Network Working Group
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Internet Draft
Communications
Expiration Date: January 2000
June 1999

Techniques in OSPF-based Network
Deployment
<center>draft-ietf-ospf-deploy-00.txt</center>

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1.
Abstract

OSPF is the preferred interior routing protocol of the Internet.
It is a complex protocol intended to deal with complex networks. While it
is a powerful mechanism, it does not handle all situations, and
its appropriate use may not be obvious to beginners. Standards track
documents deal with protocol design, but deployment of OSPF in many
enterprise networks has been limited by lack of information on best current
practice information for interior routing. Best Current Practices
documents have focused on general exterior connectivity. This memorandum is
intended to complement the protocol specification by describing the
experience-based, vendor-independent techniques of OSPF and complementary
technologies in representative networks. Better understanding of the use
of OSPF features to help exterior connectivity will help reduce the demand
for complex user BGP configuration.

2. Introduction

RFC1812, Requirements for IPv4 Routers, says "a router that implements any routing protocol (other than static   routes) MUST IMPLEMENT OSPF... A router MAY implement additional IGPs."   This is a well-crafted statement, as it recognizes that static may be a useful complement to OSPF. All too often, network operators work from the limiting belief that if they use OSPF, it must run everywhere in their networks. They see the two-level hierarchy suggested by an Area 0 and a subordinate set of nonzero areas, and assume that networks using OSPF must be strictly hierarchical with only two hierarchical levels.

3. Barriers to Understanding OSPF Deployment

Some terminology used in OSPF documents may not match more recent usage, or may be confusing to a reader encountering them the first time. OSPF, for example, uses the term "autonomous system" differently than the most recent BGP-oriented usage. OSPF's usage is discussed below.

In addition, the first-time reader should be careful to understand OSPF's use of the concept of external routes. Another point is not to confuse the hierarchy in a specific OSPF domain with the overall hierarchy of the enterprise in which it is used; you are not limited to the two apparent levels of OSPF, backbone versus non-backbone.

3.1 OSPF and Autonomous Systems

OSPF specifications assume an enterprise's set of networks equate to an
autonomous system. These specifications use the term autonomous system
in a manner inconsistent with the current usage, which speaks of an AS
in terms of exterior routing. RFC1930 defines an AS as a set of
routers, under one or more administrations, that presents a common
routing policy to the global Internet.

It is useful to define an
OSPF domain as an Area 0 and some number of
nonzero areas. In the broader
sense, a routing domain is a set of
routers, with a common set of routing
mechanisms and routing policies,
under a single administration.

A general
observation: OSPF has a terminology problem here. "Inter-zone"
communication is the role of what OSPF calls a "Autonomous System Border

Router," but the "zones" don't need, in reality, to be distinct
AS. A term
from the routing literature that probably is more recognized
than "AS" or
"zone" is "routing domain."

OSPF has a built-in mechanism for connecting
different domains, the
ASBR. ASBRs interconnect routing domains. Any
OSPF router
that advertises external routes is an ASBR. Examples
include:

   1. An OSPF process that accepts routes from another separate

OSPF process:

   2. An OSPF process that accepts routes from another
dynamic interior
        routing process:

        Another option is to have
static routes going to an
        enterprise core network
        from each
OSPF Area 0, such that the Area 0's advertise the default
        route into
their subordinate areas, but the ASBR containing the
        static route
advertises the default into Area 0.

   3. An OSPF process that accepts
static routes and advertises the
        default.

   4. An OSPF process
that accepts routes from a BGP exterior routing
        process and
advertises them into OSPF. Details of this are
        not shown, because
configurations involving redistribution to
        and from OSPF usually
involve fairly complex filtering and other
        mechanisms to avoid loops
and injections of huge numbers of
        routes.

3.2 **Thinking about**
Externals

The path determination workload of an OSPF area is influenced

most
strongly by the number of network, summary, and external LSAs
involved
in the routing computation. The various stub area schemes, stub,
not-
so-stubby, and the vendor-specific totally stubby, all help when a
large
number of externals would be injected into an area.

In medicine,
there is a classic piece of advice from a physician to a
patient who
complains that some odd movement of his arm hurts: if that
hurts, don't do
it. If the nature of a routing environment is such that
large numbers of
externals do not exist, then there is no benefit to
exploring stub area
techniques to control the propagation of externals.

Most beginners tend to
think of floods of externals into OSPF due
primarily to Internet
connectivity. They imagine nearly 50,000 routes of
a current Internet
default-free routing table overwhelming their
routers. In practice, it
would be extremely unlikely to find any
significant benefit would come from
injecting such a table into the OSPF
routing system. In most cases, no
more than a default route needs to
injected to achieve connectivity. Even
if preferential exits for
certain exterior destinations are desired, that
is more likely to be an
Interior BGP problem than an OSPF one.

In
practice, a major source of external routes can come from one's
own
enterprise, as part of a migration from RIP or IGRP, or
from
static/default routes used to connect edge routers to the main
routing
system. Another way to think of this is that large numbers of
external
routes can come from other routing domains in your own
organization.

If the intra-organizational external routes are injected

into OSPF
through ASBRs connected to Area 0, stub techniques may be
effective in
controlling the number of externals that impose workload on
nonzero
areas. Even in this case, do summarize the externals as much
as
possible.

More challenging situations arise when the
intra-organizational routes
come in at the edge of a nonzero area.
Assume, for example, that an
organization has a large number of small
offices, each with a single
frame relay PVC that carries its traffic to the
next level of the
corporate routing hierarchy. Each of the small edge
routers needs a
default route toward the next level.

The next level,
however, is composed of OSPF-speaking routers. Even though
they are in a
nonzero area, they are still ASBRs. Since these routers will
not speak OSPF
to the edge routers, these second-level routers will need to
have static
routes that point to these edge subnets, and then the static
routing
information needs to be advertised as external routes into OSPF.
Remember
that these externals can be summarized on the ASBR.

3.3 Hierarchy and
OSPF

It should never be forgotten there are two ways to achieve hierarchy
and
aggregation: address summarization, and physical topology. Many
newcomers
to OSPF think only of the first, since OSPF summarizes on ABRs
and ASBRs.
This leads to an incorrect assumption that OSPF has at best
three levels of
hierarchy:

     1. Intra-area
     2. Inter-area
     3.
External

It is true that reduction in routing information and consequent reduction
of the routing computation workload only can come at these levels. But
there are other benefits of hierarchy, such as minimizing hop count,
simplifying debugging as opposed to complex meshes, etc.

Inside a
nonzero area, it is perfectly reasonable to have a hierarchy of internal
routers, leading up to area border routers at the apex of the area
hierarchy. Several small OSPF speakers at "branch offices" might single-
or dual home to "district level" interior routers. Groups of district
routers might in turn single or dual home to regional routers, and groups
of regional routers might single or dual home to area border routers.

Hierarchy can begin anew inside area 0. ABRs can be concentrated
topologically by homing to backbone routers, and the backbone routers may
in turn home on ASBRs.

A higher-level, non-OSPF core network
may usefully link the top
hierarchical ASBRs of multiple OSPF routing
domains. Such a core network
could be statically routed or use BGP.

3.4
Virtual Links

A virtual link is a tunnel that has at least one end in Area
0. **Virtual**
Links (VL) are a mechanism that can be used within OSPF to handle
certain connectivity patterns. The standard is a bit "soft" on their
applications, and support engineers have seen a variety of VL
applications. For some of the problems being raised, it appears better
OSPF solutions may exist.

A matter of particular interest is the

potential advantages of NSSAs
over some of the VL solutions to bringing in
a new "community of
interest." See the discussion below of VL
applicability in other than
backbone robustness.

The perception of virtual
links' untility seems to be as a means of
accomodating specical
connectivity requirements "inside" a single "OSPF
domain," the latter
defined as a set of an Area 0 and some number of
nonzero areas.

In some of
these requirements, virtual links may be completely
appropriate, one of
several potential solutions, or definitiely not an
appropriate
solution.

Some designers may use virtual links to avoid other mechanisms
that they
do not like, such as defining the enterprise's network with
multiple
interconnected OSPF domains.

Virtual links are not necessarily
the appropriate solution, but cases
have been seen where they are used
for:

    --- Protecting against Area 0 partitioning
    --- Making one
area 0 following the merger of two enterprises,
         both of which ran
independent OSPF
    --- Providing connectivity to a newly acquired
enterprise
         whose best connectivity is to a router in a nonzero
area
         of the acquiring enterprise

[4](#). Area Sizing and Numbering
Strategies

[4.1](#) Communities of Interest

Select a set of clients and
servers that primarily speak to one another.

Is the number of routers
required, after growth projections have been
applied, less than the
vendor-recommended limit?

Let's review basic OSPF, emphasizing points that
can help establish
hierarchies of more than two levels.   Let's also review
some sizing
considerations for areas, bearing in mind
that this can be as
much art and science. Experienced routing designers
know they won't always
hit the correct area structure, and expect to
have to monitor and tune the
design of a large OSPF system. Especially
experienced routing designers
know this tuning will primarily involve
topology and bandwidth, rather than
"knob twisting" for timers and
buffers.

The guideline about limiting the
number of nonzero areas in an ABR, in
practice, means that large numbers of
areas within a single OSPF system
tend to require large and expensive
numbers of ABRs. This is especially
true attempting to avoid a single point
of failure -- a single ABR --
per area.

Many factors go into choosing the
number of OSPF speakers inside an
area. A few conservative guidelines for
these and other sizing
considerations:

   1. Begin setting up area
definitions based on communities of interest.
It is highly desirable if the
majority of traffic can stay intra-area.

   2. Do not exceed your vendor
guidelines on routers per nonzero area.
Counts from 50 to 200 routes are
often cited, although much larger numbers
have worked in specific
environments. Use the lower numbers when media
tend to "bounce" up and
down. As we will see below, this doesn't preclude

a large number of
routers in what can be considered an area, because the
"stub" routers need
not speak OSPF.
        This is conservative, and many vendor
implementations have wored
well with larger numbers of OSPF speakers per
area. The specific limit will
vary with the OSPF software implementation,
the processing power of the
router platform, and the size and stability of
the topological database.
        If areas defined on community of interest
contain too many routers
under rule #2, consider splitting the area. Look
for geographic/provider
natural boundaries for splitting.

   3.   Think
carefully about the relationships you want between the
backbone and each
non-backbone area. Some small OSPF environments put
everything into Area
[0]. **This can be reasonable if the only reasons for**
using OSPF are fast
convergence and flexible addressing among a small set
of routers. The
power of OSPF is only fully realized with multiple areas.

   4.   Area 0 is
intended as a transit area. Capacity planning and
troubleshooting tend to
be easiest when there are no application servers in
area 0. Given the
connectivity of area 0, it may be reasonable to place
network management or
DNS servers there.
        If the application topology is hierarchical, as
might be found where
a mainframes or server farms provides most application
services, still use
caution in putting this server in area 0. Mainframes
or server farms often
have local inter-server communications, such as
backup, that should be kept
out of area 0. It may be wise to put the
central servers in a small area
of their own.

   5.   Several techniques
exist for setting up areas and controlling

advertisements in and out of
them.   You don't need to use the same
techniques in every nonzero area.
Remember that you don't use these
simply to reduce the amount of routing
traffic, but also for stability.
Stability increases as the number of
routing table recomputations
decreases.

Summarization and the various
kinds of stub areas reduce routing table
recomputation by hiding specific
routes. In other words, an
interior router in Area 1, doesn't need to
recompute the Area 1
routing table if a link goes up or down in Area 0.
Media, especially,
have a habit of bouncing up and down; hiding links
outside my area
reduces "route flapping" leading to recomputation.

An Area
Border Router between Area 1 and Area 0 probably needs
to know if a link
in Area 0 changes state, but it doesn't need to
know if a link in Area 51
changes state. The exception to this case is
where finding the absolutely
optimal path from Area 1 to Area 0 to Area 51
is more important than
stability. This might be the case in some
international networks with
low-bandwidth links.

The reason to use the less general types of areas is
they allow reducing
the amount of routing information advertised from the
backbone into
nonzero areas.

Inside a given area, be it backbone or
non-backbone, there can be a
hierarchy among OSPF speakers. For example,
it is perfectly reasonable
to reduce the peering in the backbone by
connecting the Area 0 side of
ABRs to "collapsed backbone" router(s).   In
large
networks, it can avoid problems due to excessive numbers of neighbors
to

any given Area 0 router.

Numbering

There is a widespread
misperception that areas will only work with a single
contiguous address
range. Even a small amount of summarization, however,
will considerably
increase the stability of OSPF systems because it hides
route flap.

A
common recommendation, assuming that a single contiguous block, such as
an
/18 prefix is given to the enterprise, is to "bit split" the prefix
such
that the first high-order bits below the global prefix identifies the
area.
For a routing domain with four nonzero areas, this would allocate a
/20
prefix to each area:

     /20 starting 00xxxx...   area 1

starting 01xxxx...   area 2
         starting 10xxxx...   area 3

starting 11xxxx...   area 4

This approach seems straightforward, but
suffers from several limitations.

First, what about area 0? No space has
been left for it. In any case, it
is likely that a /20 assigned to area 0
would waste a great deal of space,
since area 0 should have a small number
of router interfaces in it.

One technique when using the bit-split method,
and assuming registered
addresses are used in the nonzero areas, is to use
RFC1918 private address
space for area 0. This can be quite reasonable,
because there are few
legitimate reasons why an arbitrary external Internet
host would need to
access a backbone interface internal to an enterprise
network. One
possible criticism of this approach is that traceroutes that

traversed the
backbone might show the private address space, but it is
usually apparent
when this is happening. Another reason why area 0
interfaces might need
registered addresses is that the management of the
network is outsourced.
In outsourcing situations, the service provider
commonly can assign some of
its allocated address space for interfaces it
will manage,

Another and more general approach is to bit-split to a level
deeper than
the number of areas. In the example above, there were 4 nonzero
areas, and
[4] /20 blocks. **The /20 comes from it being the first power of two**
that can
contain 4 areas.

Consider, however, going 2 or 3 powers of two
deeper. Divide the available
address space into 8, 16, or 32 blocks. These,
respectively, would be /21,
/22, or /23 address prefixes.

One of these
blocks can be assigned to Area 0. It is a reality that the
number of users
in individual areas will vary, so area 1 might, for
example, need three /21
blocks, area 2 might need two such blocks, area 1
might need one. Several
blocks can be reserved for growth as needed.

These blocks can still be
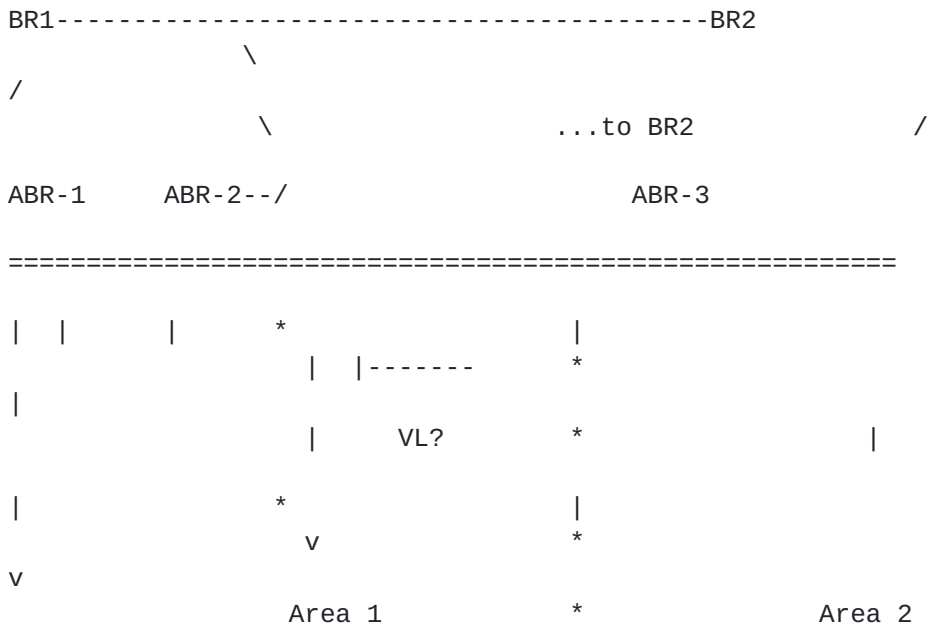summarized to avoid route flap.

[5]. **Increasing Backbone Reliability**

A
failure in Area 0 is critical.

A single Area 0 has a single point of
failure. Hopefully, the ASCII
graphic shows this. Area 0 has two
interconnected Border Routers, BR1
and BR2. To avoid single router points
of failure, there are two ABRs,
each with three interfaces: Area 0, Area
1, and Area 2.

If the BR1-BR2 link fails, a VL can be
defined between the Area 1
interface of ABR-1 and between the Area 1
interface of ABR-2. This
reconstitutes backbone connectivity with a tunnel
through Area 1.

```
BR1------------------------------------------BR2
               \
/
               \                    ...to BR2              /

ABR-1     ABR-2--/                          ABR-3

========================================================

| |      |       *                 |
              |   |-------       *
|
              |     VL?          *                 |

|              *                  |
                *                *
v
                v
                  Area 1            *              Area 2
```

5.2
Alternative using Adding Circuit(s)

The preferred way to solve this
problem is adding a parallel link
between BR1 and BR2.   Especially if
these links can be per-packet load
balanced, convergence would be extremely
fast.

This solution, however, incurs additional cost for the
additional
circuit. Balanced against this cost is the performance impact
the VL
would have on the routers and links in the nonzero area through
which
the VL is tunneled. Those routers and links may have been engineered
for
the traffic estimates and performance goals under the workload of
that
single area, not of that area with backbone traffic added to it.

5.3

Alternative using non-OSPF network

An alternative approach, especially
useful if demand OSPF is not
available, is to split Area 0 and create two
OSPF domains. Each domain
has a static route that points to the address
range in the other domain.
This route is advertised into the local domain
as a Type 1 external.

[6](). Backbones of Backbones

The method described in
[5.3]() **above can be generalized to give more**
effective levels of hierarchy in
an overall network that uses OSPF for
its dynamic routing.

True, OSPF's
area structure has two levels, Area 0 and everything else.
A routing
architecture for an enterprise that uses OSPF, however, can be
more than a
simple hierarchy of backbone and non-backbone areas. We can
extend its
notion of hierarchy both above Area 0 and below the nonzero
areas. Even
inside an area, there are some forms of hierarchy.

Such an architecture
also lends itself to evolution to a high-performance
layer 2 or Multiprotocol Label Switching (MPLS) service in
the core. It can
also be reasonable to have interior routers that
"concentrate" traffic, or
act as collapsed backbones within an area.

It is also perfectly reasonable
to have a broader OSPF routing
environment, in which some routers do not
speak OSPF but cooperate with
those that do. At the "high" end, this
involves redistribution of
external routes into OSPF. At the "low" end,
this involves static and
default routes from stub routers to the lowest
level of OSPF router
inside a nonzero area. Let's talk about the lowest
level first.

The lowest level is a "stub" or "edge" router with a single
outgoing
path, such as a branch office router with several LAN links,
perhaps a
STUN serial interface for IBM support, and a single WAN link.
There are
no routers on any of the LANs.

Such a router really doesn't need
to run any dynamic routing protocol.
It should default to a higher-level
router.

Assuming the higher-level router has multiple links going toward
the
backbone, that router does need to run OSPF. It doesn't need to
connect
directly to the backbone.

[7]. Transition and Network
Consolidation

A management imperative that often occurs after the merger
of two
enterprises is eliminating the "expense of duplicate backbones." At
a
slighly more technical level, this means an OSPF design that has a
single
Area 0.

Among many OSPF users, it is a matter of faith and morals that there
entire
enterprise appear as a single OSPF domain. As a consequence,
I've seen
designs with a single area 0 spanning serveral continents,
with each
continent having significantly different line quality and
speed, needs for
demand backup circuits between parts of the area, etc.

Two companies, A,
and B, merge. Each has an existing OSPF system, with
its own area 0.
These Area 0s are widely separated geographically, but
they each have an
Area 1 whose boundaries are in fairly close proximity.
Each ABR has a
single interface to Area 0.

In designing solutions, engineers should consider not only pure OSPF
mechanisms, but the use of non-OSPF tunneling mechanisms. OSPF virtual

links are, of course, appropriate for some topologies.

Also, consider having separate OSPF domains linked into a "backbone of
backbones," using static or BGP routing among the domains.

7.1 Non-OSPF tunneling

Generic Route Encapsulation (GRE) can solve numerous OSPF topology
problems, both in backbone area 0.0.0.0 and in non-backbone areas. GRE is
appropriate
when the underlying transmission infrastructure is considered adequately
secure. If, however, the traffic needs to cross the untrusted global
Internet,
IPsec tunnel mode [RFC2401] may be more appropriate.

Let's say that the
two companies merge, and want to put their Western Region into the same area
because the geographic divisions will share a good deal of information that
does not need to cross the backbone.

Both areas, of course, could be connected separately to area 0.0.0.0. There
might not be sufficient backbone bandwidth to carry the combined Western
Region traffic.

If there were a management directive to merge these areas immediately, and
dedicated WAN circuits between them were not immediately available, an
alternative could be to tunnel between them. The next design issue would
be deciding if the tunnels need to be secure. Tunneling, of course, will
add overhead bytes to every routed packet, and will also impose additional
processing workload on the routers at the endpoints of the tunnel.

In spite of the overhead it produces, tunneling may still be a good
interim step to achieving desired connectivity during network redesign.
OSPF has its own tunneling mechanism for routing information, the virtual
link, which is appropriate for other topological problems.

7.2 Solution using VLs

The two companies perceive they want "a single
backbone". They do not
wish to renumber every network and router, but are
willing to merge two
nonzero areas if that were helpful. They are also
unwilling, at the
present time, to merge their two backbones, principally
due to the
geographic distance between them.

They merge their Area 1's,
renumbering appropriately adding physical
connectivity between the company
A area 1 and the company B area 1. They

now have a common Area 1, and then
define a VL between the two ABRs.

There is now a "single backbone."
Potentially, a large amount of
inter-area traffic now flows through the
combined Area 1. Neither Area
1 presumably was designed to support that
flow, but that of the traffic
of the community of routers for which it
originally was built.

7.3 An Alternate Solution using External Links
between the Area 0's

Do not attempt to create a single Area 0. Rather
than trying to merge
the backbones or the area 1's, define an ASBR function
in each Area 0
that has one or more static (or even BGP) routes to the ASBR
of the
other Area 0, and vice versa. Each ASBR advertises the default, and
may
or may not advertise the external routes to the other Area 0.
Doing
this requires adding one or more links between A-Area 0 and B-Area
0.

This requires no changes to any of the nonzero areas, which still
can
default to their existing Area 0. If tuning or topology changes
are
needed to handle traffic flows, most of this can be done at the
core
tier. Such tuning would involve a smaller set of routers not
directly
connected, in most cases, to end systems.

The core tier now
consists of two Area 0's and a set of links between
them.

7.4 An Alternate
Solution using Two Area 0's

Both companies have OSPF, but topological or
other factors make it
difficult to make a direct connection between Area
0s. In this case,
establish a Company B ASBR that will advertise Company B
routes to

Company A. This ASBR might be on the Company B Area 0, or in another
area. In either case, it advertises routes to the other ASBR, using
multiple static routes or BGP.

The company A ASBR can generate a
default and advertise Company A
addresses to Company B, using appropriate
filtering. If the Company A
ASBR is in a non-zero area, NSSA may be
appropriate.

Company B has OSPF in place. Add an ASBR to its Area 0, with
a static
route to the Area 0 of Company A.

[8](). Transition of Legacy
Routing Protocol Domains to OSPF

[8.1]() Problems of Integrating a Newly
Acquired Enterprise; OSPF not used
by new acquisition

Company A acquires a
smaller Company B. Company B now runs RIP, or
possibly has a limited OSPF
implementation. Company B is not
geographically close to the Area 0 of
Company A.

There are several ways to deal with this situation while
imposing
minimal impact on Company B users.

[8.2]() An OSPF and VL
Solution.

Replace RIP with OSPF on the Company B routers, assigning the
Company B
address space to a new nonzero area. Define a VL from one of the
new
area's routers, tunneled through an existing Company A area,
that
attaches to the backbone at the edge of the Company A
area.

Eventually, provide direct connectivity to Area 0 from the Company
B
area, and delete the VL.

Disadvantages here include an immediate

conversion to OSPF, the cost of
connectivity between the new area and the
existing area that carries the
VL, and the additional traffic load imposed
on the nonzero area with the
Area 0 connection.

8.3 **Run RIP in Company B**
area, with link to Area 0 ASBR that learns RIP

Leave Company B running
RIP. Run a link to a Company A, Area 0 router.
Either redistribute the RIP
routes into Area 0, or simply run RIP on the
ASBR and have it originate the
default into Area 0. If additional
bandwidth or connectivity changes are
needed to handle the Company B
trafic, this primarily can be restricted to
Area 0 where it is not
visible to end users.

The disadvantage here is the
cost of additional circuits from the
Company B area to Area 0. Also, ASBR
default injection into a nonzero
area can create loops if conflicting
defaults are being advertised
elsewhere, as by an ABR.

8.4 **Run RIP in**
Company B area, with an ASBR in the transit nonzero area
of Company
A.

Again Company B runs RIP. It connects to the nearest potential ASBR
in
an established Company A area, and is advertised as an external
route
into that area. This nonzero area then injects the external,
possibly
summarizing it, into Area 0. This method is less flexible in terms
of
advertising defaults than is 5.2, and also has the disadvantage
of
injecting external traffic into an area not originally designed
to
handle it. Since the area with the ASBR can no longer be stubby, it
may
be flooded with significant numbers of Type 5 LSAs from the backbone
and

other areas.

8.5 ASBR Solution with NSSAs

Again Company B runs RIP.
It connects to the nearest potential ASBR in
an established Company A area,
and is advertised as an external route
into that area. This ASBR supports
NSSA, and translates the RIP routes
into Type 7 LSAs, which are sent to
ABRs of this area and translated to
externals in Area 0.

The established
nonzero area maitains its generally stubby quality, and
will not be flooded
by unnecessary Type 5 LSAs.

9. Traffic Management

In the real world,
situations may arise where a client in one area has a
significant traffic
exchange with a server in another area. The volume of
this traffic is such
that a special virtual circuit or dedicated line would
be warranted, but
establishing such a link would violate the OSPF
hierarchy. If routers on
both ends were in different areas, the hello
protocol handshake would fail
and there would be no routing between them.

Again, this is a matter of if
it hurts to do something, don't do it. Most
routers have a mechanism for
preferring one source of routing information
over another. In this case,
establish a static route between the client
and server prefixes.

In the
routers along this path between client and server, give the static
route a
preference factor that makes it more preferable than OSPF. While
the
details will be specific to individual router implementations, it
is
usually quite practical to establish OSPF routing, through area 0, as
a

backup to the preferred static path.

10. Multiple Exit
Points/Multihoming

Use the power of OSPF's two types of externals when
defining your policy
for Internet connectivity.   Many enterprise designers
assume, incorrectly,
they must run BGP to deal properly with connection to
multiple Points of
Presence (POP) of the same ISP, or to multiple ISPs when
a
primary/secondary policy is desired. See [Multihome] for a discussion
of
multihoming.

11. Security Considerations

Another potentially confusing area is OSPF's use of authentication. Do not
confuse OSPF authentication mechanisms with security mechanisms for user
traffic. The purpose of the OSPF authentication mechanism is to protect the
OSPF system itself from denial of service attacks.

Cleartext authentication is useful when combining different OSPF domains.
By putting a password on the new or merged domain, you get some protection
against configuration errors. An old router, not configured with the
password, will not have its routing advertisements accepted by the new.
Cleartext passwords are a simple method to confirm all routers in the
routing domain have been examined by an administrator with the new design
in mind.

Cryptographic authentication protects an OSPF domain against malicious
attacks, typically launched from inside the OSPF domain. Such protection
might, for example, be useful in a university network.

12. Acknowledgments

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