

Module 3 – iBGP Configuration for Training Lab Network

Objective: All the workshop lab routers are configured with required basic, interface and OSPF/IS-IS configuration according to the topology diagram below. Network level reachability testing for all twelve routers loopback interfaces, all twelve point-to-point links and two transport links are successfully done in our previous modules (Module 1&2). Participants will require to configure iBGP peering and related configuration on this module for both IPv6 and IPv4 protocol. Workshop instructor will be presenting iBGP design goal & specification for this module. Workshop team has already been build and participants have got access to their designated routers.

Prerequisites: Intermediate routing concept (OSPF/IS-IS), Cisco router CLI, Telnet/SSH software etc.

The following will be the common topology and IP address plan used for the labs.

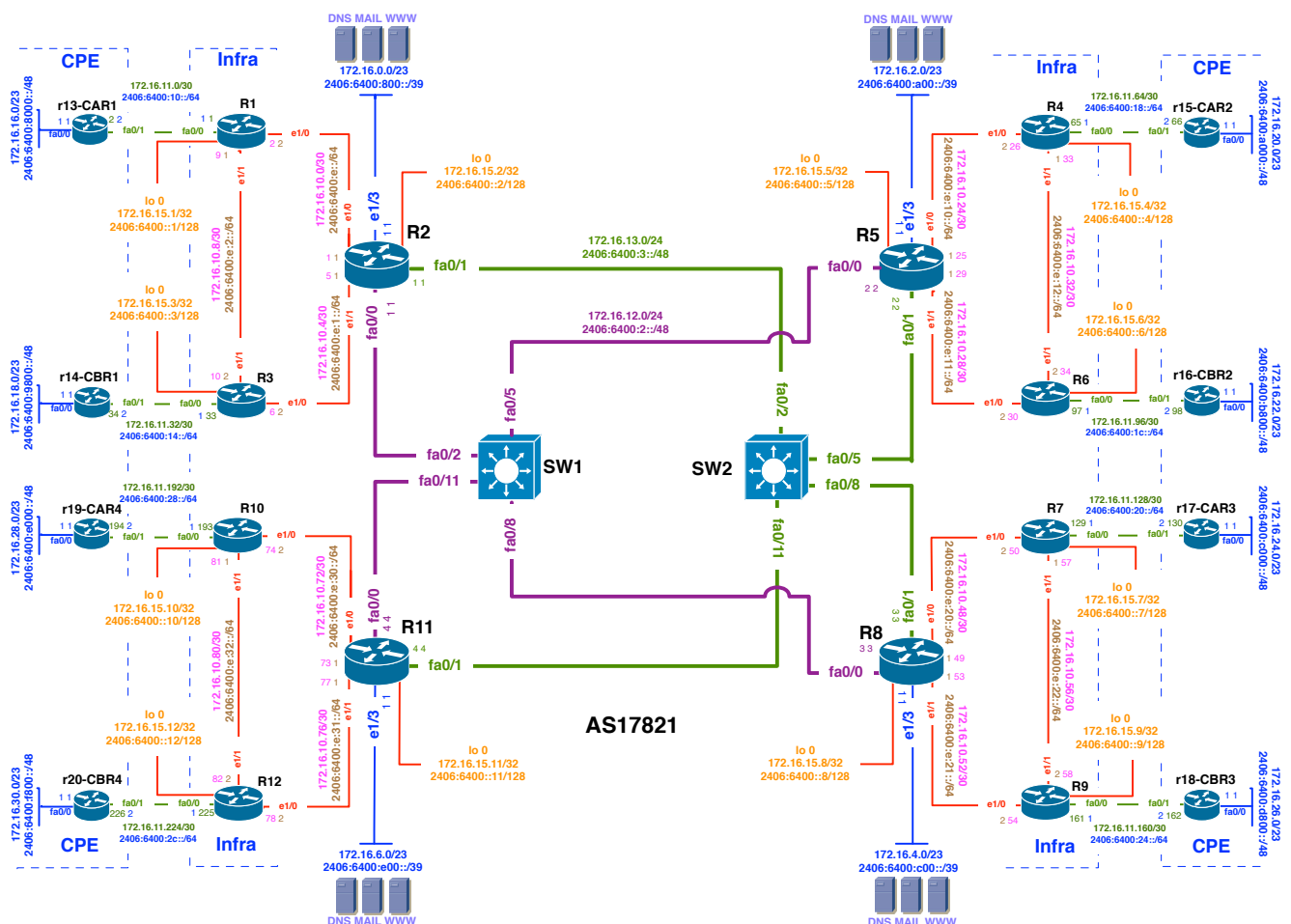


Figure 1 – ISP Lab Topology

Lab Notes

This workshop is intended to be run on a real cisco routers or Dynamips server with the above lab topologies set up. The routers are using both IPv4 and IPv6 supported IOS software. Participants should do their workshop module three configuration to achieve following goals.

1. After finishing the required interfaces and IGP (i.e. OSPF) configuration in module one and two we only can ping those infrastructure prefixes i.e. loopback, point-to-point interfaces and transport link interfaces. At this stage we have an IGP network baseline with 26 prefixes in all twelve infrastructure routers. Our change management system is locked for IGP until we have a new POP, region or prefixes to be added.
2. For the scalability purpose of IGP (i.e. OSPF) for ISP we will not advertise/re-distribute any external prefixes (Customer, Internet, Peering etc) into our IGP. Now the plan is when the external prefixes are collected by the perimeter routers (I.e. POP, Internet gateway or IX Peering) using either static or eBGP peering those will be announced to ISP infrastructure via iBGP. So our IGP is de-coupled from the growth of external prefixes and our network can scale in future. In MPLS network PE-CE routing we can still use any IGP class of protocol and isolation is done from the global routing table by VRF and VPN prefixes. Scalability concern is a separate discussion in MPLS network.
3. For the same purpose of iBGP we will use peer group and Route Reflector (RR). POP routers will only peer with regional core routers or RR to resolve iBGP full mesh peering requirement. As a design principle we could avoid to place RR on the same path of data and control traffic. But for the simplicity of our lab regional core routers will work as RR for each region. We will use peer group to scale our BGP configuration requirement.
4. After finishing iBGP configuration we would like to see following 12 new prefixes are learn by our infrastructure routers using iBGP.

Customer Side P-2-P	Datacentre
R1=> 2406:6400:10::/48	R2=> 2406:6400:800::/48
R3=> 2406:6400:14::/48	R5=> 2406:6400:a00::/48
R4=> 2406:6400:18::/48	R8=> 2406:6400:c00::/48
R6=> 2406:6400:1c::/48	R11=> 2406:6400:e00::/48
R7=> 2406:6400:20::/48	
R9=> 2406:6400:24::/48	
R10=> 2406:6400:28::/48	
R12=> 2406:6400:2c::/48	

5. Due to time restriction in workshop iBGP analysis and example will cover IPv6 prefixes only. You can check IPv4 prefixes for your own understanding purpose.
6. As an example here we have outlined IPv6 related configuration only. Since we are building dual stack routers, please make sure you will finish IPv4 related configuration as well. For relevant command please visit the reference section of this document.
7. After finishing required iBGP configuration our lab infrastructure routers will be ready to add customer on the POP routers and connect to Internet to allow transit for them.

Lab Exercise

1. **iBGP Peering Configuration:** Multi protocol BGP or MP-BGP address family configuration support both IPv6 and IPv4 as a routed protocol. We need to configure different address family related configuration from the corresponding address family mode in BGP.

Example Config on a Router:

```
config t
```

To enter into a cisco router global configuration mode.

```
router bgp 17821
```

Configure BGP routing process with AS number 17821

```
no bgp default ipv4-unicast
```

Cisco IOS assumes that all BGP neighbours will be IPv4 unicast neighbours by default. This command will prepare the router to be multiprotocol and not only to advertise ipv4 unicast address family. Without this command running configuration shows cluttered, confusing and difficult to diagnose and troubleshoot.

```
address-family ipv6
```

Switching to IPv6 address family to execute IPv6 related configuration command.

```
no synchronization
```

BGP synchronization rule is – not installing iBGP routes into the routing table before being synchronized to the IGP. You can disable synchronization if one of the following conditions is true.

- a. Your AS does not pass traffic from one AS to another AS.
- b. All the transit routers in your AS run BGP (valid reason for our lab case).

```
neighbor IPV6-iBGP-REG2 peer-group
```

Using peer group to scale BGP configuration requirement. Please note that regional core routers (Router 2, 5, 8, 11) might need to create one more peer group as IPV6-iBGP-TRCORE

```
neighbor IPV6-iBGP-REG2 remote-as 17821
```

```
neighbor IPV6-iBGP-REG2 update-source loopback 0
```

iBGP peering is configured with loopback address from both side but BGP open message will use outgoing interface as source by default. To resolve this source address mismatch we need to use this command on both side of peering.

```
neighbor 2406:6400::5 peer-group IPV6-iBGP-REG2
```

```
neighbor 2406:6400::5 activate
```

This command will enable the corresponding address family for this Neighbor. It is advisable to use this command in MP-BGP specially if you are using different address family i.e. IPv4, IPv6, VPNv4 etc.

```
neighbor 2406:6400::6 peer-group IPV6-iBGP-REG2
```

```
neighbor 2406:6400::6 activate
```

```
exit
```

```
exit
```

```
exit
```

```
wr
```

- 2. Network Advertisement:** This configuration will originate a prefix in BGP. Our approach will be to originate a legitimate aggregated prefix (i.e. /48) in BGP from all infrastructure routers. So BGP problem debugging and trouble shooting will be easy.

Example Config on a Router:

```
config t
router bgp 17821
address-family ipv6
network 2406:6400:0010:0000::/48
exit
exit
ipv6 route 2406:6400:0010:0000::/48 null 0
```

Since we are using /64 end side prefix on all interfaces of a router and originating /48 atomic aggregation we need this pull-up route. If there is no specific match on this router, traffic will be directed to null 0. Otherwise BGP will not start advertising to make sure routing loop will not occur.

```
exit
wr
```

- 3. Route Reflector (RR) Configuration:** This configuration is only required to the regional core routers i.e. R2, R5, R8 and R11. Because of the iBGP full mesh peering requirement all POP routers will require peering with another regional POP routers which is a big scaling issue. Number of peering requirement is $2^n - 1$. To solve this will use all regional core routers as RR.

Example Config on a Core Router:

```
config t
router bgp 17821
address-family ipv6
neighbor IPV6-iBGP-REG2 route-reflector-client
```

Defining all members of IPV6-iBGP-REG2 peer group as RR client. Please note if there are any other peer group or BGP peer they will be considered as RR non-client. In our case another peer group IPV6-iBGP-REG2 and they will be RR non-client.

```
exit
exit
exit
wr
```

4. Verify iBGP Configuration:

Example IPv6 protocol verification on a Router:

After iBGP Peering Config:

```
sh bgp ipv6 unicast summary [To check bgp peering status in summary]
sh bgp ipv6 unicast [To check detail bgp table]
sh ipv6 route bgp [To check the routing table prefixes learned by BGP ]
```

After prefix announcement:

```
sh bgp ipv6 unicast neighbors [router 1.....router12 loopback] advertised-routes
[To check prefixes advertised to iBGP peers]
sh bgp ipv6 unicast neighbors [router 1.....router12 loopback] routes [To check
prefixes learn from iBGP peers]
sh ipv6 route [R2, R5, R8, R11 datacenter & R1, R3, R4, R6, R7, R9, R10, R12 CS
WAN Link prefix] [To check prefixes in routing table]
```

After RR configuration on regional core routers. Verification need to be done from all infrastructure routers to see the outcome:

```
sh bgp ipv6 unicast summary
sh bgp ipv6 unicast
sh ip route bgp
sh bgp ipv6 unicast neighbors [router 1.....router12 loopback] advertised-routes
sh bgp ipv6 unicast neighbors [router 1.....router12 loopback] routes
sh ip route [R2, R5, R8, R11 datacenter & R1, R3, R4, R6, R7, R9, R10, R12 CS
WAN Link prefix]
```

Example IPv4 protocol verification on a Router:

After iBGP Peering Config:

```
sh bgp ipv4 unicast summary [To check bgp peering status in summary]
sh bgp ipv4 unicast [To check detail bgp table]
sh ipv4 route bgp [To check the routing table prefixes learned by BGP ]
```

After prefix announcement:

```
sh bgp ipv4 unicast neighbors [router 1.....router12 loopback] advertised-routes
[To check prefixes advertised to iBGP peers]
sh bgp ipv4 unicast neighbors [router 1.....router12 loopback] routes [To check
prefixes learn from iBGP peers]
sh ip route [R2, R5, R8, R11 datacenter & R1, R3, R4, R6, R7, R9, R10, R12 CS
WAN Link prefix] [To check prefixes in routing table]
```

After RR configuration on regional core routers. Verification need to be done from all infrastructure routers to see the outcome:

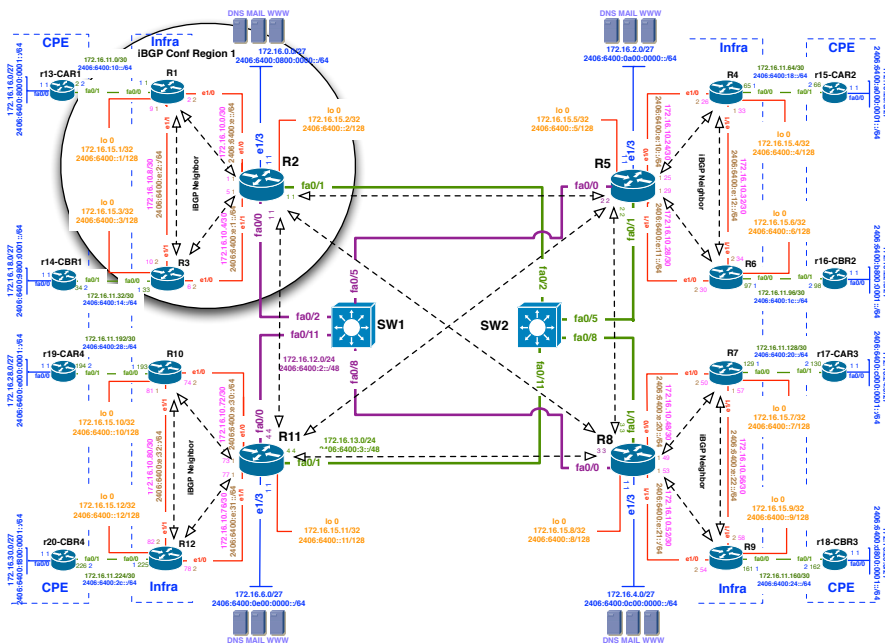
```
sh bgp ipv4 unicast summary
sh bgp ipv4 unicast
sh ip route bgp
sh bgp ipv4 unicast neighbors [router 1.....router12 loopback] advertised-routes
sh bgp ipv4 unicast neighbors [router 1.....router12 loopback] routes
sh ip route [R2, R5, R8, R11 datacenter & R1, R3, R4, R6, R7, R9, R10, R12 CS
WAN Link prefix]
```

END OF MODULE THREE.....

Next pages for reference template used on different routers....

'Workshop templates for reference purpose only'

iBGP configuration for training ISP network Region1:



IPv4 iBGP Conf Router1:

```
config t
router bgp 17821
address-family ipv4
no auto-summary
no synchronization
neighbor IPV4-iBGP-REG1 peer-group
neighbor IPV4-iBGP-REG1 remote-as 17821
neighbor IPV4-iBGP-REG1 update-source loopback 0
neighbor 172.16.15.2 peer-group IPV4-iBGP-REG1
neighbor 172.16.15.2 activate
neighbor 172.16.15.3 peer-group IPV4-iBGP-REG1
neighbor 172.16.15.3 activate
exit
exit
exit
wr
```

IPv6 iBGP Conf Router1:

```
config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG1 peer-group
neighbor IPV6-iBGP-REG1 remote-as 17821
neighbor IPV6-iBGP-REG1 update-source loopback 0
neighbor 2406:6400::2 peer-group IPV6-iBGP-REG1
neighbor 2406:6400::2 activate
neighbor 2406:6400::3 peer-group IPV6-iBGP-REG1
neighbor 2406:6400::3 activate
```



```
exit
exit
exit
wr
```

IPv4 iBGP Conf Router2:

```
config t
router bgp 17821
address-family ipv4
no auto-summary
no synchronization
neighbor IPV4-iBGP-REG1 peer-group
neighbor IPV4-iBGP-REG1 remote-as 17821
neighbor IPV4-iBGP-REG1 update-source loopback 0
neighbor 172.16.15.1 peer-group IPV4-iBGP-REG1
neighbor 172.16.15.1 activate
neighbor 172.16.15.3 peer-group IPV4-iBGP-REG1
neighbor 172.16.15.3 activate
neighbor IPV4-iBGP-TRCORE peer-group
neighbor IPV4-iBGP-TRCORE remote-as 17821
neighbor IPV4-iBGP-TRCORE update-source loopback 0
neighbor 172.16.15.5 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.5 activate
neighbor 172.16.15.8 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.8 activate
neighbor 172.16.15.11 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.11 activate
exit
exit
exit
wr
```

IPv6 iBGP Conf Router2:

```
config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG1 peer-group
neighbor IPV6-iBGP-REG1 remote-as 17821
neighbor IPV6-iBGP-REG1 update-source loopback 0
neighbor 2406:6400::1 peer-group IPV6-iBGP-REG1
neighbor 2406:6400::1 activate
neighbor 2406:6400::3 peer-group IPV6-iBGP-REG1
neighbor 2406:6400::3 activate
neighbor IPV6-iBGP-TRCORE peer-group
neighbor IPV6-iBGP-TRCORE remote-as 17821
neighbor IPV6-iBGP-TRCORE update-source loopback 0
neighbor 2406:6400::5 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::5 activate
neighbor 2406:6400::8 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::8 activate
neighbor 2406:6400::11 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::11 activate
exit
exit
exit
wr
```

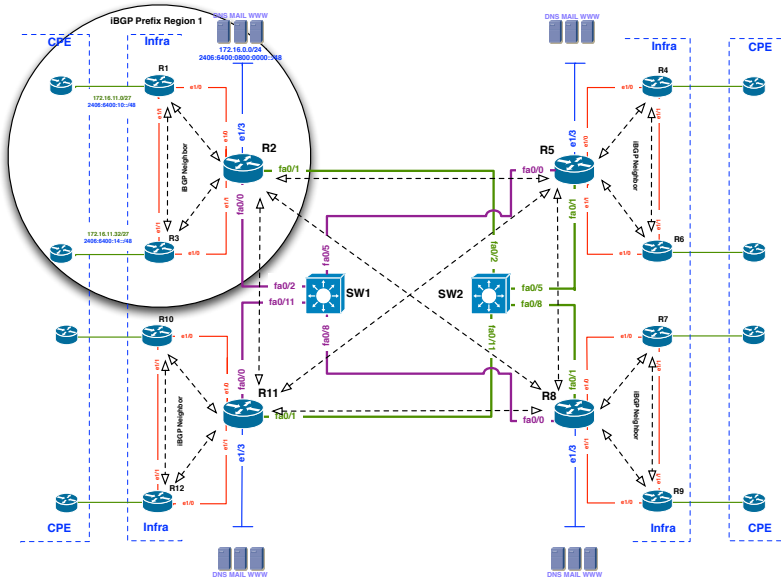
IPv4 iBGP Conf Router3:

```
config t
router bgp 17821
address-family ipv4
no auto-summary
no synchronization
neighbor IPV4-iBGP-REG1 peer-group
neighbor IPV4-iBGP-REG1 remote-as 17821
neighbor IPV4-iBGP-REG1 update-source loopback 0
neighbor 172.16.15.2 peer-group IPV4-iBGP-REG1
neighbor 172.16.15.2 activate
neighbor 172.16.15.1 peer-group IPV4-iBGP-REG1
neighbor 172.16.15.1 activate
exit
exit
exit
wr
```

IPv6 iBGP Conf Router3:

```
config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG1 peer-group
neighbor IPV6-iBGP-REG1 remote-as 17821
neighbor IPV6-iBGP-REG1 update-source loopback 0
neighbor 2406:6400::2 peer-group IPV6-iBGP-REG1
neighbor 2406:6400::2 activate
neighbor 2406:6400::1 peer-group IPV6-iBGP-REG1
neighbor 2406:6400::1 activate
exit
exit
exit
wr
```


Prefix Announcement/Advertisement from Region 1:



IPv4 Prefix Announcement on Router1:

```
config t
router bgp 17821
address-family ipv4
network 172.16.11.0 mask 255.255.255.224
exit
exit
ip route 172.16.11.0 255.255.255.224 null 0 permanent
exit
wr
```

IPv6 Prefix Announcement on Router1:

```
config t
router bgp 17821
address-family ipv6
network 2406:6400:0010:0000::/48
exit
exit
ipv6 route 2406:6400:0010:0000::/48 null 0
exit
wr
```

IPv4 Prefix Announcement on Router2:

```
config t
router bgp 17821
address-family ipv4
network 172.16.0.0 mask 255.255.255.0
exit
exit
ip route 172.16.0.0 255.255.255.0 null 0 permanent
exit
wr
```

IPv6 Prefix Announcement on Router2:

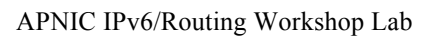
```
config t
router bgp 17821
address-family ipv6
network 2406:6400:0800:0000::/48
exit
exit
ipv6 route 2406:6400:0800:0000::/48 null 0
exit
wr
```

IPv4 Prefix Announcement on Router3:

```
config t
router bgp 17821
address-family ipv4
network 172.16.11.32 mask 255.255.255.224
exit
exit
ip route 172.16.11.32 255.255.255.224 null 0 permanent
exit
wr
```

IPv6 Prefix Announcement on Router3:

```
config t
router bgp 17821
address-family ipv6
network 2406:6400:0014:0000::/48
exit
exit
ipv6 route 2406:6400:0014:0000::/48 null 0
exit
wr
```



No configuration required

IPv6 RR Configuration Router1 (One RR Server per region):

No configuration required

Wait for R2 to finish configuration then perform following verification to analyse network effect.

```
config t
router bgp 17821
address-family ipv4
neighbor IPV4-iBGP-REG1 route-reflector-client
exit
exit
exit
wr
```

```
config t
router bgp 17821
address-family ipv6
neighbor IPV6-iBGP-REG1 route-reflector-client
exit
exit
exit
wr
```

Tuesday, August 27, 2013

IPv4 RR Configuration on Router3 (One RR Server per region):

No configuration required

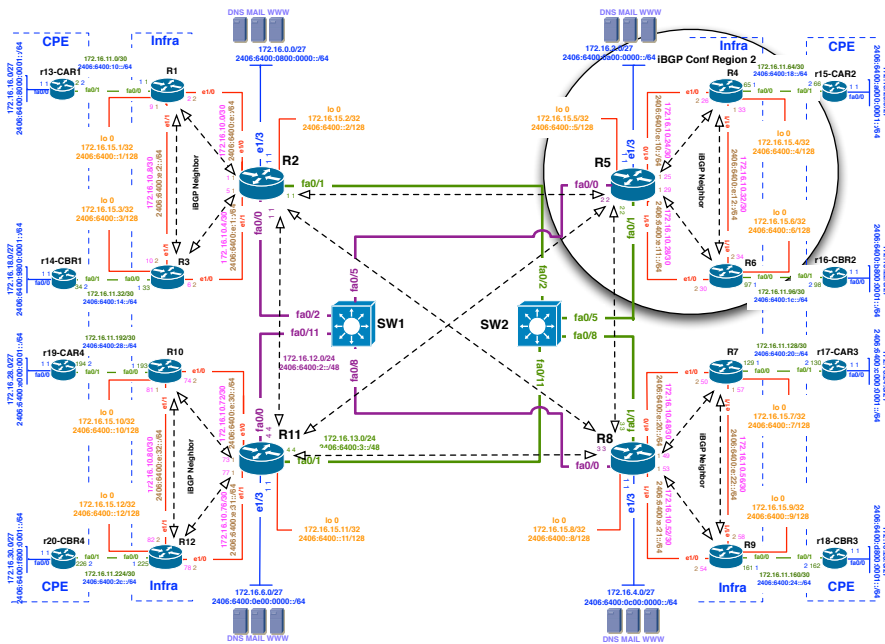
Wait for R2 to finish configuration then perform following verification to analyse network effect.

IPv6 RR Configuration Router3 (One RR Server per region):

No configuration required

Wait for R2 to finish configuration then perform following verification to analyse network effect.

iBGP configuration for training ISP network Region2:



IPv4 iBGP Conf Router4:

```

config t
router bgp 17821
address-family ipv4
no auto-summary
no synchronization
neighbor IPV4-iBGP-REG2 peer-group
neighbor IPV4-iBGP-REG2 remote-as 17821
neighbor IPV4-iBGP-REG2 update-source loopback 0
neighbor 172.16.15.5 peer-group IPV4-iBGP-REG2
neighbor 172.16.15.5 activate
neighbor 172.16.15.6 peer-group IPV4-iBGP-REG2
neighbor 172.16.15.6 activate
exit
exit
exit
wr

```

IPv6 iBGP Conf Router4:

```

config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG2 peer-group
neighbor IPV6-iBGP-REG2 remote-as 17821
neighbor IPV6-iBGP-REG2 update-source loopback 0
neighbor 2406:6400::5 peer-group IPV6-iBGP-REG2
neighbor 2406:6400::5 activate
neighbor 2406:6400::6 peer-group IPV6-iBGP-REG2
neighbor 2406:6400::6 activate
exit

```

Tuesday, August 27, 2013

```
exit
exit
wr
```

IPv4 iBGP Conf Router5:

```
config t
router bgp 17821
address-family ipv4
no auto-summary
no synchronization
neighbor IPV4-iBGP-REG2 peer-group
neighbor IPV4-iBGP-REG2 remote-as 17821
neighbor IPV4-iBGP-REG2 update-source loopback 0
neighbor 172.16.15.4 peer-group IPV4-iBGP-REG2
neighbor 172.16.15.4 activate
neighbor 172.16.15.6 peer-group IPV4-iBGP-REG2
neighbor 172.16.15.6 activate
neighbor IPV4-iBGP-TRCORE peer-group
neighbor IPV4-iBGP-TRCORE remote-as 17821
neighbor IPV4-iBGP-TRCORE update-source loopback 0
neighbor 172.16.15.2 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.2 activate
neighbor 172.16.15.8 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.8 activate
neighbor 172.16.15.11 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.11 activate
exit
exit
exit
wr
```

IPv6 iBGP Conf Router5:

```
config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG2 peer-group
neighbor IPV6-iBGP-REG2 remote-as 17821
neighbor IPV6-iBGP-REG2 update-source loopback 0
neighbor 2406:6400::4 peer-group IPV6-iBGP-REG2
neighbor 2406:6400::4 activate
neighbor 2406:6400::6 peer-group IPV6-iBGP-REG2
neighbor 2406:6400::6 activate
neighbor IPV6-iBGP-TRCORE peer-group
neighbor IPV6-iBGP-TRCORE remote-as 17821
neighbor IPV6-iBGP-TRCORE update-source loopback 0
neighbor 2406:6400::2 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::2 activate
neighbor 2406:6400::8 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::8 activate
neighbor 2406:6400::11 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::11 activate
exit
exit
exit
wr
```

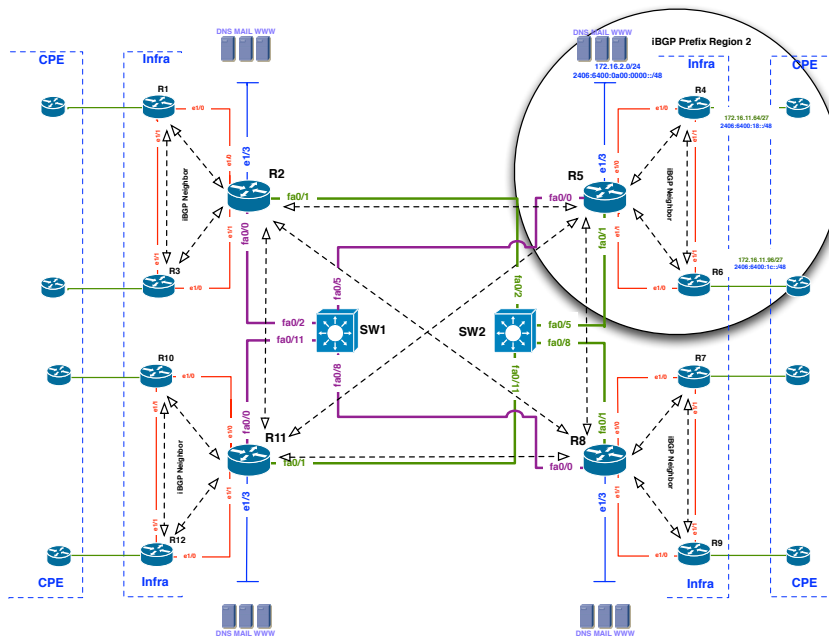
IPv4 iBGP Conf Router6:

```
config t
router bgp 17821
address-family ipv4
no auto-summary
no synchronization
neighbor IPV4-iBGP-REG2 peer-group
neighbor IPV4-iBGP-REG2 remote-as 17821
neighbor IPV4-iBGP-REG2 update-source loopback 0
neighbor 172.16.15.5 peer-group IPV4-iBGP-REG2
neighbor 172.16.15.5 activate
neighbor 172.16.15.4 peer-group IPV4-iBGP-REG2
neighbor 172.16.15.4 activate
exit
exit
exit
wr
```

IPv6 iBGP Conf Router6:

```
config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG2 peer-group
neighbor IPV6-iBGP-REG2 remote-as 17821
neighbor IPV6-iBGP-REG2 update-source loopback 0
neighbor 2406:6400::5 peer-group IPV6-iBGP-REG2
neighbor 2406:6400::5 activate
neighbor 2406:6400::4 peer-group IPV6-iBGP-REG2
neighbor 2406:6400::4 activate
exit
exit
exit
wr
```

Prefix Announcement/Advertisement from Region 2:



IPv4 Prefix Announcement on Router4:

```
config t
router bgp 17821
address-family ipv4
network 172.16.11.64 mask 255.255.255.224
exit
exit
ip route 172.16.11.64 255.255.255.224 null 0 permanent
exit
wr
```

IPv6 Prefix Announcement on Router4:

```
config t
router bgp 17821
address-family ipv6
network 2406:6400:0018:0000::/48
exit
exit
ipv6 route 2406:6400:0018:0000::/48 null 0
exit
wr
```

IPv4 Prefix Announcement on Router5:

```
config t
router bgp 17821
address-family ipv4
network 172.16.2.0 mask 255.255.255.0
exit
exit
ip route 172.16.2.0 255.255.255.0 null 0 permanent
exit
wr
```


IPv6 Prefix Announcement on Router5:

```
config t
router bgp 17821
address-family ipv6
network 2406:6400:0a00:0000::/48
exit
exit
ipv6 route 2406:6400:0a00:0000::/48 null 0
exit
wr
```

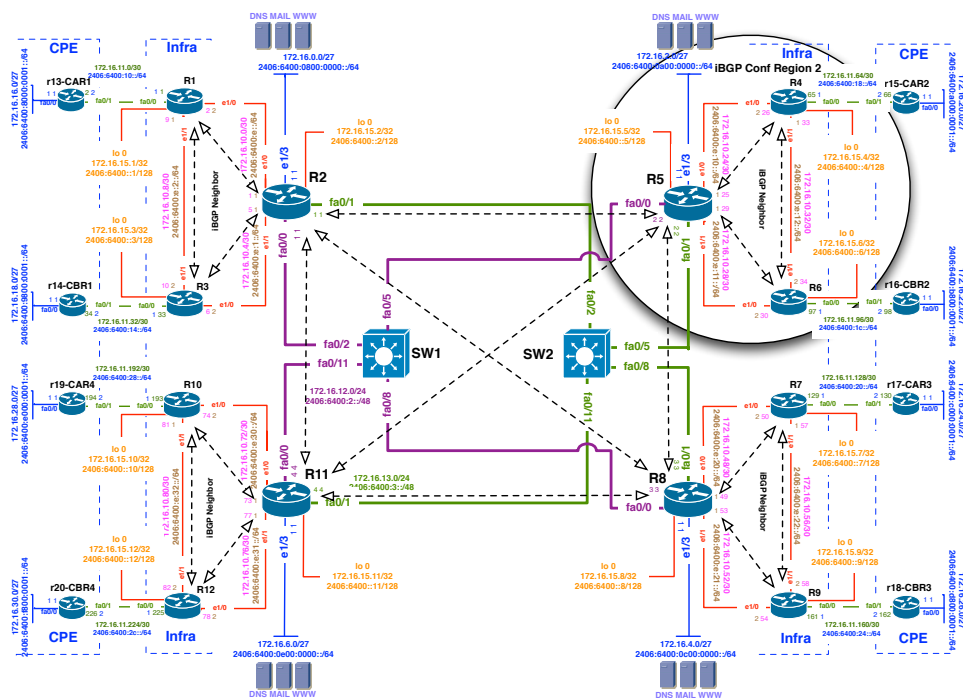
IPv4 Prefix Announcement on Router6:

```
config t
router bgp 17821
address-family ipv4
network 172.16.11.96 mask 255.255.255.224
exit
exit
ip route 172.16.11.96 255.255.255.224 null 0 permanent
exit
wr
```

IPv6 Prefix Announcement on Router6:

```
config t
router bgp 17821
address-family ipv6
network 2406:6400:001c:0000::/48
exit
exit
ipv6 route 2406:6400:001c:0000::/48 null 0
exit
wr
```

Route Reflector (RR) Conf Training ISP Network Region 2 (One RR per region):



IPv4 RR Configuration on Router4 (One RR Server per region):

No configuration required

Wait for R5 to finish configuration then perform following verification to analyse network effect.

IPv6 RR Configuration Router4 (One RR Server per region):

No configuration required

Wait for R5 to finish configuration then perform following verification to analyse network effect.

IPv4 RR Configuration on Router5 (One RR Server per region):

```
config t
router bgp 17821
address-family ipv4
neighbor IPV4-iBGP-REG2 route-reflector-client
exit
exit
exit
wr
```

IPv6 RR Configuration Router5 (One RR Server per region):

```
config t
router bgp 17821
address-family ipv6
neighbor IPV6-iBGP-REG2 route-reflector-client
exit
exit
exit
wr
```

IPv4 RR Configuration on Router6 (One RR Server per region):

No configuration required

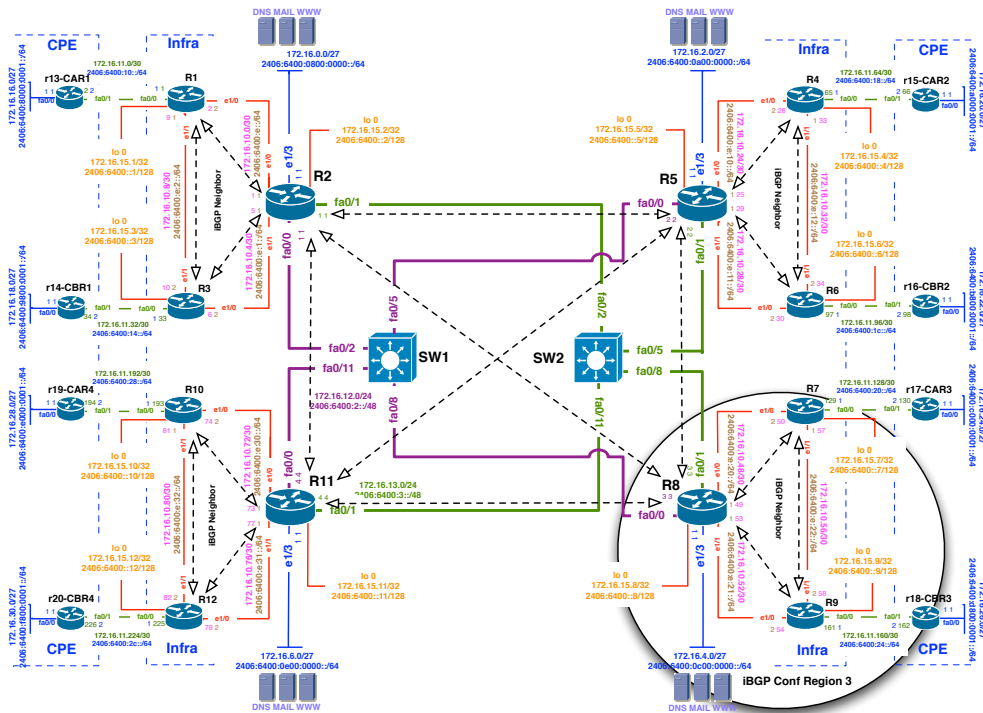
Wait for R5 to finish configuration then perform following verification to analyse network effect.

IPv6 RR Configuration Router6 (One RR Server per region):

No configuration required

Wait for R5 to finish configuration then perform following verification to analyse network effect.

iBGP configuration for training ISP network Region3:



IPv4 iBGP Conf Router7:

```

config t
router bgp 17821
address-family ipv4
no auto-summary
no synchronization
neighbor IPV4-iBGP-REG3 peer-group
neighbor IPV4-iBGP-REG3 remote-as 17821
neighbor IPV4-iBGP-REG3 update-source loopback 0
neighbor 172.16.15.8 peer-group IPV4-iBGP-REG3
neighbor 172.16.15.8 activate
neighbor 172.16.15.9 peer-group IPV4-iBGP-REG3
neighbor 172.16.15.9 activate
exit
exit
exit
wr

```

IPv6 iBGP Conf Router7:

```

config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG3 peer-group
neighbor IPV6-iBGP-REG3 remote-as 17821
neighbor IPV6-iBGP-REG3 update-source loopback 0
neighbor 2406:6400::8 peer-group IPV6-iBGP-REG3
neighbor 2406:6400::8 activate
neighbor 2406:6400::9 peer-group IPV6-iBGP-REG3
neighbor 2406:6400::9 activate

```



```
exit
exit
exit
wr
```

IPv4 iBGP Conf Router8:

```
config t
router bgp 17821
address-family ipv4
no auto-summary
no synchronization
neighbor IPV4-iBGP-REG3 peer-group
neighbor IPV4-iBGP-REG3 remote-as 17821
neighbor IPV4-iBGP-REG3 update-source loopback 0
neighbor 172.16.15.7 peer-group IPV4-iBGP-REG3
neighbor 172.16.15.7 activate
neighbor 172.16.15.9 peer-group IPV4-iBGP-REG3
neighbor 172.16.15.9 activate
neighbor IPV4-iBGP-TRCORE peer-group
neighbor IPV4-iBGP-TRCORE remote-as 17821
neighbor IPV4-iBGP-TRCORE update-source loopback 0
neighbor 172.16.15.2 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.2 activate
neighbor 172.16.15.5 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.5 activate
neighbor 172.16.15.11 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.11 activate
exit
exit
exit
wr
```

IPv6 iBGP Conf Router8:

```
config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG3 peer-group
neighbor IPV6-iBGP-REG3 remote-as 17821
neighbor IPV6-iBGP-REG3 update-source loopback 0
neighbor 2406:6400::7 peer-group IPV6-iBGP-REG3
neighbor 2406:6400::7 activate
neighbor 2406:6400::9 peer-group IPV6-iBGP-REG3
neighbor 2406:6400::9 activate
neighbor IPV6-iBGP-TRCORE peer-group
neighbor IPV6-iBGP-TRCORE remote-as 17821
neighbor IPV6-iBGP-TRCORE update-source loopback 0
neighbor 2406:6400::2 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::2 activate
neighbor 2406:6400::5 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::5 activate
neighbor 2406:6400::11 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::11 activate
exit
exit
exit
wr
```

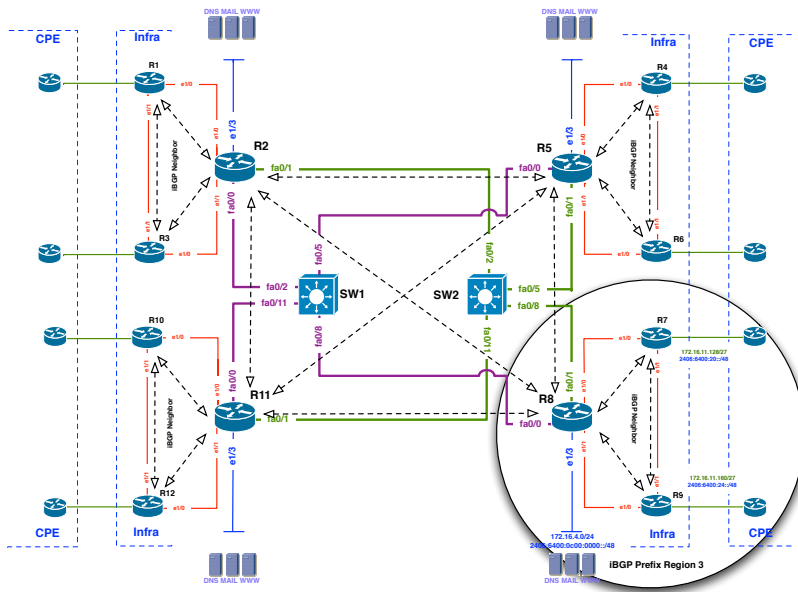
IPv4 iBGP Conf Router9:

```
config t
router bgp 17821
address-family ipv4
no synchronization
no auto-summary
neighbor IPV4-iBGP-REG3 peer-group
neighbor IPV4-iBGP-REG3 remote-as 17821
neighbor IPV4-iBGP-REG3 update-source loopback 0
neighbor 172.16.15.8 peer-group IPV4-iBGP-REG3
neighbor 172.16.15.8 activate
neighbor 172.16.15.7 peer-group IPV4-iBGP-REG3
neighbor 172.16.15.7 activate
exit
exit
exit
wr
```

IPv6 iBGP Conf Router9:

```
config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG3 peer-group
neighbor IPV6-iBGP-REG3 remote-as 17821
neighbor IPV6-iBGP-REG3 update-source loopback 0
neighbor 2406:6400::8 peer-group IPV6-iBGP-REG3
neighbor 2406:6400::8 activate
neighbor 2406:6400::7 peer-group IPV6-iBGP-REG3
neighbor 2406:6400::7 activate
exit
exit
exit
wr
```

Prefix Announcement/Advertisement from Region 3:



IPv4 Prefix Announcement on Router7:

```

config t
router bgp 17821
address-family ipv4
network 172.16.11.128 mask 255.255.255.224
exit
exit
ip route 172.16.11.128 255.255.255.224 null 0 permanent
exit
wr

```

IPv6 Prefix Announcement on Router7:

```

config t
router bgp 17821
address-family ipv6
network 2406:6400:0020:0000::/48
exit
exit
ipv6 route 2406:6400:0020:0000::/48 null 0
exit
wr

```

IPv4 Prefix Announcement on Router8:

```

config t
router bgp 17821
address-family ipv4
network 172.16.4.0 mask 255.255.255.0
exit
exit
ip route 172.16.4.0 255.255.255.0 null 0 permanent
exit
wr

```

IPv6 Prefix Announcement on Router8:

```
config t
router bgp 17821
address-family ipv6
network 2406:6400:0c00:0000::/48
exit
exit
ipv6 route 2406:6400:0c00:0000::/48 null 0
exit
wr
```

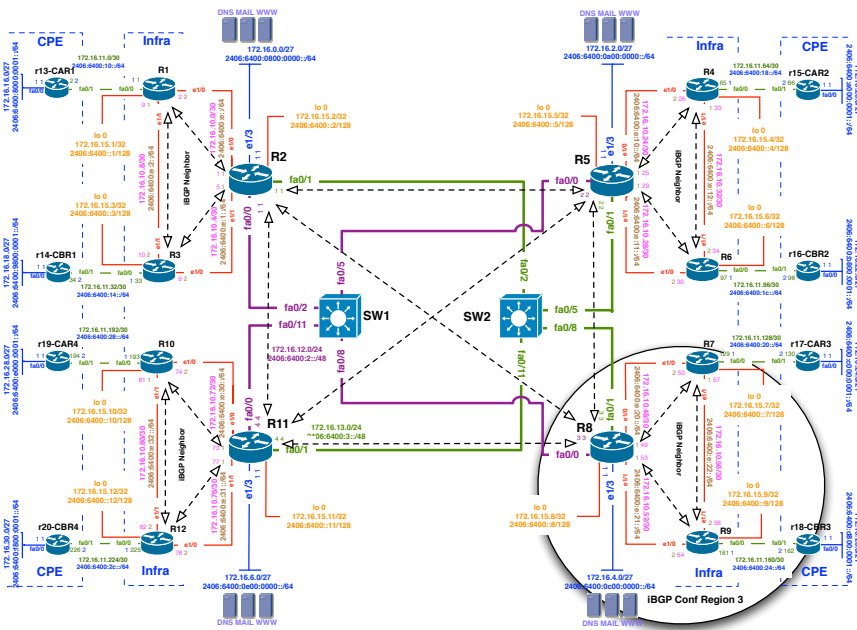
IPv4 Prefix Announcement on Router9:

```
config t
router bgp 17821
address-family ipv4
network 172.16.11.160 mask 255.255.255.224
exit
exit
ip route 172.16.11.160 255.255.255.224 null 0 permanent
exit
wr
```

IPv6 Prefix Announcement on Router9:

```
config t
router bgp 17821
address-family ipv6
network 2406:6400:0024:0000::/48
exit
exit
ipv6 route 2406:6400:0024:0000::/48 null 0
exit
wr
```


Route Reflector (RR) Conf Training ISP Network Region 3 (One RR per region):



IPv4 RR Configuration on Router7 (One RR Server per region):

No configuration required

Wait for R8 to finish configuration then perform following verification to analyse network effect.

IPV6 RR Configuration Router7 (One RR Server per region):

No configuration required

Wait for R8 to finish configuration then perform following verification to analyse network effect.

IPv4 RR Configuration on Router8 (One RR Server per region):

```
config t
router bgp 17821
address-family ipv4
neighbor IPV4-iBGP-REG3 route-reflector-client
exit
exit
exit
wr
```

IPv6 RR Configuration Router8 (One RR Server per region):

```
config t
router bgp 17821
address-family ipv6
neighbor IPV6-iBGP-REG3 route-reflector-client
exit
exit
exit
wr
```

IPv4 RR Configuration on Router9 (One RR Server per region):

No configuration required

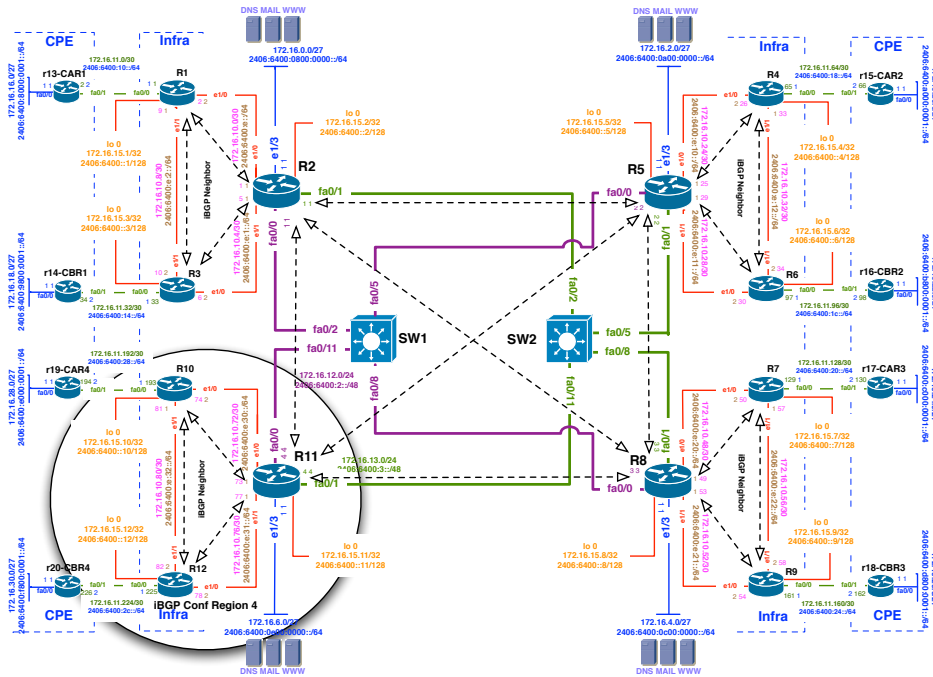
Wait for R8 to finish configuration then perform following verification to analyse network effect.

IPv6 RR Configuration Router9 (One RR Server per region):

No configuration required

Wait for R8 to finish configuration then perform following verification to analyse network effect.

iBGP configuration for training ISP network Region4:



IPv4 iBGP Conf Router10:

```

config t
router bgp 17821
address-family ipv4
no auto-summary
no synchronization
neighbor IPV4-iBGP-REG4 peer-group
neighbor IPV4-iBGP-REG4 remote-as 17821
neighbor IPV4-iBGP-REG4 update-source loopback 0
neighbor 172.16.15.11 peer-group IPV4-iBGP-REG4
neighbor 172.16.15.11 activate
neighbor 172.16.15.12 peer-group IPV4-iBGP-REG4
neighbor 172.16.15.12 activate
exit
exit
exit
wr

```

IPv6 iBGP Conf Router10:

```

config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG4 peer-group
neighbor IPV6-iBGP-REG4 remote-as 17821
neighbor IPV6-iBGP-REG4 update-source loopback 0
neighbor 2406:6400::11 peer-group IPV6-iBGP-REG4
neighbor 2406:6400::11 activate
neighbor 2406:6400::12 peer-group IPV6-iBGP-REG4
neighbor 2406:6400::12 activate

```

```
exit
exit
exit
wr
```

IPv4 iBGP Conf Router11:

```
config t
router bgp 17821
address-family ipv4
no auto-summary
no synchronization
neighbor IPV4-iBGP-REG4 peer-group
neighbor IPV4-iBGP-REG4 remote-as 17821
neighbor IPV4-iBGP-REG4 update-source loopback 0
neighbor 172.16.15.10 peer-group IPV4-iBGP-REG4
neighbor 172.16.15.10 activate
neighbor 172.16.15.12 peer-group IPV4-iBGP-REG4
neighbor 172.16.15.12 activate
neighbor IPV4-iBGP-TRCORE peer-group
neighbor IPV4-iBGP-TRCORE remote-as 17821
neighbor IPV4-iBGP-TRCORE update-source loopback 0
neighbor 172.16.15.2 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.2 activate
neighbor 172.16.15.5 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.5 activate
neighbor 172.16.15.8 peer-group IPV4-iBGP-TRCORE
neighbor 172.16.15.8 activate
exit
exit
exit
wr
```

IPv6 iBGP Conf Router11:

```
config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG4 peer-group
neighbor IPV6-iBGP-REG4 remote-as 17821
neighbor IPV6-iBGP-REG4 update-source loopback 0
neighbor 2406:6400::10 peer-group IPV6-iBGP-REG4
neighbor 2406:6400::10 activate
neighbor 2406:6400::12 peer-group IPV6-iBGP-REG4
neighbor 2406:6400::12 activate
neighbor IPV6-iBGP-TRCORE peer-group
neighbor IPV6-iBGP-TRCORE remote-as 17821
neighbor IPV6-iBGP-TRCORE update-source loopback 0
neighbor 2406:6400::2 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::2 activate
neighbor 2406:6400::5 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::5 activate
neighbor 2406:6400::8 peer-group IPV6-iBGP-TRCORE
neighbor 2406:6400::8 activate
exit
exit
exit
wr
```

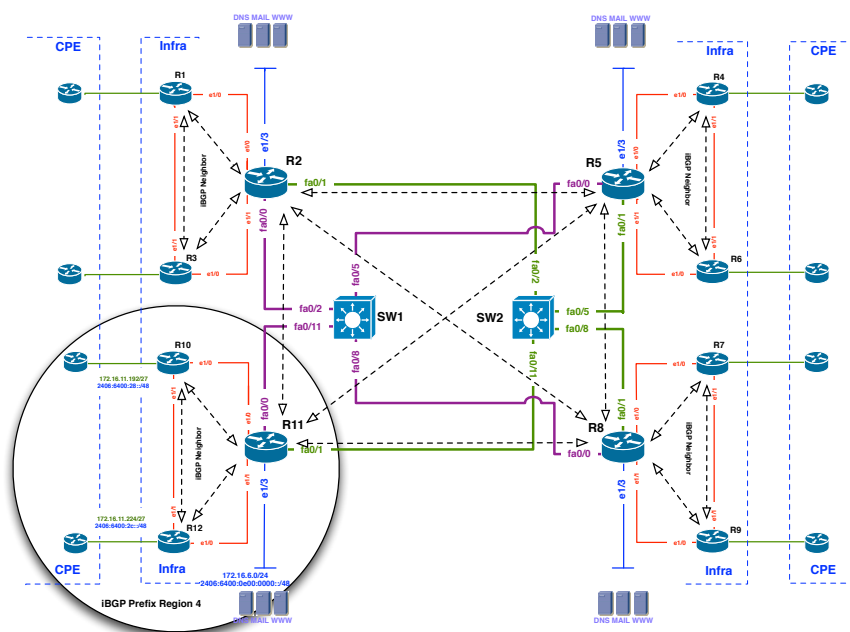
IPv4 iBGP Conf Router12:

```
config t
router bgp 17821
address-family ipv4
no auto-summary
no synchronization
neighbor IPV4-iBGP-REG4 peer-group
neighbor IPV4-iBGP-REG4 remote-as 17821
neighbor IPV4-iBGP-REG4 update-source loopback 0
neighbor 172.16.15.11 peer-group IPV4-iBGP-REG4
neighbor 172.16.15.11 activate
neighbor 172.16.15.10 peer-group IPV4-iBGP-REG4
neighbor 172.16.15.10 activate
exit
exit
exit
wr
```

IPv6 iBGP Conf Router12:

```
config t
router bgp 17821
no bgp default ipv4-unicast
address-family ipv6
no synchronization
neighbor IPV6-iBGP-REG4 peer-group
neighbor IPV6-iBGP-REG4 remote-as 17821
neighbor IPV6-iBGP-REG4 update-source loopback 0
neighbor 2406:6400::11 peer-group IPV6-iBGP-REG4
neighbor 2406:6400::11 activate
neighbor 2406:6400::10 peer-group IPV6-iBGP-REG4
neighbor 2406:6400::10 activate
exit
exit
exit
wr
```

Prefix Announcement/Advertisement from Region 4:



IPv4 Prefix Announcement on Router10:

```
config t
router bgp 17821
address-family ipv4
network 172.16.11.192 mask 255.255.255.224
exit
exit
ip route 172.16.11.192 255.255.255.224 null 0 permanent
exit
wr
```

IPv6 Prefix Announcement on Router10:

```
config t
router bgp 17821
address-family ipv6
network 2406:6400:0028:0000::/48
exit
exit
ipv6 route 2406:6400:0028:0000::/48 null 0
exit
wr
```

IPv4 Prefix Announcement on Router11:

```
config t
router bgp 17821
address-family ipv4
network 172.16.6.0 mask 255.255.255.0
exit
exit
ip route 172.16.6.0 255.255.255.0 null 0 permanent
exit
wr
```

IPv6 Prefix Announcement on Router11:

```
config t
router bgp 17821
address-family ipv6
network 2406:6400:0e00:0000::/48
exit
exit
ipv6 route 2406:6400:0e00:0000::/48 null 0
exit
wr
```

IPv4 Prefix Announcement on Router12:

```
config t
router bgp 17821
address-family ipv4
network 172.16.11.224 mask 255.255.255.224
exit
exit
ip route 172.16.11.224 255.255.255.224 null 0 permanent
exit
wr
```

IPv6 Prefix Announcement on Router12:

```
config t
router bgp 17821
address-family ipv6
network 2406:6400:002c:0000::/48
exit
exit
ipv6 route 2406:6400:002c:0000::/48 null 0
exit
wr
```


IPv4 RR Configuration on Router12 (One RR Server per region):

No configuration required

Wait for R11 to finish configuration then perform following verification to analyse network effect.

IPv6 RR Configuration Router12 (One RR Server per region):

No configuration required

Wait for R11 to finish configuration then perform following verification to analyse network effect.