

Using IS-IS in place of OSPF

As an alternative to using OSPF, IS-IS can be used as the IGP for each AS. IS-IS is very similar to OSPF in both configuration and operation. In IS-IS, a router is called an Intermediate System (IS). Like OSPF, IS-IS elects a Designated Intermediate System (Designated Router in OSPF) which forms an adjacency with each neighboring router (Intermediate System) on the segment. Each IS-IS router sends a single Link State Protocol-data-unit (LSP) to advertise all the networks that are attached to it. This is very similar to OSPF's Link State Advertisements but more efficient since only one LSP is sent per router. IS-IS also supports multiple areas using a two level hierarchy. Unlike OSPF, IS-IS was not originally designed for IP and uses the OSI network layer protocol CLNS as the basis for communication between routers.

To communicate using OSI CLNS, each IS-IS router must be given a Network Entity Title (NET), which serves as the router's OSI address. The NET address is an 8 to 20 byte hexadecimal number separated at key places by dots. The OSI standard permits the length and included parts of the NET to vary but in general it has a format similar to **<Area ID>.<System ID>.<NSEL>**. The exact values of each part are also left up to individual preference but with some conditions.

As the name implies, the area ID identifies the area to which the router belongs. All routers within the same area must have the same area ID. The area ID consists of two hex values separated by a dot, a two digit address class and a four digit area number. The address class identifies the type of address. Although any number will work, the OSI standards designate type 49 as the private address class. The area number can be any number but is easiest if it corresponds to the AS number. We use 49.0001, 49.0002, and 49.0003 as the area IDs for AS1, AS2, and AS3 respectively.

The system ID is 6 byte hex value that uniquely identifies the router within the area. It is formatted as three numbers of four digits each separated by dots, very much like a MAC address. On many production networks, MAC addresses are used as the system ID. Another popular convention is to simply start at 0000.0000.0001 and assign values sequentially. To better relate the NET address to the router's AS and IP address, we use the AS number as the first four digits and the last number in the router's 10.x address for the last number in the system ID. For example, AS2's 10.20.10.4 would have a system ID of 2222.0000.0004.

The final number in the NET, the NSAP Selector (NSEL), is similar in nature to a TCP/UDP port number. The NSEL has no function in routing and must always be set to 00 to signify that the connection is to the router itself and not an upper layer protocol.

Note that since there is no IS-IS connection between areas, it is possible to reuse the same NET addresses within each AS. However, it is best if each router has a globally unique NET since this serves as the router's address in OSI protocols. It is also possible to use the same area number for every router.

As of the time of this writing, IS-IS support in Quagga is in the alpha development stage. None of the binary distributions of Quagga include the isisd server, nor is it enabled in the default build of the source. To install isisd, Quagga must be built with IS-IS support enabled. The primary difference between the standard build and the IS-IS build is the inclusion of the --enable-isisd flag in the configure script options. Specific instructions for building Quagga can be found in the appendix. Once installed, isisd will require the same initial configuration file used for the other Quagga servers. The server can be started with **service isisd start** and configured through **telnet localhost <port>**, where <port> is either isisd or 2608.

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To start the IS-IS routing process and enter IS-IS router config mode, issue the command **router isis <area tag>** in global config mode. Use the name of your AS (AS1, AS2, AS3) as the area tag. The area tag is merely a label for the local IS-IS process and is used when associating interfaces the process.

To assign a NET address to the router, issue the command **net 49.000<x>.<xxxx>.0000.000<y>.00** in router-config mod, where <x> is your AS number and <y> is the last number in your router's 10.<x>.10.<y> address. It is important to be aware that because the lengths and parts of the NET address are variable, the router will not complain if a part is left out or is shorter than it should be. However, it is likely that any unintentional variations in the NET address will prevent the router from communicating with its neighbors. To be notified when a link to a neighbor has been established, enter **log-adjacency-changes** in router-config mode.

When doing multi-area IS-IS, routing information within an area is normally exchanged at Level-1 (L1) and routing information between areas is exchanged at Level-2 (L2). Routers that forward packets between areas operate at both levels and are designated as L1L2 routers. Both Cisco and Quagga IS-IS routers operate as L1L2 routers by default. When all routers are in a single area, it is best to set the router to operate at L2 only by entering **is-type level-2-only** in router-config mode. The following configuration was taken from AS1R1:

```
AS1R1 (config)#
router isis AS1
net 49.0001.1111.0000.0001.00
is-type level-2-only
log-adjacency-changes
```

Unlike other routing protocols, IS-IS does not have a network statement. To include an IP network in the IS-IS process, the **ip router isis <area tag>** command must be used on the interface associated with that network. On the AS routers, only the 10.x.0.0 interface should be included in IS-IS. On the pod routers, both Ethernet interfaces should be in IS-IS. To ensure that only an AS router is elected as the DIS, the pod routers should also have the IS-IS priority set to 0 on the AS network interface. The following examples are from the AS1R2 (Quagga) and Pod1 (Cisco) routers:

```
AS1R2-isisd (config)#
interface eth1
ip router isis AS1
```

```
Pod1router (config)#
interface fa0/0
ip router isis AS1
interface fa0/1
ip router isis AS1
isis priority 0
```

To verify that IS-IS is able to communicate with neighboring routers use **show isis neighbors**. To view the routing information database use **show isis database detail**. If the IS-IS process is making connections to its neighbors but does not appear to be updating its database or the routing table, use **clear isis *** on the Cisco routers to reinitialize IS-IS. The use of the clear isis command is often necessary to remove stale entries in the IS-IS database and trigger updates to the routing table. Note that it is sometimes necessary to simultaneously issue the clear command on all of the Cisco routers and do a **service isisd restart** on the Linux routers to completely reinitialize the IS-IS database.

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Normally, the only remaining step in the IS-IS configuration process is to issue the default-information originate command in router isis config mode. However, the alpha version of isisd that is available at the time of this writing lacks support for propagating a default route back to the AS network. Fortunately, iBGP can be used as a substitute source for the default route. Note that if later versions of isisd include the default-information originate command, be aware that IS-IS only advertises the default route at Level-2. The IS-IS protocol uses the Attached (ATT) bit in advertisements to find the default router at Level-1, but only when using a multi-area configuration.

BGP can propagate default routes from the AS routers by using the network 0.0.0.0 command but that would advertise the default route over BGP to the entire lab network. To prevent that, the default route advertisement should be restricted to the immediate neighbors on the AS network (10.x.0.0). BGP has a per neighbor default-information option to limit the propagation of default routes. Only the two neighboring pod routers on the AS network need to receive the default route. On each AS router, issue the command **neighbor <pod router> default-information** for both of the neighboring pod routers. The following example is from AS1R2:

```
AS1R2-bgpd (config)#  
router bgp 1  
  neighbor 10.10.10.3 default-information  
  neighbor 10.10.10.4 default-information
```

Once two default routes are being propagated to the AS network using iBGP, the pod routers must be configured to load balance between the two paths. By default, BGP will only place one route to a destination in the routing table. To allow both default routes to appear in the table, issue the command **maximum-paths ibgp 2** in BGP router config mode. Since the default routes will be learned via BGP, the only IS-IS route in the pod router's table will be that of the neighboring pod network.

As with the normal OSPF setup, the topology can be tested by shutting down each AS router. The easiest way to simulate a shutdown on the Linux routers is with **network service stop** or by using **ifdown** on each Ethernet interface. However, the current developmental version of Quagga isisd will die without warning when either method is used to shutdown the network interfaces. These methods can still be used but isisd will have to be restarted with **service isisd start**.

To access the Internet from the pod networks, the backbone router must have a route back to each pod. One of the options presented to enable the lab router to learn these routes is to use RIP with suppressed routes. With the RIP method, each AS router redistributes routes from the IGP into RIP. This method will not work with the currently available versions of Quagga because the ripd server does not support redistribution of IS-IS routes into RIP. Either the non-transit BGP or proxy ARP method must be used.