IPv6 Lab - BGP

Configuring iBGP

The next step is to configure iBGP mesh between the four routers in each autonomous system. We'll use a route-reflector set up to handle this, as this is very common practice today, and full mesh iBGP does not scale, as was covered in the presentations.

We will make the core router the route reflector, as is standard practice. The border router will be a client, the access router will be a client, and the peering router will also be a client. Before setting up the iBGP route reflector, we need to consider the following:

- border router connects to transit ISP, so can in theory receive the entire global routing table from the upstream (either as a default route, or as every individual announced prefix).

- peering and access routers connect to customers, private and public peers - the peering router should only hear routes that the peers should be able to receive. A common mistake is for peering routers in service provider backbones to carry the full Internet routing table, resulting in bandwidth hijack, misrouted traffic, and so on. The access router only needs routes local to the AS and the default route - it should never need to carry Internet routes.

Configuring Core Router iBGP

First we set up the core router. We create two peer groups, one for the standard iBGP mesh, the other for use with the access and peering routers. Here is an example:

```
router bgp X0
 bgp deterministic-med
 no bgp default ipv4-unicast
!
 address-family ipv4
  distance bgp 200 200 200
  neighbor ibgp-partial peer-group
  neighbor ibgp-partial description Local Routes only
  neighbor ibgp-partial remote-as X0
  neighbor ibgp-partial update-source loopback0
  neighbor ibgp-partial next-hop-self
  neighbor ibgp-partial send-community
  neighbor ibgp-partial route-reflector-client
  neighbor ibgp-partial filter-list 10 out
  neighbor ibgp-full peer-group
  neighbor ibgp-full description Local Routes only
  neighbor ibgp-full remote-as X0
  neighbor ibgp-full update-source loopback0
  neighbor ibgp-full next-hop-self
  neighbor ibgp-full send-community
  neighbor ibgp-full route-reflector-client
```

```
  neighbor 100.68.X.1 peer-group ibgp-full
  neighbor 100.68.X.1 description iBGP with BX
  neighbor 100.68.X.3 peer-group ibgp-partial
  neighbor 100.68.X.3 description iBGP with PX
  neighbor 100.68.X.4 peer-group ibgp-partial
  neighbor 100.68.X.4 description iBGP with AX
!
 address-family ipv6
  distance bgp 200 200 200
  neighbor ibgp-partialv6 peer-group
  neighbor ibgp-partialv6 remote-as X0
  neighbor ibgp-partialv6 description Local Routes only
  neighbor ibgp-partialv6 update-source Loopback0
  neighbor ibgp-partialv6 send-community
  neighbor ibgp-partialv6 route-reflector-client
  neighbor ibgp-partialv6 next-hop-self
  neighbor ibgp-partialv6 filter-list 10 out
  neighbor ibgp-fullv6 peer-group
  neighbor ibgp-fullv6 remote-as X0
  neighbor ibgp-fullv6 description Local Routes only
  neighbor ibgp-fullv6 update-source Loopback0
  neighbor ibgp-fullv6 send-community
  neighbor ibgp-fullv6 route-reflector-client
  neighbor ibgp-fullv6 next-hop-self
  neighbor 2001:DB8:X::1 peer-group ibgp-fullv6
  neighbor 2001:DB8:X::1 description iBGP with BX
  neighbor 2001:DB8:X::3 peer-group ibgp-partialv6
  neighbor 2001:DB8:X::3 description iBGP with PX
  neighbor 2001:DB8:X::4 peer-group ibgp-partialv6
  neighbor 2001:DB8:X::4 description iBGP with AX
!
ip as-path access-list 10 permit ^$
```

Notice how we have set up one peer-group called ibgp-partial for use with the access and peering routers - its only difference from the peer-group called ibgp-full is that it has one additional line only permit prefixes originated by the local AS to go to that router. So if the upstream provider sends a default route, or any prefixes from the global BGP table, they will now not make their way to the peering router. While we have used an AS-path filter here, we could also use BGP communities (much more scalable!).

Originating Prefixes

We will now originate our prefixes into iBGP. We will only do this on the core router (common practice is to originate prefixes on the core routers in a network operator's backbone, never on the peering or border routers). So, returning to the core router, we now add in network statements to cover our IPv4 and IPv6 address blocks. Here is an example:

```
router bgp X0
 address-family ipv4
  network 100.68.X.0 mask 255.255.255.0
```

```
 address-family ipv6
  network 2001:DB8:X::/48
!
ip route 100.68.X.0 255.255.255.0 Null0
ipv6 route 2001:DB8:X::/48 Null0
```

Don’t forget the pull up routes for the aggregate - the network statement in Cisco IOS only tells BGP to put that address block into BGP if the match block is in the global RIB - and the simplest way to install it in the global RIB is to set up a static route pointing to the Null0 interface.

Configuring Access and Peering Router iBGP

We now turn to the access and peering routers, and will configure iBGP on those as well. We’ll follow the same ideas as we used for the Core router, only the access and peering routers are route reflector clients. Here is a configuration example for either the access or peering routers:

```
router bgp X0
 bgp deterministic-med
 no bgp default ipv4-unicast
!
 address-family ipv4
  distance bgp 200 200 200
  neighbor ibgp-rr peer-group
  neighbor ibgp-rr description iBGP with RR
  neighbor ibgp-rr remote-as X0
  neighbor ibgp-rr update-source loopback0
  neighbor ibgp-rr next-hop-self
  neighbor ibgp-rr send-community
  neighbor 100.68.X.2 peer-group ibgp-rr
  neighbor 100.68.X.2 description iBGP with CX
!
 address-family ipv6
 < do the same for IPv6 >
!
```

Configuring Border Router iBGP

We now turn to the border router, and will configure iBGP on that as well. We’ll follow the same ideas as we used for the Core router, only the Border router is a route reflector client. Here is a configuration example:

```
router bgp X0
 bgp deterministic-med
 no bgp default ipv4-unicast
!
 address-family ipv4
  distance bgp 200 200 200
  neighbor ibgp-rr peer-group
```

```
  neighbor ibgp-rr description iBGP with RR
  neighbor ibgp-rr remote-as X0
  neighbor ibgp-rr update-source loopback0
  neighbor ibgp-rr next-hop-self
  neighbor ibgp-rr send-community
  neighbor 100.68.X.2 peer-group ibgp-rr
  neighbor 100.68.X.2 description iBGP with CX
!
 address-family ipv6
 < do the same for IPv6 >
!
```

Notice that the peer-group is identical to the one used on the Peering Router.

Improving Routing Security

There are a few things we need to tidy up here before we continue with the lab.

Peering Router

The peering router is just that, a router that peers with other network operators. It does not provide any transit. The peers should only see the routes that you want them to see. We've made sure of this by putting in a route filter on the core router so that the peering router can only see locally originated routes. But it is also a good idea to null route the default route, as we will soon be distributing a default route around the AS using IS-IS. So on the peering router we now do:

```
ip route 0.0.0.0 0.0.0.0 null0
ipv6 route ::/0 null0
```

Now if any of the IXP participants point a default route to the local network, the traffic will simply be dumped in the Null interface of the peering router. Only traffic for specific destinations which available in the routing table on the IXP router will be forwarded to the rest of the network. This is a very important **network security** requirement.

Border Router

The border router connects to the upstream provider, and therefore gives us access to the whole Internet. The upstream provider will usually send us a default route by eBGP (yet to be set up). Once we hear this default route, how should it be propagated around the autonomous system?

It can be propagated using iBGP, but that tends to be non-optimal, certainly when trying to load balance between two or more transit providers, as the BGP best path is just that. If we distribute the default by the IGP instead, then at least the default route becomes the nearest exit, to the nearest border router. So we will now configure this - for example:

```
router isis asX0
```

```
 default-information originate
!
 address-family ipv6
  default-information originate
!
```

We now should be ready to proceed with the next part of the lab.

Adding a customer route

Consult the address plan and now set up customer routes on the Access Router pointing to the Customer Router. We'll just use one IPv4 and one IPv6 customer per Autonomous System. Take the address assigned for the "End User Space 1"; we will simply point a static route for the customer route to the other end of the point-to-point link to the Customer router. We'll use a /26 for IPv4 and a /52 for IPv6 out of the "End User Space 1" assignments.

Here is an example for the Access router.

```
ip route 100.68.X.64 255.255.255.192 100.68.X.34
ipv6 route 2001:DB8:X:4000::/52 2001:DB8:X:20::1
!
router bgp X0
 address-family ipv4
  network 100.68.X.64 mask 255.255.255.192
 address-family ipv6
  network 2001:DB8:X:4000::/52
!
```

On the Customer router, we need to set up a static default route (IPv4 and IPv6) pointing to the Access router, and we need to create a source anchor point for the address space we have assigned to the customer. The simplest way to do this is to route create a Loopback interface on the Customer router with the IPv4 and IPv6 address blocks in question. Here is an example configuration:

```
interface Loopback0
 description Address anchor for Customer X
 ip address 100.68.X.64 255.255.255.192
 ipv6 address 2001:DB8:X:4000::/52
!
ip route 0.0.0.0 0.0.0.0 100.68.X.33
ipv6 route ::/0 2001:DB8:X:20::
```

Once this has been configured you should then see the customer IPv4 /26 and IPv6 /52 visible in the iBGP for the AS. Check on the Border, Peering and Core routers, and make sure the prefix is visible. Use these commands:

```
show ip bgp
show bgp ipv6 unicast
```

Configuring the link to the Transit Provider

The next step is to set up eBGP with the Transit Provider. The lab instructors will be running the routers for the two Transit Providers and will have already configured them.

Physical Link

Follow the guidelines in the [IP Address Plan](address-plan) document to configure the link to the upstream. Make sure that you can ping the upstream's router using both IPv4 and IPv6 - if it doesn't work, investigate why.

Here is an example configuration for AS60:

```
interface fastethernet 0/0
 description Link to TR2
 ip address 100.122.1.10 255.255.255.252
 ipv6 address 2001:19:0:12::1/127
!
```

IGP

Do not configure any IGP (IS-IS or OSPF) towards the upstream provider! They are not part of your autonomous system.

External BGP

We now configure eBGP with the upstream. Again, the configuration on the two transit routers will have already been completed by the instructors, so once configured, the eBGP session should just come up and work.

Here is a configuration example for AS10:

```
router bgp 10
 address-family ipv4
  neighbor 100.121.1.1 remote-as 121
  neighbor 100.121.1.1 description eBGP with TRANSIT 1
!
 address-family ipv6
  neighbor 2001:18:0:10:: remote-as 121
  neighbor 2001:18:0:10:: description eBGP with TRANSIT 1
!
```

Once this has been configured, you should now see routes coming from the upstream provider, and you should be able to see your aggregate being sent to your upstream. The commands to see what you are receiving are:

```
show ip bgp neigh 100.121.1.1 routes
show bgp ipv6 uni neigh 2001:18:0:10:: routes
```

and to show what you are sending:

```
show ip bgp neigh 100.121.1.1 advertised-routes
show bgp ipv6 uni neigh 2001:18:0:10:: advertised-routes
```

Confirmation

Check on the Core and Peering Router what you now see in the BGP table. Are there differences? Can you explain what they are, and why?

What does:

```
show ip bgp 0.0.0.0 0.0.0.0
show ip route 0.0.0.0 0.0.0.0
show ipv6 route ::/0
show bgp ipv6 uni ::/0
```

show you on the core router and on the peering router?

You will notice that the default route is being propagated by BGP throughout the AS.

- On the core router, it will complain of a **RIB failure** when you look at the BGP table, because OSPF has a default route with a lower protocol distance.

- On the border router, it will complain of a **RIB failure** when you look at the BGP table, because there is a static default route to the Null interface.

While there is nothing wrong with a **RIB failure**, we can just remove the default from being propagated by the iBGP. To do this, we go back to the eBGP session, look for the default, tag it with the *no-advertise* community, and then the border router will no longer announce the default by iBGP.

Here is a configuration example for AS20:

```
ip prefix-list default-route permit 0.0.0.0/0
!
route-map tag-default permit 10
 match ip address prefix-list default-route
 set community no-advertise
!
route-map tag-default permit 20
!
ipv6 prefix-list default-v6route permit ::/0
!
route-map tag-v6default permit 10
 match ipv6 address prefix-list default-v6route
 set community no-advertise
```

```
!
route-map tag-v6default permit 20
!
router bgp 20
 address-family ipv4
  neighbor 100.121.1.5 route-map tag-default in
 address-family ipv6
  neighbor 2001:18:0:11:: route-map tag-v6default in
!
```

To confirm, has the default route now disappeared from the BGP table on the Core and Peering routers? If not, did you remember to do route-refresh after you applied the above configuration?

Testing

Once this has been completed, test the connectivity. Can you reach the other groups in the class? You should be able to ping all the IPv4 and IPv6 loopbacks across the whole classroom.

Can you see the Internet too? The lab has IPv4 connectivity to the Internet - check that this works by trying a few pings or trace routes to well known destinations (e.g. to 8.8.8.8).

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