::= { ospfConformance 1 }
ospfCompliances OBJECT IDENTIFIER ::= { ospfConformance 2 }

-- compliance statements

    ospfCompliance MODULE-COMPLIANCE
        STATUS  current
        DESCRIPTION
            "The compliance statement "
        MODULE  -- this module
        MANDATORY-GROUPS {
                    ospfBasicGroup,
                    ospfAreaGroup,
                    ospfStubAreaGroup,
                    ospfIfGroup,
                    ospfIfMetricGroup,
                    ospfVirtIfGroup,
                    ospfNbrGroup,
                    ospfVirtNbrGroup,
                    ospfAreaAggregateGroup
            }
        ::= { ospfCompliances 1 }


-- units of conformance

    ospfBasicGroup      OBJECT-GROUP
        OBJECTS {
                    ospfRouterId,
                    ospfAdminStat,
                    ospfVersionNumber,
                    ospfAreaBdrRtrStatus,
                    ospfASBdrRtrStatus,
                    ospfExternLsaCount,
                    ospfExternLsaCksumSum,
```

```
                     ospfTOSSupport,
                     ospfOriginateNewLsas,
                     ospfRxNewLsas,
                     ospfExtLsdbLimit,
                     ospfMulticastExtensions,
                     ospfExitOverflowInterval,
                     ospfDemandExtensions
            }
        STATUS  current
        DESCRIPTION
           "These objects are required for OSPF systems."
        ::= { ospfGroups 1 }


    ospfAreaGroup     OBJECT-GROUP
        OBJECTS {
                     ospfAreaId,
                     ospfImportAsExtern,
                     ospfSpfRuns,
                     ospfAreaBdrRtrCount,
                     ospfAsBdrRtrCount,
                     ospfAreaLsaCount,
                     ospfAreaLsaCksumSum,
                     ospfAreaSummary,
                     ospfAreaStatus
            }
        STATUS  current
        DESCRIPTION
           "These objects are required  for  OSPF  systems
           supporting areas."
        ::= { ospfGroups 2 }


    ospfStubAreaGroup    OBJECT-GROUP
        OBJECTS {
                     ospfStubAreaId,
                     ospfStubTOS,
                     ospfStubMetric,
                     ospfStubStatus,
                     ospfStubMetricType
            }
        STATUS  current
        DESCRIPTION
           "These objects are required  for  OSPF  systems
           supporting stub areas."
        ::= { ospfGroups 3 }
```

```
ospfLsdbGroup     OBJECT-GROUP
    OBJECTS {
                ospfLsdbAreaId,
                ospfLsdbType,
                ospfLsdbLsid,
                ospfLsdbRouterId,
                ospfLsdbSequence,
                ospfLsdbAge,
                ospfLsdbChecksum,
                ospfLsdbAdvertisement
    }
    STATUS  current
    DESCRIPTION
      "These objects are required  for  OSPF  systems
      that display their link state database."
    ::= { ospfGroups 4 }


ospfAreaRangeGroup     OBJECT-GROUP
    OBJECTS {
                ospfAreaRangeAreaId,
                ospfAreaRangeNet,
                ospfAreaRangeMask,
                ospfAreaRangeStatus,
                ospfAreaRangeEffect
    }
    STATUS  obsolete
    DESCRIPTION
      "These objects are required for  non-CIDR  OSPF
      systems that support multiple areas."
    ::= { ospfGroups 5 }


ospfHostGroup     OBJECT-GROUP
    OBJECTS {
                ospfHostIpAddress,
                ospfHostTOS,
                ospfHostMetric,
                ospfHostStatus,
                ospfHostAreaID
    }
    STATUS  current
    DESCRIPTION
      "These objects are required  for  OSPF  systems
      that support attached hosts."
    ::= { ospfGroups 6 }
```

```
    ospfIfGroup    OBJECT-GROUP
        OBJECTS {
                    ospfIfIpAddress,
                    ospfAddressLessIf,
                    ospfIfAreaId,
                    ospfIfType,
                    ospfIfAdminStat,
                    ospfIfRtrPriority,
                    ospfIfTransitDelay,
                    ospfIfRetransInterval,
                    ospfIfHelloInterval,
                    ospfIfRtrDeadInterval,
                    ospfIfPollInterval,
                    ospfIfState,
                    ospfIfDesignatedRouter,
                    ospfIfBackupDesignatedRouter,
                    ospfIfEvents,
                    ospfIfAuthType,
                    ospfIfAuthKey,
                    ospfIfStatus,
                    ospfIfMulticastForwarding,
                    ospfIfDemand
         }
        STATUS  current
        DESCRIPTION
           "These objects are required for OSPF systems."
        ::= { ospfGroups 7 }


    ospfIfMetricGroup    OBJECT-GROUP
        OBJECTS {
                    ospfIfMetricIpAddress,
                    ospfIfMetricAddressLessIf,
                    ospfIfMetricTOS,
                    ospfIfMetricValue,
                    ospfIfMetricStatus
         }
        STATUS  current
        DESCRIPTION
           "These objects are required for OSPF systems."
        ::= { ospfGroups 8 }


    ospfVirtIfGroup    OBJECT-GROUP
        OBJECTS {
                    ospfVirtIfAreaId,
                    ospfVirtIfNeighbor,
                    ospfVirtIfTransitDelay,
```

```
                    ospfVirtIfRetransInterval,
                    ospfVirtIfHelloInterval,
                    ospfVirtIfRtrDeadInterval,
                    ospfVirtIfState,
                    ospfVirtIfEvents,
                    ospfVirtIfAuthType,
                    ospfVirtIfAuthKey,
                    ospfVirtIfStatus
            }
       STATUS  current
       DESCRIPTION
          "These objects are required for OSPF systems."
       ::= { ospfGroups 9 }


   ospfNbrGroup     OBJECT-GROUP
       OBJECTS {
                    ospfNbrIpAddr,
                    ospfNbrAddressLessIndex,
                    ospfNbrRtrId,
                    ospfNbrOptions,
                    ospfNbrPriority,
                    ospfNbrState,
                    ospfNbrEvents,
                    ospfNbrLsRetransQLen,
                    ospfNbmaNbrStatus,
                    ospfNbmaNbrPermanence,
                    ospfNbrHelloSuppressed
            }
       STATUS  current
       DESCRIPTION
          "These objects are required for OSPF systems."
       ::= { ospfGroups 10 }


   ospfVirtNbrGroup    OBJECT-GROUP
       OBJECTS {
                    ospfVirtNbrArea,
                    ospfVirtNbrRtrId,
                    ospfVirtNbrIpAddr,
                    ospfVirtNbrOptions,
                    ospfVirtNbrState,
                    ospfVirtNbrEvents,
                    ospfVirtNbrLsRetransQLen,
                    ospfVirtNbrHelloSuppressed
            }
       STATUS  current
       DESCRIPTION
```

```
                  "These objects are required for OSPF systems."
              ::= { ospfGroups 11 }


        ospfExtLsdbGroup      OBJECT-GROUP
            OBJECTS {
                        ospfExtLsdbType,
                        ospfExtLsdbLsid,
                        ospfExtLsdbRouterId,
                        ospfExtLsdbSequence,
                        ospfExtLsdbAge,
                        ospfExtLsdbChecksum,
                        ospfExtLsdbAdvertisement
            }
            STATUS  current
            DESCRIPTION
              "These objects are required  for  OSPF  systems
               that display their link state database."
            ::= { ospfGroups 12 }


        ospfAreaAggregateGroup      OBJECT-GROUP
            OBJECTS {
                        ospfAreaAggregateAreaID,
                        ospfAreaAggregateLsdbType,
                        ospfAreaAggregateNet,
                        ospfAreaAggregateMask,
                        ospfAreaAggregateStatus,
                        ospfAreaAggregateEffect
            }
            STATUS  current
            DESCRIPTION
              "These objects are required for OSPF systems."
            ::= { ospfGroups 13 }

    END
```

4. OSPF Traps

   OSPF is an event driven routing protocol, where an event can be a
   change in an OSPF interface's link-level status, the expiration of an
   OSPF timer or the reception of an OSPF protocol packet. Many of the
   actions that OSPF takes as a result of these events will result in a
   change of the routing topology. As routing topologies become large
   and complex it is often difficult to locate the source of a topology
   change or unpredicted routing path by polling a large number or
   routers. Another approach is to notify a network manager of
   potentially critical OSPF events with SNMP traps.

This section defines a set of traps, objects and mechanisms to enhance the ability to manage IP internetworks which use OSPF as its IGP. It is an optional but useful extension to the OSPF MIB.

4.1. Format Of Trap Definitions

Section 7 contains contains the trap definitions.

4.2. Approach

The mechanism for sending traps is straight-forward. When an exception event occurs, the application notifies the local agent who sends a trap to the appropriate SNMP management stations. The message includes the trap type and may include a list of trap specific variables. A new object is defined in section 3.2 that will allow a network manager to enable or disable particular OSPF traps. Section 5 gives the trap definitions which includes the variable lists. The router ID of the originator of the trap is included in the variable list so that the network manager may easily determine the source of the trap.

To limit the frequency of OSPF traps, the following additional mechanisms are suggested.

4.3. Ignoring Initial Activity

The majority of critical events occur when OSPF is enabled on a router, at which time the designated router is elected and neighbor adjacencies are formed. During this initial period a potential flood of traps is unnecessary since the events are expected. To avoid unnecessary traps, a router should not originate expected OSPF interface related traps until two of that interface's dead timer intervals have elapsed. The expected OSPF interface traps are ospfIfStateChange, ospfVirtIfStateChange, ospfNbrStateChange, ospfVirtNbrStateChange, ospfTxRetranmit and ospfVirtIfTxRetransmit. Additionally, ospfMaxAgeLsa and ospfOriginateLsa traps should not be originated until two dead timer intervals have elapsed where the dead timer interval used should be the dead timer with the smallest value.

4.4. Throttling Traps

The mechanism for throttling the traps is similar to the mechanism explained in RFC 1224 [11], section 5. The basic idea is that there is a sliding window in seconds and an upper bound on the number of traps that may be generated within this window. Unlike RFC 1224, traps are not sent to inform the network manager that the throttling mechanism has kicked in.

A single window should be used to throttle all OSPF traps types
except for the ospfLsdbOverflow and the ospfLsdbApproachingOverflow
trap which should not be throttled. For example, if the window time
is 3, the upper bound is 3 and the events that would cause trap types
1,3,5 and 7 occur within a 3 second period, the type 7 trap should
not be generated.

Appropriate values are 7 traps with a window time of 10 seconds.

4.5. One Trap Per OSPF Event

Several of the traps defined in section 5 are generated as the result
of finding an unusual condition while parsing an OSPF packet or a
processing a timer event. There may be more than one unusual
condition detected while handling the event. For example, a link-
state update packet may contain several retransmitted link-state
advertisements (LSAs), or a retransmitted database description packet
may contain several database description entries. To limit the
number of traps and variables, OSPF should generate at most one trap
per OSPF event. Only the variables associated with the first unusual
condition should be included with the trap. Similarly, if more than
one type of unusual condition is encountered while parsing the
packet, only the first event will generate a trap.

4.6. Polling Event Counters

Many of the tables in the OSPF MIB contain generalized event
counters. By enabling the traps defined in this document a network
manager can obtain more specific information about these events. A
network manager may want to poll these event counters and enable
specific OSPF traps when a particular counter starts increasing
abnormally.

The following table shows the relationship between the event counters
defined in the OSPF MIB and the trap types defined in section 5.

Counter32	Trap Type
ospfOriginateNewLsas	ospfOriginateLsa
ospfIfEvents	ospfIfStateChange
	ospfConfigError
	ospfIfAuthFailure
	ospfRxBadPacket
	ospfTxRetransmit
ospfVirtIfEvents	ospfVirtIfStateChange
	ospfVirtIfConfigError
	ospfVirtIfAuthFailure

```
                                ospfVirtIfRxBadPacket
                                ospfVirtIfTxRetransmit
        ospfNbrEvents           ospfNbrStateChange
        ospfVirtNbrEvents       ospfVirtNbrStateChange
        ospfExternLSACount      ospfLsdbApproachingOverflow
        ospfExternLSACount      ospfLsdbOverflow
```

5.   OSPF Trap Definitions

OSPF-TRAP-MIB DEFINITIONS ::= BEGIN

```
        IMPORTS
                MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE, IpAddress
                    FROM SNMPv2-SMI
                MODULE-COMPLIANCE, OBJECT-GROUP
                    FROM SNMPv2-CONF
                ospfRouterId, ospfIfIpAddress, ospfAddressLessIf, ospfIfState,
                ospfVirtIfAreaId, ospfVirtIfNeighbor, ospfVirtIfState,
                ospfNbrIpAddr, ospfNbrAddressLessIndex, ospfNbrRtrId,
                ospfNbrState, ospfVirtNbrArea, ospfVirtNbrRtrId, ospfVirtNbrState
                ospfLsdbType, ospfLsdbLsid, ospfLsdbRouterId, ospfLsdbAreaId,
                ospfExtLsdbLimit, ospf
                    FROM OSPF-MIB;

        ospfTrap MODULE-IDENTITY
                LAST-UPDATED "9501201225Z" -- Fri Jan 20 12:25:50 PST 1995
                ORGANIZATION "IETF OSPF Working Group"
                CONTACT-INFO
                "                       Fred Baker
                Postal:                 Cisco Systems
                                        519 Lado Drive
                                        Santa Barbara, California 93111
                Tel:                    +1 805 681 0115
                E-Mail:                 fred@cisco.com

                                        Rob Coltun
                Postal:                 RainbowBridge Communications
                Tel:                    (301) 340-9416
                E-Mail:                 rcoltun@rainbow-bridge.com"
            DESCRIPTION
                "The MIB module to describe traps for  the  OSPF
                Version 2 Protocol."
            ::= { ospf 16 }
```

-- Trap Support Objects

--   The following are support objects for the OSPF traps.

```
ospfTrapControl OBJECT IDENTIFIER ::= { ospfTrap 1 }
ospfTraps OBJECT IDENTIFIER ::= { ospfTrap 2 }

    ospfSetTrap OBJECT-TYPE
        SYNTAX   OCTET STRING (SIZE(4))
        MAX-ACCESS   read-write
        STATUS   current
        DESCRIPTION
           "A four-octet string serving as a bit  map  for
           the trap events defined by the OSPF traps. This
           object is used to enable and  disable  specific
           OSPF   traps   where  a  1  in  the  bit  field
           represents enabled.  The right-most bit  (least
           significant) represents trap 0."
        ::= { ospfTrapControl 1 }


    ospfConfigErrorType OBJECT-TYPE
        SYNTAX   INTEGER   {
                    badVersion (1),
                    areaMismatch (2),
                    unknownNbmaNbr (3), -- Router is Dr eligible
                    unknownVirtualNbr (4),
                    authTypeMismatch(5),
                    authFailure (6),
                    netMaskMismatch (7),
                    helloIntervalMismatch (8),
                    deadIntervalMismatch (9),
                    optionMismatch (10) }
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
           "Potential types  of  configuration  conflicts.
           Used  by the ospfConfigError and ospfConfigVir-
           tError traps."
      ::= { ospfTrapControl 2 }


    ospfPacketType OBJECT-TYPE
        SYNTAX   INTEGER   {
                    hello (1),
                    dbDescript (2),
                    lsReq (3),
                    lsUpdate (4),
                    lsAck (5) }
        MAX-ACCESS   read-only
        STATUS   current
        DESCRIPTION
```

```
        "OSPF packet types."
::= { ospfTrapControl 3 }


 ospfPacketSrc OBJECT-TYPE
     SYNTAX    IpAddress
     MAX-ACCESS   read-only
     STATUS    current
     DESCRIPTION
        "The IP address of an inbound packet that  can-
        not be identified by a neighbor instance."
     ::= { ospfTrapControl 4 }
```

-- Traps

```
 ospfIfStateChange NOTIFICATION-TYPE
     OBJECTS {
                 ospfRouterId, -- The originator of the trap
                 ospfIfIpAddress,
                 ospfAddressLessIf,
                 ospfIfState    -- The new state
               }
     STATUS               current
     DESCRIPTION
        "An ospfIfStateChange trap signifies that there
        has been a change in the state of a non-virtual
        OSPF interface. This trap should  be  generated
        when  the interface state regresses (e.g., goes
        from Dr to Down) or progresses  to  a  terminal
        state (i.e.,  Point-to-Point, DR Other, Dr, or
        Backup)."
::= { ospfTraps 16 }


 ospfVirtIfStateChange NOTIFICATION-TYPE
     OBJECTS {
                 ospfRouterId, -- The originator of the trap
                 ospfVirtIfAreaId,
                 ospfVirtIfNeighbor,
                 ospfVirtIfState  -- The new state
               }
     STATUS               current
     DESCRIPTION
        "An ospfIfStateChange trap signifies that there
        has  been a change in the state of an OSPF vir-
        tual interface.
```

              This trap should be generated when the inter-
              face state regresses (e.g., goes from Point-
              to-Point to Down) or progresses to a terminal
              state (i.e., Point-to-Point)."
       ::= { ospfTraps 1 }

     ospfNbrStateChange NOTIFICATION-TYPE
         OBJECTS {
                     ospfRouterId, -- The originator of the trap
                     ospfNbrIpAddr,
                     ospfNbrAddressLessIndex,
                     ospfNbrRtrId,
                     ospfNbrState -- The new state
                    }
         STATUS   current
         DESCRIPTION
            "An ospfNbrStateChange trap signifies   that
            there has been a change in the state of a non-
            virtual OSPF neighbor.   This trap should be
            generated when the neighbor state regresses
            (e.g., goes from Attempt or Full to 1-Way or
            Down) or progresses to a terminal state (e.g.,
            2-Way or Full). When an neighbor transitions
            from or to Full on non-broadcast multi-access
            and broadcast networks, the trap should be gen-
            erated by the designated router. A designated
            router transitioning to Down will be noted by
            ospfIfStateChange."
       ::= { ospfTraps 2 }

     ospfVirtNbrStateChange NOTIFICATION-TYPE
         OBJECTS {
                     ospfRouterId, -- The originator of the trap
                     ospfVirtNbrArea,
                     ospfVirtNbrRtrId,
                     ospfVirtNbrState -- The new state
                    }
         STATUS   current
         DESCRIPTION
            "An ospfIfStateChange trap signifies that there
            has been a change in the state of an OSPF vir-
            tual neighbor. This trap should be generated
            when the neighbor state regresses (e.g., goes
            from Attempt or Full to 1-Way or Down) or
            progresses to a terminal state (e.g., Full)."
       ::= { ospfTraps 3 }

       ospfIfConfigError NOTIFICATION-TYPE
           OBJECTS {
                       ospfRouterId, -- The originator of the trap
                       ospfIfIpAddress,
                       ospfAddressLessIf,
                       ospfPacketSrc, -- The source IP address
                       ospfConfigErrorType, -- Type of error
                       ospfPacketType
                     }
           STATUS   current
           DESCRIPTION
              "An ospfIfConfigError trap signifies that a
              packet has been received on a non-virtual in-
              terface from a router whose configuration
              parameters conflict with this router's confi-
              guration parameters. Note that the event op-
              tionMismatch should cause a trap only if it
              prevents an adjacency from forming."
                     ::= { ospfTraps 4 }

       ospfVirtIfConfigError NOTIFICATION-TYPE
           OBJECTS {
                       ospfRouterId, -- The originator of the trap
                       ospfVirtIfAreaId,
                       ospfVirtIfNeighbor,
                       ospfConfigErrorType, -- Type of error
                       ospfPacketType
                     }
           STATUS   current
           DESCRIPTION
              "An ospfConfigError trap signifies that a pack-
              et has been received on a virtual interface
              from a router whose configuration parameters
              conflict   with   this router's configuration
              parameters. Note that the event optionMismatch
              should cause a trap only if it prevents an ad-
              jacency from forming."
        ::= { ospfTraps 5 }

       ospfIfAuthFailure NOTIFICATION-TYPE
           OBJECTS {
                       ospfRouterId, -- The originator of the trap
                       ospfIfIpAddress,
                       ospfAddressLessIf,
                       ospfPacketSrc, -- The source IP address
                       ospfConfigErrorType, -- authTypeMismatch or

```
                                        -- authFailure
                     ospfPacketType
                 }
        STATUS              current
        DESCRIPTION
            "An ospfIfAuthFailure  trap  signifies  that  a
            packet  has  been received on a non-virtual in-
            terface from a router whose authentication  key
            or  authentication  type  conflicts  with  this
            router's authentication key  or  authentication
            type."
     ::= { ospfTraps 6 }


      ospfVirtIfAuthFailure NOTIFICATION-TYPE
        OBJECTS {
                     ospfRouterId, -- The originator of the trap
                     ospfVirtIfAreaId,
                     ospfVirtIfNeighbor,
                     ospfConfigErrorType, -- authTypeMismatch or
                                         -- authFailure
                     ospfPacketType
                 }
        STATUS              current
        DESCRIPTION
            "An ospfVirtIfAuthFailure trap signifies that a
            packet has been received on a virtual interface
            from a router whose authentication key  or  au-
            thentication  type conflicts with this router's
            authentication key or authentication type."
     ::= { ospfTraps 7 }


      ospfIfRxBadPacket NOTIFICATION-TYPE
        OBJECTS {
                     ospfRouterId, -- The originator of the trap
                     ospfIfIpAddress,
                     ospfAddressLessIf,
                     ospfPacketSrc,  -- The source IP address
                     ospfPacketType
                 }
        STATUS              current
        DESCRIPTION
            "An ospfIfRxBadPacket trap  signifies  that  an
            OSPF  packet has been received on a non-virtual
            interface that cannot be parsed."
     ::= { ospfTraps 8 }
```

```
    ospfVirtIfRxBadPacket NOTIFICATION-TYPE
        OBJECTS {
                    ospfRouterId, -- The originator of the trap
                    ospfVirtIfAreaId,
                    ospfVirtIfNeighbor,
                    ospfPacketType
                  }
        STATUS              current
        DESCRIPTION
           "An ospfRxBadPacket trap signifies that an OSPF
           packet has been received on a virtual interface
           that cannot be parsed."
    ::= { ospfTraps 9 }


    ospfTxRetransmit NOTIFICATION-TYPE
        OBJECTS {
                    ospfRouterId, -- The originator of the trap
                    ospfIfIpAddress,
                    ospfAddressLessIf,
                    ospfNbrRtrId, -- Destination
                    ospfPacketType,
                    ospfLsdbType,
                    ospfLsdbLsid,
                    ospfLsdbRouterId
                  }
        STATUS              current
        DESCRIPTION
           "An ospfTxRetransmit  trap  signifies  than  an
           OSPF  packet  has  been retransmitted on a non-
           virtual interface.  All packets that may be re-
           transmitted  are associated with an LSDB entry.
           The LS type, LS ID, and Router ID are  used  to
           identify the LSDB entry."
    ::= { ospfTraps 10 }


    ospfVirtIfTxRetransmit NOTIFICATION-TYPE
        OBJECTS {
                    ospfRouterId, -- The originator of the trap
                    ospfVirtIfAreaId,
                    ospfVirtIfNeighbor,
                    ospfPacketType,
                    ospfLsdbType,
                    ospfLsdbLsid,
                    ospfLsdbRouterId
                  }
        STATUS              current
```

        DESCRIPTION
            "An ospfTxRetransmit trap signifies than an
            OSPF packet has been retransmitted on a virtual
            interface. All packets that may be retransmit-
            ted are associated with an LSDB entry. The LS
            type, LS ID, and Router ID are used to identify
            the LSDB entry."
    ::= { ospfTraps 11 }

    ospfOriginateLsa NOTIFICATION-TYPE
        OBJECTS {
                    ospfRouterId, -- The originator of the trap
                    ospfLsdbAreaId, -- 0.0.0.0 for AS Externals
                    ospfLsdbType,
                    ospfLsdbLsid,
                    ospfLsdbRouterId
                 }
        STATUS   current
        DESCRIPTION
            "An ospfOriginateLsa trap signifies that a new
            LSA has been originated by this router. This
            trap should not be invoked for simple refreshes
            of LSAs (which happesn every 30 minutes), but
            instead will only be invoked when an LSA is
            (re)originated due to a topology change. Addi-
            tionally, this trap does not include LSAs that
            are being flushed because they have reached
            MaxAge."
    ::= { ospfTraps 12 }

    ospfMaxAgeLsa NOTIFICATION-TYPE
        OBJECTS {
                    ospfRouterId, -- The originator of the trap
                    ospfLsdbAreaId, -- 0.0.0.0 for AS Externals
                    ospfLsdbType,
                    ospfLsdbLsid,
                    ospfLsdbRouterId
                 }
        STATUS   current
        DESCRIPTION
            "An ospfMaxAgeLsa trap signifies that one of
            the LSA in the router's link-state database has
            aged to MaxAge."
    ::= { ospfTraps 13 }

```
    ospfLsdbOverflow NOTIFICATION-TYPE
        OBJECTS {
                    ospfRouterId, -- The originator of the trap
                    ospfExtLsdbLimit
                 }
        STATUS              current
        DESCRIPTION
          "An ospfLsdbOverflow trap  signifies  that  the
          number of LSAs in the router's link-state data-
          base has exceeded ospfExtLsdbLimit."
   ::= { ospfTraps 14 }


    ospfLsdbApproachingOverflow NOTIFICATION-TYPE
        OBJECTS {
                    ospfRouterId, -- The originator of the trap
                    ospfExtLsdbLimit
                 }
        STATUS              current
        DESCRIPTION
          "An ospfLsdbApproachingOverflow trap  signifies
          that  the  number of LSAs in the router's link-
          state database has exceeded ninety  percent  of
          ospfExtLsdbLimit."
   ::= { ospfTraps 15 }


-- conformance information

ospfTrapConformance OBJECT IDENTIFIER ::= { ospfTrap 3 }

ospfTrapGroups      OBJECT IDENTIFIER ::= { ospfTrapConformance 1 }
ospfTrapCompliances OBJECT IDENTIFIER ::= { ospfTrapConformance 2 }

-- compliance statements

    ospfTrapCompliance MODULE-COMPLIANCE
        STATUS  current
        DESCRIPTION
          "The compliance statement "
      MODULE  -- this module
      MANDATORY-GROUPS { ospfTrapControlGroup }


        GROUP        ospfTrapControlGroup
        DESCRIPTION
          "This group is optional but recommended for all
          OSPF systems"
```

```
        ::= { ospfTrapCompliances 1 }


-- units of conformance

   ospfTrapControlGroup     OBJECT-GROUP
      OBJECTS {
                         ospfSetTrap,
                         ospfConfigErrorType,
                         ospfPacketType,
                         ospfPacketSrc
      }
      STATUS   current
      DESCRIPTION
         "These objects are required  to  control  traps
         from OSPF systems."
      ::= { ospfTrapGroups 1 }


END
```

6. Acknowledgements

This document was produced by the OSPF Working Group.

7. References

[1] Cerf, V., "IAB Recommendations for the Development of Internet
    Network Management Standards", RFC 1052, NRI, April 1988.

[2] Cerf, V., "Report of the Second Ad Hoc Network Management Review
    Group", RFC 1109, NRI, August 1989.

[3] Rose M., and K. McCloghrie, "Structure and Identification of
    Management Information for TCP/IP-based internets", STD 16, RFC
    1155, Performance Systems International, Hughes LAN Systems, May
    1990.

[4] McCloghrie K., and M. Rose, "Management Information Base for
    Network Management of TCP/IP-based internets", RFC 1156, Hughes
    LAN Systems, Performance Systems International, May 1990.

[5] Case, J., Fedor, M., Schoffstall, M., and J. Davin, "Simple
    Network Management Protocol", STD 15, RFC 1157, SNMP Research,
    Performance Systems International, Performance Systems
    International, MIT Laboratory for Computer Science, May 1990.

   [6] Rose M., Editor, "Management Information Base for Network
        Management of TCP/IP-based internets: MIB-II", STD 17, RFC 1213,
        Performance Systems International, March 1991.

   [7] Information processing systems - Open Systems Interconnection -
        Specification of Abstract Syntax Notation One (ASN.1),
        International Organization for Standardization, International
        Standard 8824, December 1987.

   [8] Information processing systems - Open Systems Interconnection -
        Specification of Basic Encoding Rules for Abstract Notation One
        (ASN.1), International Organization for Standardization,
        International Standard 8825, December 1987.

   [9] Rose, M., and K. McCloghrie, Editors, "Concise MIB Definitions",
        STD 16, RFC 1212, Performance Systems International, Hughes LAN
        Systems, March 1991.

  [10] Rose, M., Editor, "A Convention for Defining Traps for use with
        the SNMP", RFC 1215, Performance Systems International, March
        1991.

  [11] Steinberg, L., "Techniques for Managing Asynchronously Generated
        Alerts", RFC 1224, IBM Corporation, May 1991.

  [12] Moy, J., "Multicast Extensions to OSPF", RFC 1584, Proteon, Inc.,
        September 1993.

8. Security Considerations

    Security issues are not discussed in this memo.

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