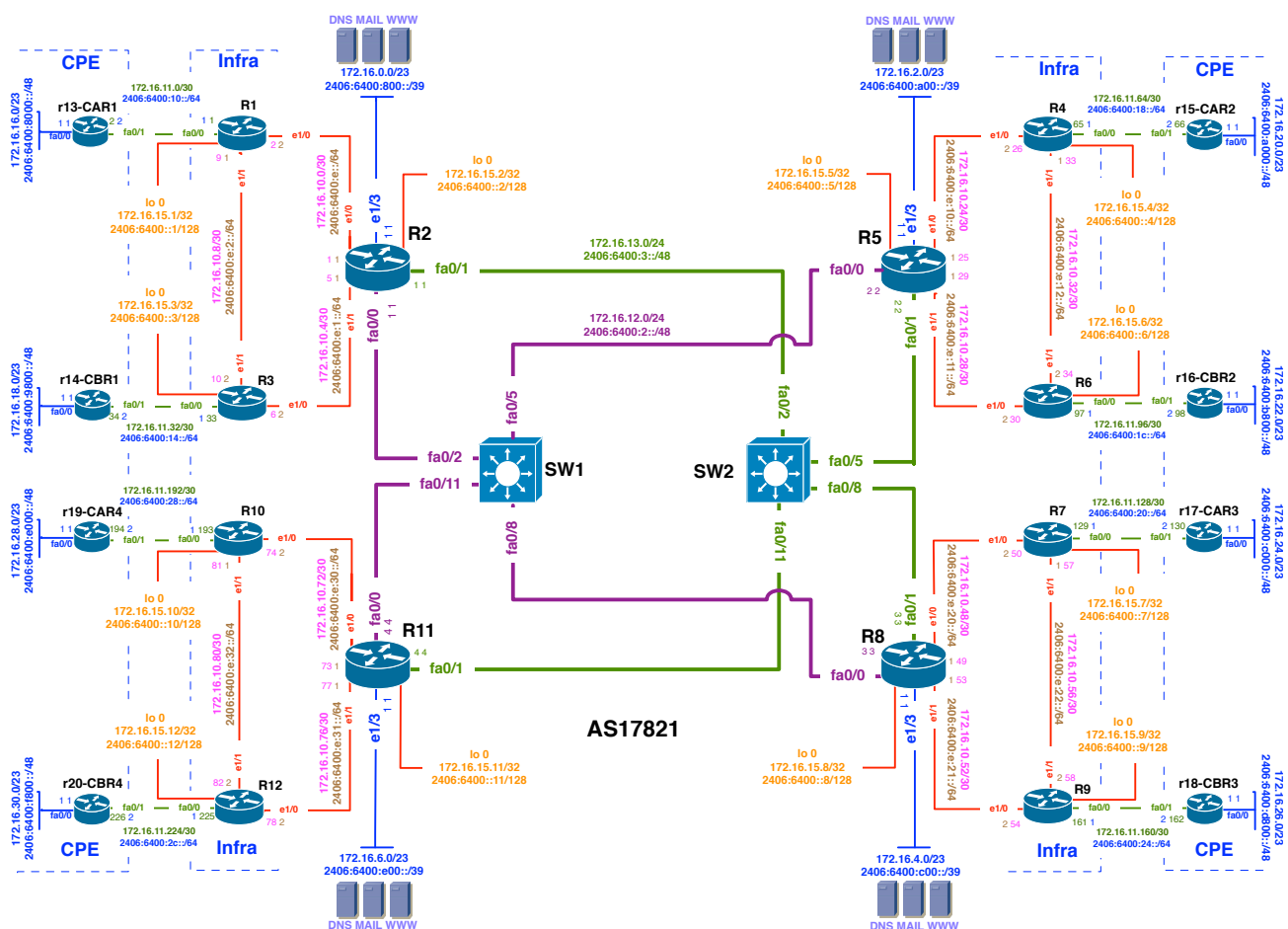


## Module 5 – eBGP with Upstream for Native and Tunnel Transit

**Objective:** All the workshop lab routers are configured with required basic, interface, OSPF/IS-IS, iBGP and eBGP with CPE router configuration according to the topology diagram below. Network level reachability testing for all twelve routers loopback interfaces, all twelve point-to-point links, two transport links, eight customer side point-to-point aggregated, four datacentre aggregated and eight customer LAN prefixes are successfully done in our previous modules (Module 1, 2, 3 & 4). Participants on regional core routers will only require to configure eBGP peering with the upstream service provider routers either IPv4/IPv6 native (R5 & R11) or through IPv6 in IPv4 tunnel and other related configuration on this module. Workshop instructor will be presenting upstream eBGP (Both native & tunnel) 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, iBGP, eBGP, 6in4 tunnel etc.), Cisco router CLI, Telnet/SSH software etc.

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



## Lab Notes

This workshop is intended to be run on real cisco routers with the above lab topologies set up. This module lab is installed in APNIC office in Brisbane. It is a live network connected to the Internet. Lab routers are using both IPv4 and IPv6 supported Cisco IOS software. Workshop instructor will be providing required username, password and IP address related information to be able to SSH to the lab routers. Participants should do their workshop module configuration to achieve following goals.

1. In our previous module (Module 4) exercise we have successfully finished adding customers using eBGP to the regional POP routers. We have investigated those options on how our perimeter router learns external prefix (i.e. downstream customer) using eBGP and how those prefixes are propagated across other part of the network using iBGP protocol.
2. In this module we will connect our region two and region four core routers (i.e R5 & R11) to AS45192 using IPv6 native transport and region one and region three core routers (i.e. R2 & R8) to AS 131107 (4 byte) using IPv6 in IPv4 tunnel transit. We will be getting full BGP feed for IPv6 prefixes and default for IPv4 from both of our upstream ISPs on four core routers. Regional core routers will forward those prefixes to regional POP routers using iBGP. After finishing the required configuration in this module we will be able to see all available IPv6 global prefixes into our network. Our prefix (2406:6400::/32) will also be advertised to the global IPv6 Internet originated from our AS17821. Configuration outcome can be verified from any publicly available looking glass or route servers. I.e. <http://www.route-servers.net> or <http://lookingglass.level3.net>
3. For the time management purpose upstream routers are already configured with required interface and BGP configuration. Participants only need to configure their allocated routers and can be able to verify the configuration outcome.
4. In this particular module each regional team need to configure only one router i.e. their regional core routers. From the POP routers you only need to verify the configuration outcome.
5. Here are the steps involved on the regional core routers:
  - a. Upstream WAN interface/Tunnel interface configuration
  - b. eBGP peering configuration
  - c. Prefix advertisement using aggregate address command.
  - d. Change the eBGP next-hop to next-hop self on the border router.
6. Due to time restriction in workshop eBGP analysis and example will cover IPv6 prefixes only. You can check IPv4 prefixes for your own understanding purpose.
7. 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.

## Lab Exercise Example Region 1

1. **Region 1 IPv4 Configuration:** Only Router2 will require to configure IPv4 transit with AS45192 in region 1. But the upstream router in AS45192 does not support IPv6 transit yet. So the workshop group for region 1 need to configure IPv6 transit using IPv6 in IPv4 tunnel. All the steps are explained below. Command description can be found in Module 1 exercise.

### Step one example IPv4 upstream interface config on Router2:

```
config t
interface e1/2
This interface is connecting to upstream ISP

description Transit with AS45192
no ip redirects
no ip directed-broadcast
no ip unreachableables
no cdp enable
ip address 192.168.1.22 255.255.255.252
no shutdown
exit
exit
wr
```

### Step two example interface connectivity verification:

```
Ping 192.168.1.21 [!!!!!!]
```

Other side of point-to-point link

### Step three example eBGP peering config:

```
config t
router bgp 17821
address-family ipv4
neighbor 192.168.1.21 remote-as 45192
neighbor 192.168.1.21 activate
exit
exit
exit
wr
```

### Step four example prefix advertisement config:

```
config t
router bgp 17821
address-family ipv4
aggregate-address 172.16.0.0 255.255.224.0
```

This command will install a pull up route (null 0) in the IGP table and send a summarized /19 advertisement from BGP.

```
exit
exit
exit
wr
```

### Step five change the next-hop to self for eBGP prefixes:

```
config t
router bgp 17821
address-family ipv4
neighbor IPV4-iBGP-REG2 next-hop-self
neighbor IPV4-iBGP-TRCORE next-hop-self
exit
exit
exit
wr
```

### Step six verify IPv4 upstream transit configuration:

```
sh bgp ipv4 unicast summary          [Number of prefixes received from peers]
sh bgp ipv4 unicast                  [Any new prefix?]
sh ip route bgp                      [Any new prefix?]
sh bgp ipv4 unicast neighbors [Upstream ISP Router] received-routes/routes
sh ip route
```

```
ping 192.168.1.6          [!!!!!!]
ping 192.168.1.10         [!!!!!!]
ping 192.168.1.26         [!!!!!!]
ping 192.168.1.1          [!!!!!!]
```

2. **Region 1 IPv6 Configuration:** Upstream router connected to Router2 does not support IPv6 native transit. So we found a tunnel broker AS131107 who is not a directly connected AS but happy to provide us IPv6 transit service through 6in4 tunnel. Since we can ping tunnel broker router on IPv4 (Tunnel destination 192.168.1.1) we are ready to setup the tunnel and then BGP peering. Here are the steps:

### Step one example IPv6 tunnel interface config on Router2:

```
config t
interface Tunnel0
description Tunnel Interface to AS131107
tunnel source 172.16.15.2
Loopback address of Router 2
```

```
tunnel destination 192.168.1.1
Egress interface address of tunnel broker router
```

```
tunnel mode ipv6ip
Tunnel encapsulation protocol ipv6ip
```

```
ipv6 address 2406:6400:E:40::2/64
```

Virtual P-to-P interface between Router2 and Tunnel broker router belongs to same subnet.

```
exit
exit
wr
```

### Step two tunnel interface connectivity verification:

```
ping 2406:6400:E:40::1 [!!!!!!]
```

**Step three example eBGP peering config:**

```
config t
router bgp 17821
address-family ipv6
neighbor 2406:6400:e:40::1 remote-as 23456
neighbor 2406:6400:e:40::1 activate
```

Notice the remote AS is 23456 which is a special AS in 2 byte range. Tunnel broker AS is 131107 which is a 4 byte range. Since router2 IOS version does not support 4 byte AS number we need to use this special AS number to setup the peering. Presentation on 4 byte AS number will cover more detail on this.

```
exit
exit
exit
wr
```

**Step four example prefix advertisement config:**

```
config t
router bgp 17821
address-family ipv6
aggregate-address 2406:6400::/32
```

This command will install a pull up route (null 0) in the IGP table and send a summarized /32 advertisement from BGP.

```
exit
exit
exit
wr
```

**Step five change the next-hop to self for eBGP prefixes:**

```
config t
router bgp 17821
address-family ipv6
neighbor IPV6-iBGP-REG1 next-hop-self
neighbor IPV6-iBGP-TRCORE next-hop-self
exit
exit
exit
wr
```

**Step six verify IPv4 upstream transit configuration:**

```
sh bgp ipv6 unicast summary          [Number of prefixes received from peers]
sh bgp ipv6 unicast                  [Any new prefix?]
sh ipv6 route bgp                    [Any new prefix?]
sh bgp ipv6 unicast neighbors [Upstream ISP Router] received-routes/routes
sh ip route
```

```
ping 2406:6400::5                    [!!!!!!]
ping 2001:DF0:A:100::1                [!!!!!!]
ping 2001:DF0:A:F00::1                [!!!!!!]
```

## **Lab Exercise Example Region 2**

- 3. Region 2 IPv4 Configuration:** Only Router5 will require to configure IPv4 transit with AS45192 in region 2. Upstream router in AS45192 does support IPv6 native transit. So the workshop group for region 2 need to configure native IPv6 transit with AS45192. All the steps are explained below. Command description can be found in Module 1 and previous exercise.

### **Step one example IPv4 upstream interface config on Router2:**

```
config t
interface Ethernet1/2
description Transit with AS45192
no ip redirects
no ip directed-broadcast
no ip unreachable
no cdp enable
ip address 192.168.1.6 255.255.255.252
no shutdown
exit
exit
wr
```

### **Step two example interface connectivity verification:**

```
Ping 192.168.1.5 [!!!!!]
Other side of point-to-point link
```

### **Step three example eBGP peering config:**

```
config t
router bgp 17821
address-family ipv4
neighbor 192.168.1.5 remote-as 45192
neighbor 192.168.1.5 activate
exit
exit
exit
wr
```

### **Step four example prefix advertisement config:**

```
config t
router bgp 17821
address-family ipv4
aggregate-address 172.16.0.0 255.255.224.0
exit
exit
exit
wr
```

### **Step five change the next-hop to self for eBGP prefixes:**

```
config t
router bgp 17821
address-family ipv4
neighbor IPV4-iBGP-REG2 next-hop-self
neighbor IPV4-iBGP-TRCORE next-hop-self
```

```
exit
exit
exit
wr
```

### Step six verify IPv4 upstream transit configuration:

```
sh bgp ipv4 unicast summary          [Number of prefixes received from peers]
sh bgp ipv4 unicast                  [Any new prefix?]
sh ip route bgp                      [Any new prefix?]
sh bgp ipv4 unicast neighbors [Upstream ISP Router] received-routes/routes
sh ip route
```

```
ping 192.168.1.6          [!!!!!!]
ping 192.168.1.10         [!!!!!!]
ping 192.168.1.26         [!!!!!!]
ping 192.168.1.1          [!!!!!!]
```

4. **Region 2 IPv6 Configuration:** Upstream router connected to Router5 does support IPv6 native transit. So we can setup native IPv6 transit service with upstream AS45192 router. Here are the steps:

### Step one example IPv6 tunnel interface config on Router2:

```
config t
interface Ethernet1/2
ipv6 address 2001:DF0:A:F00::2/64
exit
exit
wr
```

### Step two tunnel interface connectivity verification:

```
ping 2001:DF0:A:F00::1 [!!!!!!]
```

### Step three example eBGP peering config:

```
config t
router bgp 17821
address-family ipv6
neighbor 2001:df0:a:f00::1 remote-as 45192
neighbor 2001:df0:a:f00::1 activate
exit
exit
exit
wr
```

### Step four example prefix advertisement config:

```
config t
router bgp 17821
address-family ipv6
aggregate-address 2406:6400::/32
exit
exit
exit
wr
```

**Step five change the next-hop to self for eBGP prefixes:**

```
config t
router bgp 17821
address-family ipv6
neighbor IPV6-iBGP-REG2 next-hop-self
neighbor IPV6-iBGP-TRCORE next-hop-self
exit
exit
exit
wr
```

**Step six verify IPv4 upstream transit configuration:**

```
sh bgp ipv6 unicast summary      [Number of prefixes received from peers]
sh bgp ipv6 unicast             [Any new prefix?]
sh ipv6 route bgp               [Any new prefix?]
sh bgp ipv6 unicast neighbors [Upstream ISP Router] received-routes/routes
sh ip route
```

```
ping 2406:6400::5               [!!!!!]
ping 2001:DF0:A:100::1          [!!!!!]
ping 2001:DF0:A:F00::1         [!!!!!]
```

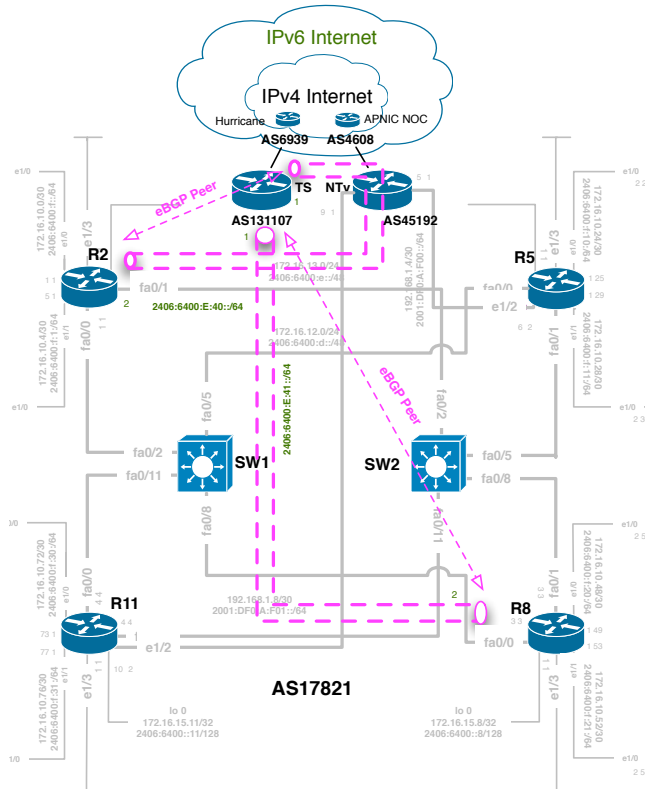
END OF MODULE FIVE.....

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



## ‘Workshop templates for reference purpose only’

### Upstream Transit Service Conf Region 1:



### IPv4 upstream conf Router1 & Router3:

No configuration required

Wait for R2, R5, R8 & R11 to finish configuration then perform following verification to analyse network effect.

### IPv4 WAN interface conf Router2:

```
config t
interface e1/2
description Transit with AS45192
no ip redirects
no ip directed-broadcast
no ip unreachableables
no cdp enable
ip address 192.168.1.22 255.255.255.252
no shutdown
exit
exit
wr
```

### IPv4 eBGP peering config Router2:

```
config t
router bgp 17821
address-family ipv4
```

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```
neighbor 192.168.1.21 remote-as 45192
neighbor 192.168.1.21 activate
exit
exit
exit
wr
```

### **IPv4 prefix advertisement config Router2:**

```
config t
router bgp 17821
address-family ipv4
aggregate-address 172.16.0.0 255.255.224.0
exit
exit
exit
wr
```

### **IPv4 next-hop to self for eBGP prefixes Router2:**

```
config t
router bgp 17821
address-family ipv4
neighbor IPV4-iBGP-REG2 next-hop-self
neighbor IPV4-iBGP-TRCORE next-hop-self
exit
exit
exit
wr
```

### **IPv6 upstream conf Router1 & Router3:**

No configuration required

Wait for R2, R5, R8 & R11 to finish configuration then perform following verification to analyse network effect.

### **IPv6 Tunnel interface conf Router2:**

```
config t
interface Tunnel0
tunnel source 172.16.15.2
tunnel destination 192.168.1.1
tunnel mode ipv6ip
ipv6 address 2406:6400:E:40::2/64
exit
exit
wr
```

### **IPv6 eBGP peering config Router2:**

```
config t
router bgp 17821
address-family ipv6
neighbor 2406:6400:e:40::1 remote-as 23456
neighbor 2406:6400:e:40::1 activate
exit
exit
exit
wr
```

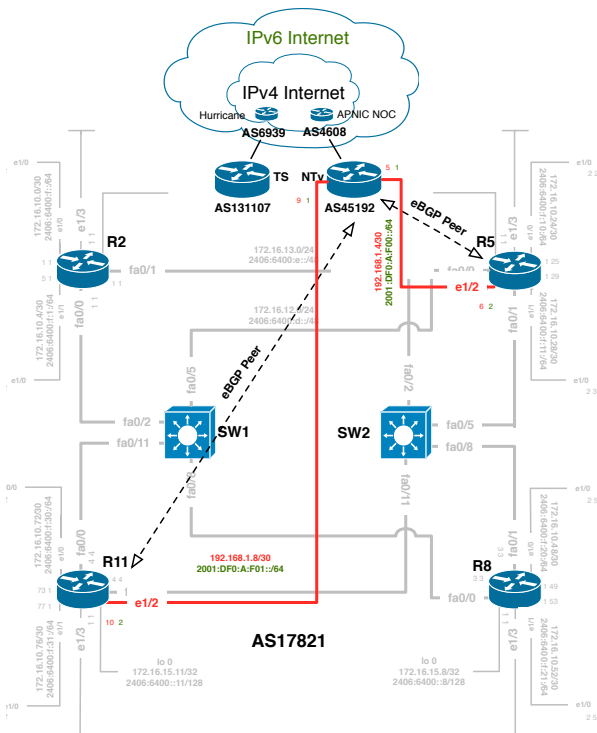
### IPv6 prefix advertisement config Router2:

```
config t
router bgp 17821
address-family ipv6
aggregate-address 2406:6400::/32
exit
exit
exit
wr
```

### IPv6 next-hop to self for eBGP prefixes Router2:

```
config t
router bgp 17821
address-family ipv6
neighbor IPV6-iBGP-REG1 next-hop-self
neighbor IPV6-iBGP-TRCORE next-hop-self
exit
exit
exit
wr
```

## Upstream Transit Service Conf Region 2:



### IPv4 upstream conf Router4 & Router6:

No configuration required

Wait for R2, R5, R8 & R11 to finish configuration then perform following verification to analyse network effect.

### IPv4 WAN interface conf Router5:

```
config t
interface Ethernet1/2
description Transit with AS45192
no ip redirects
no ip directed-broadcast
no ip unreachable
no cdp enable
ip address 192.168.1.6 255.255.255.252
no shutdown
exit
exit
wr
```

### IPv4 eBGP peering config Router5:

```
config t
router bgp 17821
address-family ipv4
neighbor 192.168.1.5 remote-as 45192
neighbor 192.168.1.5 activate
exit
exit
exit
wr
```

**IPv4 prefix advertisement config Router5:**

```
config t
router bgp 17821
address-family ipv4
aggregate-address 172.16.0.0 255.255.224.0
exit
exit
exit
wr
```

**IPv4 next-hop to self for eBGP prefixes Router5:**

```
config t
router bgp 17821
address-family ipv4
neighbor IPV4-iBGP-REG2 next-hop-self
neighbor IPV4-iBGP-TRCORE next-hop-self
exit
exit
exit
wr
```

**IPv6 upstream conf Router4 & Router6:**

No configuration required

Wait for R2, R5, R8 & R11 to finish configuration then perform following verification to analyse network effect.

**IPv6 P-to-P interface conf Router5:**

```
config t
interface Ethernet1/2
ipv6 address 2001:DF0:A:F00::2/64
exit
exit
wr
```

**IPv6 eBGP peering config Router5:**

```
config t
router bgp 17821
address-family ipv6
neighbor 2001:df0:a:f00::1 remote-as 45192
neighbor 2001:df0:a:f00::1 activate
exit
exit
exit
wr
```

**IPv6 prefix advertisement config Router5:**

```
config t
router bgp 17821
address-family ipv6
aggregate-address 2406:6400::/32
exit
```

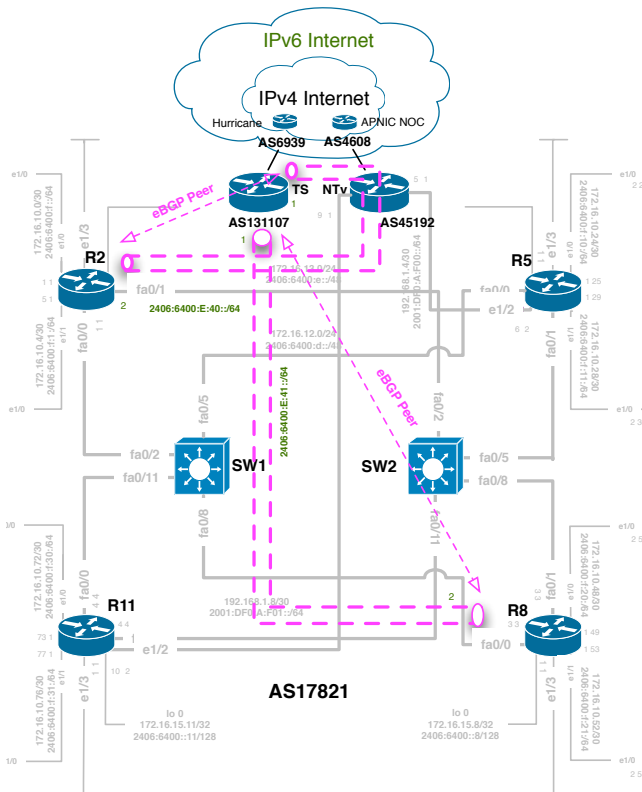
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```
exit
exit
wr
```

### **IPv6 next-hop to self for eBGP prefixes Router5:**

```
config t
router bgp 17821
address-family ipv6
neighbor IPV6-iBGP-REG2 next-hop-self
neighbor IPV6-iBGP-TRCORE next-hop-self
exit
exit
exit
wr
```

## Upstream Transit Service Conf Region 3:



### IPv4 upstream conf Router7 & Router9:

No configuration required

Wait for R2, R5, R8 & R11 to finish configuration then perform following verification to analyse network effect.

### IPv4 WAN interface conf Router8:

```
config t
interface e1/2
description Transit with AS45192
no ip redirects
no ip directed-broadcast
no ip unreachable
no cdp enable
ip address 192.168.1.26 255.255.255.252
no shutdown
exit
exit
wr
```

### IPv4 eBGP peering config Router8:

```
config t
router bgp 17821
address-family ipv4
neighbor 192.168.1.25 remote-as 45192
neighbor 192.168.1.25 activate
```

```
exit
exit
exit
wr
```

### **IPv4 prefix advertisement config Router8:**

```
config t
router bgp 17821
address-family ipv4
aggregate-address 172.16.0.0 255.255.224.0
exit
exit
exit
wr
```

### **IPv4 next-hop to self for eBGP prefixes Router8:**

```
config t
router bgp 17821
address-family ipv4
neighbor IPV4-iBGP-REG3 next-hop-self
neighbor IPV4-iBGP-TRCORE next-hop-self
exit
exit
exit
wr
```

### **IPv6 upstream conf Router7 & Router9:**

No configuration required

Wait for R2, R5, R8 & R11 to finish configuration then perform following verification to analyse network effect.

### **IPv6 Tunnel interface conf Router8:**

```
config t
interface Tunnel0
tunnel source 172.16.15.8
tunnel destination 192.168.1.1
tunnel mode ipv6ip
ipv6 address 2406:6400:E:41::2/64
exit
exit
wr
```

### **IPv6 eBGP peering config Router8:**

```
config t
router bgp 17821
address-family ipv6
neighbor 2406:6400:e:41::1 remote-as 23456
neighbor 2406:6400:e:41::1 activate
exit
exit
exit
wr
```



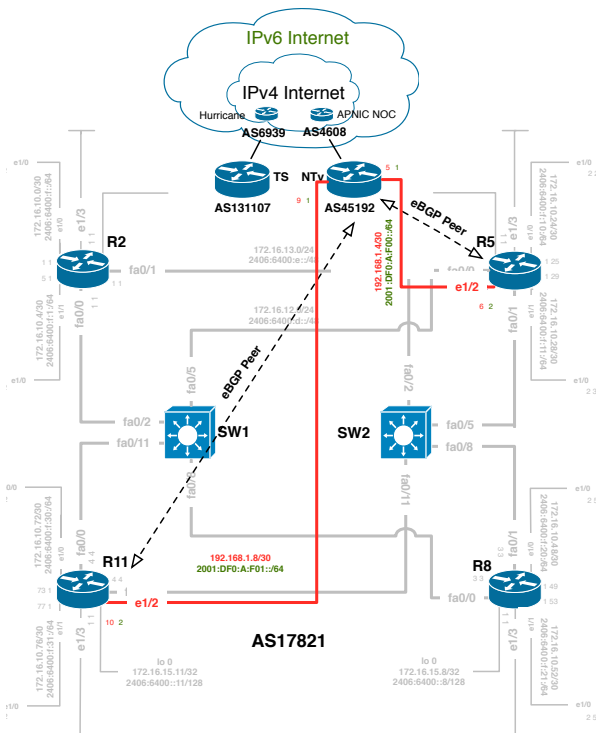
### IPv6 prefix advertisement config Router8:

```
config t
router bgp 17821
address-family ipv6
aggregate-address 2406:6400::/32
exit
exit
exit
wr
```

### IPv6 next-hop to self for eBGP prefixes Router8:

```
config t
router bgp 17821
address-family ipv6
neighbor IPV6-iBGP-REG3 next-hop-self
neighbor IPV6-iBGP-TRCORE next-hop-self
exit
exit
exit
wr
```

## Upstream Transit Service Conf Region 4:



### IPv4 upstream conf Router10 & Router12:

No configuration required

Wait for R2, R5, R8 & R11 to finish configuration then perform following verification to analyse network effect.

### IPv4 WAN interface conf Router11:

```
config t
interface Ethernet1/2
description Transit with AS45192
no ip redirects
no ip directed-broadcast
no ip unreachable
no cdp enable
ip address 192.168.1.10 255.255.255.252
no shutdown
exit
exit
wr
```

### IPv4 eBGP peering config Router11:

```
config t
router bgp 17821
address-family ipv4
neighbor 192.168.1.9 remote-as 45192
neighbor 192.168.1.9 activate
exit
exit
exit
wr
```

**IPv4 prefix advertisement config Router11:**

```
config t
router bgp 17821
address-family ipv4
aggregate-address 172.16.0.0 255.255.224.0
exit
exit
exit
wr
```

**IPv4 next-hop to self for eBGP prefixes Router11:**

```
config t
router bgp 17821
address-family ipv4
neighbor IPV4-iBGP-REG4 next-hop-self
neighbor IPV4-iBGP-TRCORE next-hop-self
exit
exit
exit
wr
```

**IPv6 upstream conf Router10 & Router12:**

No configuration required

Wait for R2, R5, R8 & R11 to finish configuration then perform following verification to analyse network effect.

**IPv6 P-to-P interface conf Router11:**

```
config t
interface Ethernet1/2
ipv6 address 2001:DF0:A:F01::2/64
exit
exit
wr
```

**IPv6 eBGP peering config Router11:**

```
config t
router bgp 17821
address-family ipv6
neighbor 2001:df0:a:f01::1 remote-as 45192
neighbor 2001:df0:a:f01::1 activate
exit
exit
exit
wr
```

### IPv6 prefix advertisement config Router11:

```
config t
router bgp 17821
address-family ipv6
aggregate-address 2406:6400::/32
exit
exit
exit
wr
```

### IPv6 next-hop to self for eBGP prefixes Router11:

```
config t
router bgp 17821
address-family ipv6
neighbor IPV6-iBGP-REG4 next-hop-self
neighbor IPV6-iBGP-TRCORE next-hop-self
exit
exit
exit
wr
```