

Module 1 – Basic Configuration Task for Training Lab Network

Objective: All the workshop lab routers are set to the default configuration and cabling requirements are prebuild according to the following topology diagram. Participants will be required to do the necessary configurations as part of a team according to the lab design specification explained in the presentation section. There are 5 routers (3 core and 2 CPE) in each team/region. So 4 team will finish 20 routers configuration in several steps throughout the workshop duration. Workshop instructor will explain how the team will be organized, router will be allocated and IP address detail to access the lab routers.

Prerequisites: Basic TCP/IP knowledge, Cisco router CLI, Telnet/SSH software etc.

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

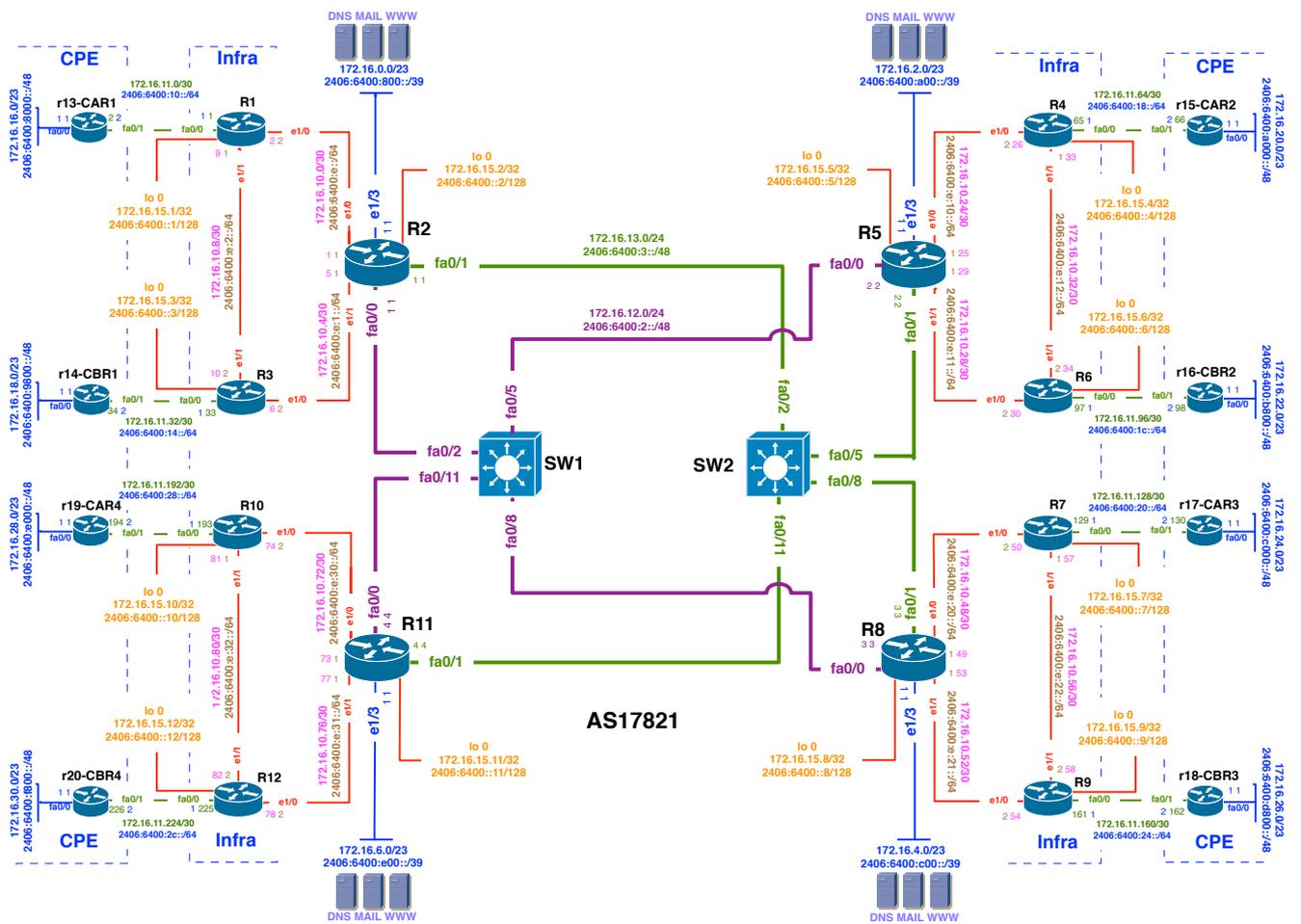


Figure 1 – ISP Lab Basic Configuration

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 one configuration in several steps as explained below:

1. Standard basic router configuration.
2. Standard interface related configuration for both IPv6 and IPv4.
3. Do necessary verification to make sure you can ping (Both IPv6 & IPv4) your neighbouring router point-to-point interface and satisfy the requirement to go to the next step.

For time management purpose we will emphasize more on IPv6 protocol when we will do verification and analysis after each lab exercise. Please notice that some Cisco commands are case sensitive, already enable by default in some recent IOS version and some are not a mandatory command for router functionality. But for lab troubleshooting and verification purpose it is strongly recommended that please do all necessary configuration exactly as it is explained in the instruction. Our objective after the exercise is to build a template for each participant so that it can be re-used after you go back to your work environment.

Lab Exercise

1. **Basic Router Configuration:** This will set the router with necessary basic configuration used in a real production router for both enterprise and service provider network.

Example Config on a Router:

```
config t
```

To enter into a cisco router global configuration mode.

```
hostname Router
```

Router host name which is an FQDN name mapped into a DNS server. There is a common practice about router hostname which is domain name then 3 digit airline city code then region/pop then a name etc. Example: router1.pop1reg1.BNE.apnic.net. Please use your router name according the topology diagram.

```
ip routing
```

It recent IOS this command is enable by default. So it can act as a router and start routing IP packet. To be safe add this command in your template. Need to look for equivalent IPv6 command if any command read IP/L3 header

```
ipv6 unicast-routing
```

Even in recent IOS [15.1(4)M3] this command is not enable by default. We must use this command so that router starts routing IPv6 packet. To be safe add this command in your template.

```
ip cef
```

Enable Cisco (Proprietary) Express Forwarding to process IPv4 packet faster.

```
ipv6 cef(Distributed)
```

Enable Cisco (Proprietary) Express Forwarding to process IPv6 packet faster. Some high end cisco router process packet using line card. Use `ipv6 cef distributed` instead on those routers.

```
no ip domain-lookup
```

To disable DNS resolver functionality on router if you do not use it. If yes then specify DNS server IP. There is no equivalent command for IPv6 yet [15.1(4)M3].

```
no ip http server
```

To disable HTTP server functionality on a router. Otherwise router is accessible from a browser and it consumes CPU and memory resources. We normally access router from a CLI. There is no equivalent command for IPv6 yet [15.1(4)M3].

```
no ip http secure-server
```

To disable HTTPS server functionality on a router. Otherwise router is accessible from a browser and it consumes router CPU and memory resources. We normally access router from CLI. There is no equivalent command for IPv6 yet [15.1(4)M3].

```
no ip finger
```

Finger service can be used to find out which users are logged into a router. Also a special DoS attack named “Finger of death” uses the finger service to continuously transmit finger requests to a given device consuming great amounts of processing resources. Depending of your IOS version it could be disable by default. To be safe add it in your command template. There is no equivalent command for IPv6 yet [15.1(4)M3].

```
no service pad
```

To disable Packet Assembler/Disassembler (PAD) service, which is used for X.25 networks in early days. If you do not use it now please disable it.

```
no service udp-small-servers
```

```
no service tcp-small-server
```

Depending on your cisco IOS version it offer by default small tcp/udp services that are basically a set of simple services that are used for diagnostic purposes. An attacker could maliciously use these services to gain system information and even launch Denial of Service (DoS) attacks to your router.

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```
no ip bootp server
```

A Cisco router can be configured to act as a BOOTP server and provide IOS software image to another Cisco network devices. This service could be used by an attacker to download a copy of a network device's IOS software. There is no equivalent command for IPv6 yet [15.1(4)M3].

```
no ip source-route  
no ipv6 source-route
```

An IP source routing function allows the sender of an IP packet to control the route that the packet will take towards its final destination. Source routing should be disabled when it's not needed because it could be used for various malicious attacks and also very CPU intensive function.

```
logging source-interface loopback 0
```

We need the router use the loopback address as the "source interface" for traffic that is generated by the router, such as syslog packets, SNMP traps, security related packets. Also DNS is mapped with the loopback address and FQDN name of the router.

```
service timestamps log datetime localtime msec show-timezone year  
service timestamps debug datetime localtime msec show-timezone year
```

Router will show either uptime or current date and time on the log it will generate based on the configuration on your router. We would like to record current date and time in msec unit for both log and debug messages to facilitate the log analysis if required.

```
clock timezone AEST 10
```

Set your router clock according to your local time zone. We used AEST 10 to reflect APNIC office where it is located and corresponding time zone.

```
ip subnet-zero
```

Under old IP subnetting rules, the all 0's subnet was reserved for the network, and the all 1's subnet was reserved for the broadcast. Over time this idea has been changed and we can use all 0's and all 1's subnet. Depending on your IOS version you might need to enable this on your cisco router. To be safe add this command in your template. IP subnet-zero concept is not applicable for IPv6 address family

```
ip classless
```

In old days routers are by default classful. Now we are in CIDR era. Depending on your cisco IOS version this command can be there by default. To be safe add this command in your template. IP classless concept is not applicable for IPv6 address family.

```
transport preferred none
```

By default telnet is the preferred protocol and when we mistyping a command the router will try to telnet the "name" we typed. If we set the transport preferred to none the router won't try to telnet when mistyping and we still can have DNS resolver enabled.

```
line console 0
logging synchronous
exit
```

Before the command:

```
SW1(config)#int vlan 1
SW1(config-if)#^Z
SW1#sh
*Mar  4 21:50:27.949: %SYS-5-CONFIG_I: Configured from console by consolerunn
```

After the command:

```
SW1(config-line)#logging synchronous
SW1(config-line)#exit
SW1(config)#int vlan
SW1(config)#int vlan 1
SW1(config-if)#^Z
SW1#sh
*Mar  4 21:53:24.890: %SYS-5-CONFIG_I: Configured from console by console
SW1#sh
```

```
ip tcp synwait-time 15
```

An attacker could flood a router with a high volume of TCP connection requests for which it does not return back an acknowledgement causing connection queues to fill up at the receiving host. Setting the TCP Synwait time to 15 seconds for example, will instruct the router to shut down any incomplete connections after 15 seconds. There is no equivalent command for IPv6 yet [15.1(4)M3].

```
security authentication failure rate 3 log
```

Configuring a router to lock access (for about 15 seconds) after three unsuccessful login attempts. This method protects a router from malicious attack (brute-force attack) and at the same time a log message is generated warning about the unsuccessful login attempts.

```
exit
wr
```

[wr] is an abbreviation or write command. Which will eventually copy (Save) the running configuration (From RAM) in to the startup-configuration (NVRAM) of cisco router.

END OF STEP ONE.....

- 2. Interface Related Configuration:** This will set the router with necessary interface related configuration (IPv6 and IPv4) used in a real production router for both enterprise and service provider network.

Example IPv4 Config on a Router:

```
config t
```

```
interface e1/0
```

To go to an interface configuration mode of a cisco router

```
description ||WAN R3-R2||
```

It is very important to add a meaningful description of a router interface to explain where this interface is connected. Otherwise we might be lost finding which interface connects where on a large data centre and need to jump behind the rack to look for a clue.

```
no ip redirects
```

This disables ICMP redirect messages. Redirects function happen when a router recognizes a packet arriving on an interface and the best route is out that same interface. In that case the router sends an ICMP redirect back to the source telling them about a better router on the same subnet. Subsequent packets take the redirected path. This function can be abused by an attacker who has got access to your layer 2 network to initiate man in the middle attack. Need to look for equivalent command for IPv6

```
no ip directed-broadcast
```

Every subnet in IPv4 has a broadcast address. If any packet arrives on a router with broadcast address as destination the router will amplify L2 frame on that interface. Any network attacker can initiate a traffic amplification attack in your LAN if directed broadcast is not disable on that Interface. Broadcast concept is not applicable in IPv6.

```
no ip unreachable
```

From a security point of view some one can initiate reconnaissance attack on a device and if you want to minimize the amount of information that the device can provides about itself to others this command is very useful. It also protect the router from the un wanted resource utilization on the device.

```
ip address 172.16.15.3 255.255.255.255
```

Assign IP address on a cisco router interface.

```
no shutdown
```

Cisco router interface is disable by default. Use this command to activate the interface to start processing IP packet.

Example IPv6 Config on a Router:

```
config t
interface loopback 0
ipv6 enable (Optional)
```

IPv6 enable command is only required if your router has only link local address but no global address will be configured.

```
ipv6 address 2406:6400:0000:0000::3/128
```

Please notice the [Network Prefix::Interface ID] part of the IPv6 global address configured on the interface. In this case interface is configured with static address and double colon is perfectly sitting in between.

```
interface e1/0
ipv6 address 2406:6400:000E:0001::2/64
interface e1/1
ipv6 address 2406:6400:000E:0002::2/64
interface fa0/0
ipv6 address 2406:6400:0014:0000::1/64
exit
exit
wr
```

END OF STEP TWO.....

3. Verify the neighbouring interface configuration:

Example IPv4 protocol verification on a Router:

```
ping 172.16.10.5          [!!!!!!]
ping 172.16.10.9          [!!!!!!]
```

You need to replace the destination IPv4 address with your relevant interface IPv4 address. Please look at the topology diagram on page 1 for further detail.

Example IPv6 protocol verification on a Router:

```
ping 2406:6400:000E:0000::1          [!!!!!!]
ping 2406:6400:000E:0002::2          [!!!!!!]
```

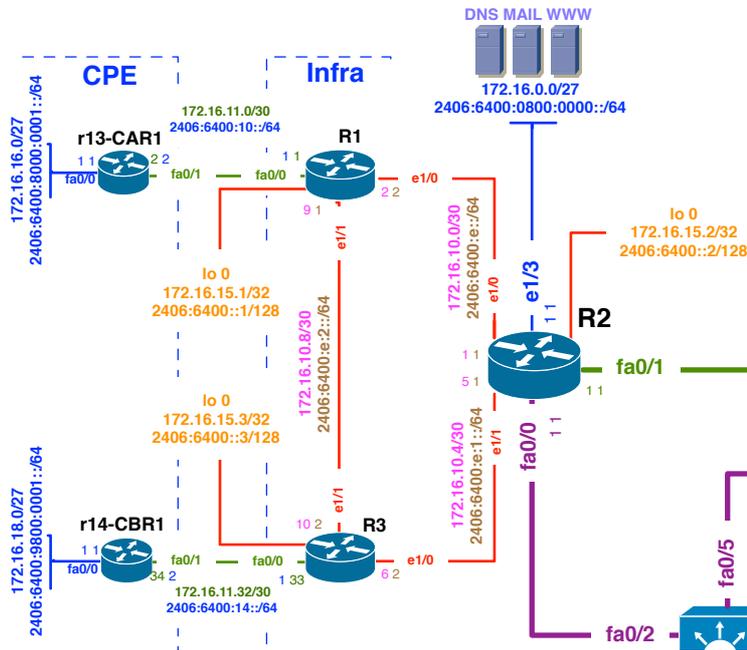
You need to replace the destination IPv6 address with your relevant interface IPv6 address. Please look at the topology diagram on page 1 for further detail.

END OF MODULE ONE.....

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

‘Workshop templates for reference purpose only’

Standard router configuration for training ISP network Region1:



Basic Conf Router1:

```
config t
hostname Router1
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
line console 0
logging synchronous
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
```

**Basic Conf Router2:**

```
config t
hostname Router2
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
line console 0
logging synchronous
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
```

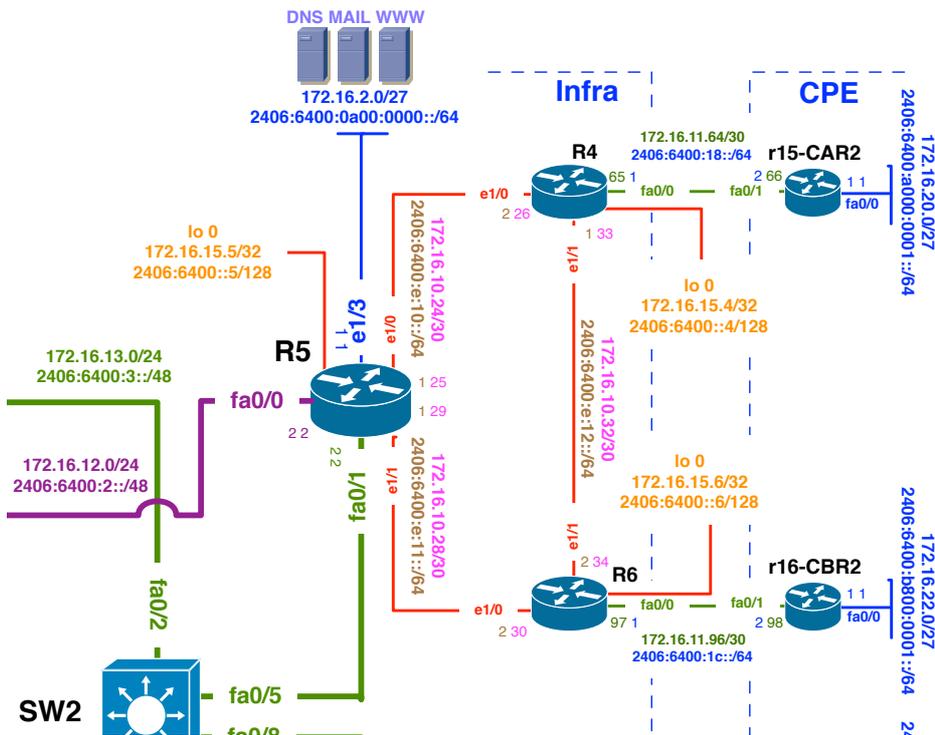
Basic Conf Router3:

```
config t
hostname Router3
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
line console 0
logging synchronous
```

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```
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
```

Standard router configuration for training ISP network Region2:



Basic Conf Router4

```

config t
hostname Router4
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
line console 0
logging synchronous
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
  
```

Basic Conf Router5

```
config t
hostname Router5
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
line console 0
logging synchronous
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
```

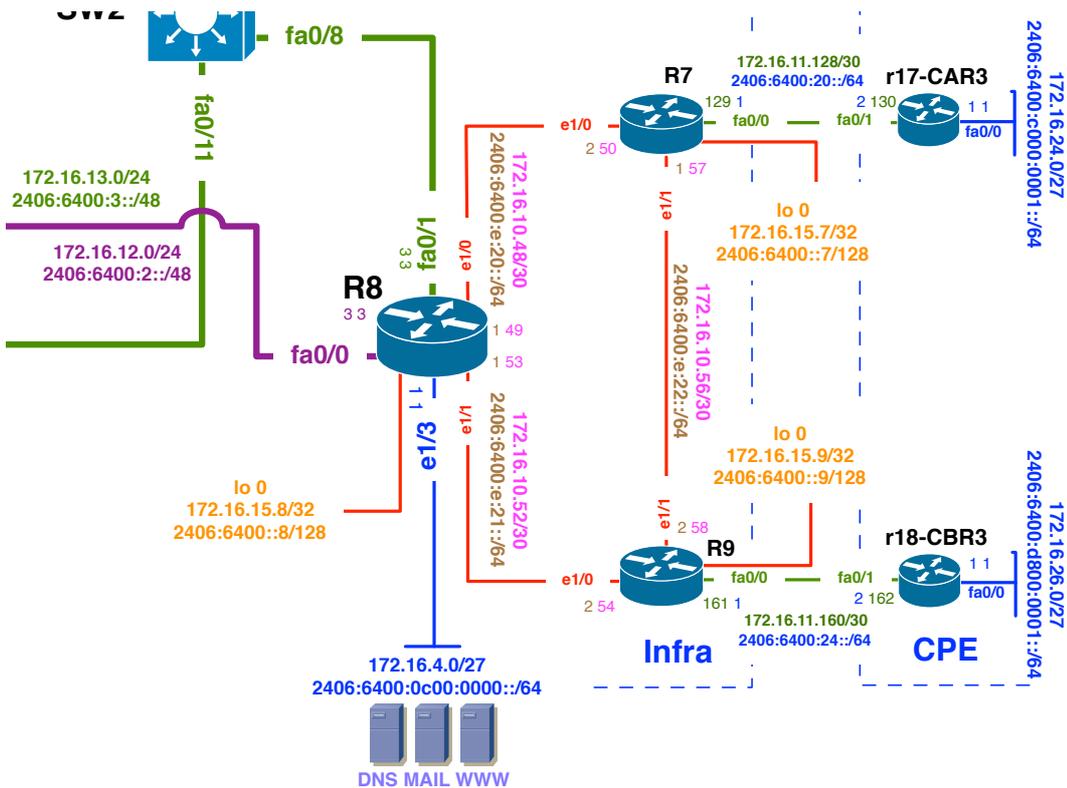
Basic Conf Router6

```
config t
hostname Router6
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
line console 0
logging synchronous
```



```
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
```

Standard router configuration for training ISP network Region3:



Basic Conf Router7:

```

config t
hostname Router7
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
line console 0
logging synchronous
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
    
```

**Basic Conf Router8:**

```
config t
hostname Router8
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
line console 0
logging synchronous
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
```

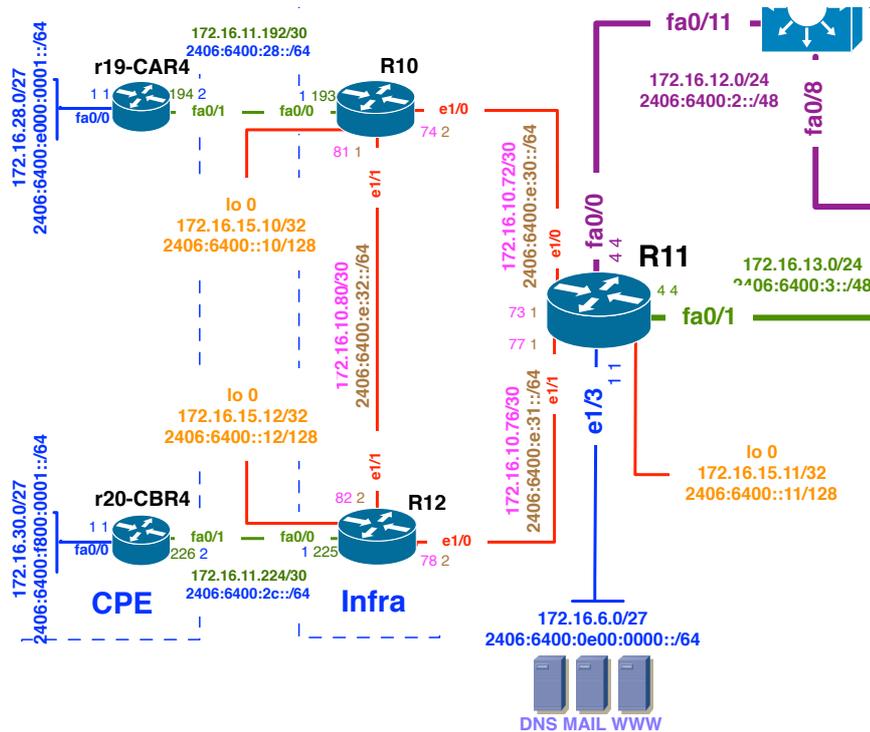
Basic Conf Router9:

```
config t
hostname Router9
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
line console 0
logging synchronous
```

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```
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
```

Standard router configuration for training ISP network Region4:



Basic Conf Router10:

```

config t
hostname Router10
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
line console 0
logging synchronous
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
  
```

Basic Conf Router11:

```
config t
hostname Router11
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
line console 0
logging synchronous
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
```

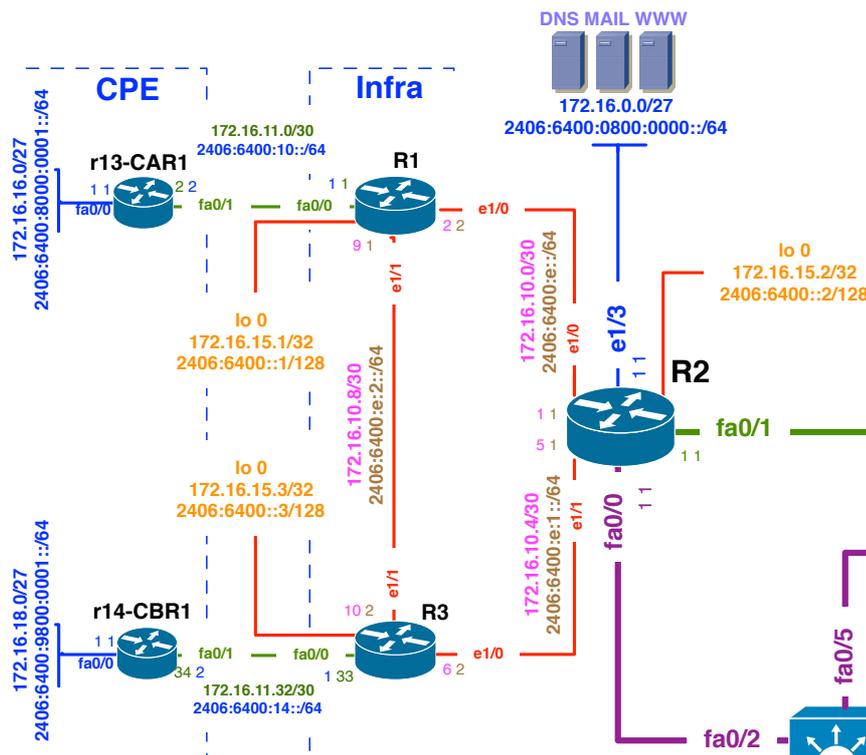
Basic Conf Router12:

```
config t
hostname Router12
ip routing
ipv6 unicast-routing
ip cef
ipv6 cef
no ip domain-lookup
no ip http server
no ip http secure-server
no ip finger
no service pad
no service udp-small-servers
no service tcp-small-server
no ip bootp server
no ip source-route
no ipv6 source-route
logging source-interface loopback 0
service timestamps log datetime localtime msec show-timezone year
service timestamps debug datetime localtime msec show-timezone year
clock timezone AEST 10
ip subnet-zero
ip classless
```



```
line console 0
logging synchronous
transport preferred none
ip tcp synwait-time 15
security authentication failure rate 3 log
exit
exit
wr
```

Interface configuration of training ISP network Region 1:



IPv4 Interface Conf Router1:

```

config t
interface loopback 0
description Router1 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachables
ip address 172.16.15.1 255.255.255.255
no shutdown
interface e1/0
description WAN R1-R2
no ip redirects
no ip directed-broadcast
no ip unreachables
ip address 172.16.10.2 255.255.255.252
no shutdown
interface e1/1
description WAN R1-R3
no ip redirects
no ip directed-broadcast
no ip unreachables
ip address 172.16.10.9 255.255.255.252
no shutdown
exit
exit
wr
    
```

Verify point-to-point connectivity:

```

ping 172.16.10.1          [!!!!!!]
ping 172.16.10.10       [!!!!!!]
    
```

**IPv6 Interface Conf Router1:**

```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::1/128
interface e1/0
ipv6 address 2406:6400:000E:0000::2/64
interface e1/1
ipv6 address 2406:6400:000E:0002::1/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0000::1      [!!!!!]
ping 2406:6400:000E:0002::2      [!!!!!]

```

IPv4 Interface Conf Router2:

```
config t
interface loopback 0
description Router2 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.15.2 255.255.255.255
no shutdown
interface e1/0
description WAN R2-R1
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.1 255.255.255.252
no shutdown
interface e1/1
description WAN R2-R3
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.5 255.255.255.252
no shutdown
interface fa0/0
description Purple Transport Link
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.12.1 255.255.255.0
no shutdown
interface fa0/1
description Green Transport Link
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.13.1 255.255.255.0
no shutdown
interface e1/3
description Router2 DC net
no ip redirects
```

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```
no ip directed-broadcast
no ip unreachable
ip address 172.16.0.1 255.255.255.224
no shutdown
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 172.16.10.2          [!!!!!]
ping 172.16.10.6          [!!!!!]

```

Verify transport link:

```
ping 172.16.12.2          [!!!!!]
ping 172.16.12.3          [!!!!!]
ping 172.16.12.4          [!!!!!]
ping 172.16.13.2          [!!!!!]
ping 172.16.13.3          [!!!!!]
ping 172.16.13.4          [!!!!!]

```

IPv6 Interface Conf Router2:

```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::2/128
interface e1/0
ipv6 address 2406:6400:000E:0000::1/64
interface e1/1
ipv6 address 2406:6400:000E:0001::1/64
interface fa0/0
ipv6 address 2406:6400:0002:0000::1/48
interface fa0/1
ipv6 address 2406:6400:0003:0000::1/48
interface e1/3
ipv6 address 2406:6400:0800:0000::1/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0000::2 [!!!!!]
ping 2406:6400:000E:0001::2 [!!!!!]

```

Verify transport link:

```
ping 2406:6400:0002:0000::2 [!!!!!]
ping 2406:6400:0002:0000::3 [!!!!!]
ping 2406:6400:0002:0000::4 [!!!!!]
ping 2406:6400:0003:0000::2 [!!!!!]
ping 2406:6400:0003:0000::3 [!!!!!]
ping 2406:6400:0003:0000::4 [!!!!!]

```

**IPv4 Interface Conf Router3:**

```
config t
interface loopback 0
description Router3 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.15.3 255.255.255.255
no shutdown
interface e1/0
description WAN R3-R2
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.6 255.255.255.252
no shutdown
interface e1/1
description WAN R3-R1
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.10 255.255.255.252
no shutdown
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 172.16.10.5          [!!!!!]
ping 172.16.10.9          [!!!!!]

```

IPv6 Interface Conf Router3:

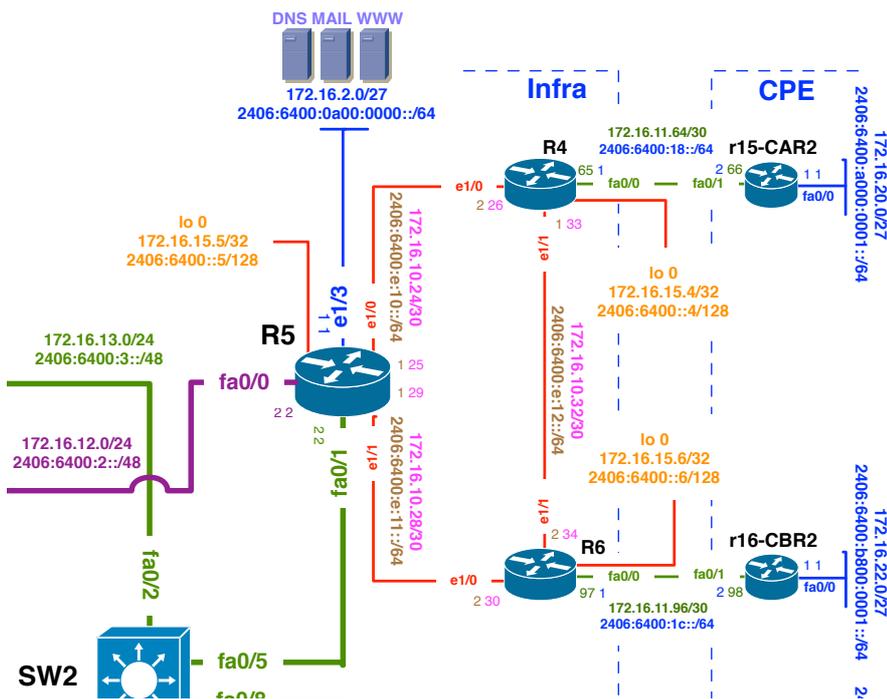
```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::3/128
interface e1/0
ipv6 address 2406:6400:000E:0001::2/64
interface e1/1
ipv6 address 2406:6400:000E:0002::2/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0001::1 [!!!!!]
ping 2406:6400:000E:0002::1 [!!!!!]

```

Interface configuration of training ISP network Region 2:



IPv4 Interface Conf Router4

```

config t
interface loopback 0
description Router4 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.15.4 255.255.255.255
no shutdown
interface e1/0
description WAN R4-R5
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.26 255.255.255.252
no shutdown
interface e1/1
description WAN R4-R6
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.33 255.255.255.252
no shutdown
exit
exit
wr
    
```

Verify point-to-point connectivity:

```

ping 172.16.10.25          [!!!!!]
ping 172.16.10.34          [!!!!!]
    
```

**IPv6 Interface Conf Router4:**

```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::4/128
interface e1/0
ipv6 address 2406:6400:000E:0010::2/64
interface e1/1
ipv6 address 2406:6400:000E:0012::1/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0010::1      [!!!!!]
ping 2406:6400:000E:0012::2      [!!!!!]

```

IPV4 Interface Conf Router5:

```
config t
interface loopback 0
description Router5 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.15.5 255.255.255.255
no shutdown
interface e1/0
description WAN R5-R4
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.25 255.255.255.252
no shutdown
interface e1/1
description WAN R5-R6
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.29 255.255.255.252
no shutdown
interface fa0/0
description Purple Transport Link
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.12.2 255.255.255.0
no shutdown
interface fa0/1
description Green Transport Link
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.13.2 255.255.255.0
no shutdown
interface e1/3
description Router5 DC net
no ip redirects
```

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```
no ip directed-broadcast
no ip unreachable
ip address 172.16.2.1 255.255.255.224
no shutdown
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 172.16.10.26      [!!!!!!]
ping 172.16.10.30      [!!!!!!]
```

Verify transport link:

```
ping 172.16.12.1      [!!!!!!]
ping 172.16.12.3      [!!!!!!]
ping 172.16.12.4      [!!!!!!]
ping 172.16.13.1      [!!!!!!]
ping 172.16.13.3      [!!!!!!]
ping 172.16.13.4      [!!!!!!]
```

IPv6 Interface Conf Router5:

```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::5/128
interface e1/0
ipv6 address 2406:6400:000E:0010::1/64
interface e1/1
ipv6 address 2406:6400:000E:0011::1/64
interface fa0/0
ipv6 address 2406:6400:0002:0000::2/48
interface fa0/1
ipv6 address 2406:6400:0003:0000::2/48
interface e1/3
ipv6 address 2406:6400:0A00:0000::1/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0010::2  [!!!!!!]
ping 2406:6400:000E:0011::2  [!!!!!!]
```

Verify transport link:

```
ping 2406:6400:0002:0000::1  [!!!!!!]
ping 2406:6400:0002:0000::3  [!!!!!!]
ping 2406:6400:0002:0000::4  [!!!!!!]
ping 2406:6400:0003:0000::1  [!!!!!!]
ping 2406:6400:0003:0000::3  [!!!!!!]
ping 2406:6400:0003:0000::4  [!!!!!!]
```

**IPv4 Interface Conf Router6:**

```
config t
interface loopback 0
description Router6 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.15.6 255.255.255.255
no shutdown
interface e1/0
description WAN R6-R5
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.30 255.255.255.252
no shutdown
interface e1/1
description WAN R6-R4
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.34 255.255.255.252
no shutdown
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 172.16.10.29      [!!!!!]
ping 172.16.10.33     [!!!!!]

```

IPv6 Interface Conf Router6:

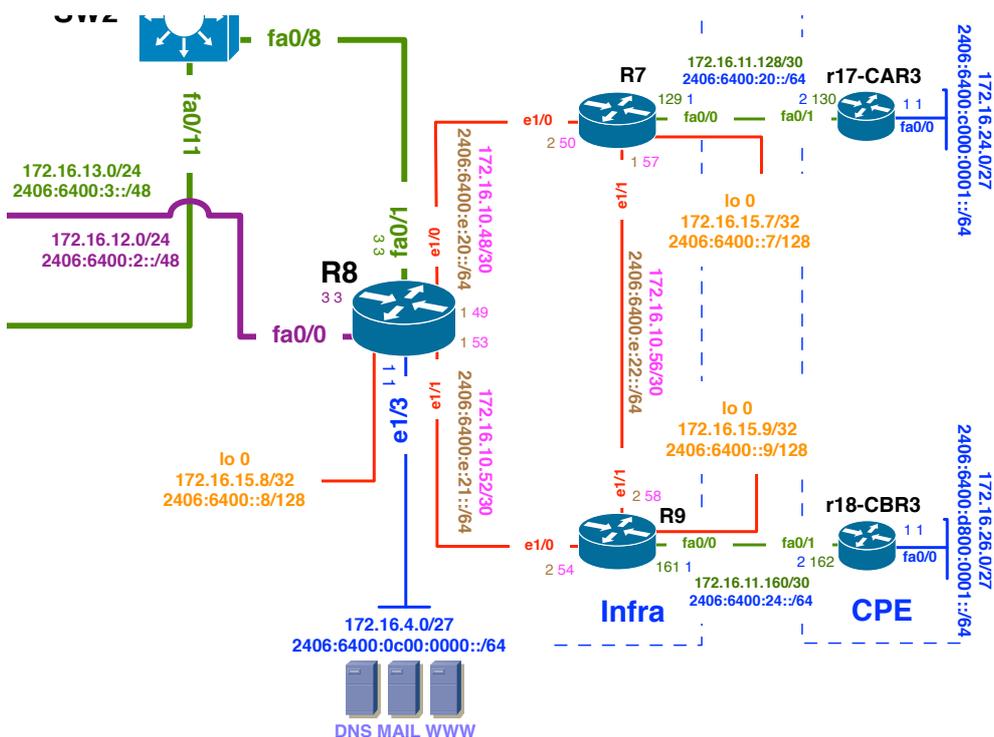
```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::6/128
interface e1/0
ipv6 address 2406:6400:000E:0011::2/64
interface e1/1
ipv6 address 2406:6400:000E:0012::2/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0011::1      [!!!!!]
ping 2406:6400:000E:0012::1      [!!!!!]

```

Interface configuration of training ISP network Region 3:



IPv4 Interface Conf Router7:

```

config t
interface loopback 0
description Router7 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachables
ip address 172.16.15.7 255.255.255.255
no shutdown
interface e1/0
description WAN R7-R8
no ip redirects
no ip directed-broadcast
no ip unreachables
ip address 172.16.10.50 255.255.255.252
no shutdown
interface e1/1
description WAN R7-R9
no ip redirects
no ip directed-broadcast
no ip unreachables
ip address 172.16.10.57 255.255.255.252
no shutdown
exit
exit
wr
    
```

Verify point-to-point connectivity:

```

ping 172.16.10.49          [!!!!!!]
ping 172.16.10.58          [!!!!!!]
    
```



IPv6 Interface Conf Router7:

```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::7/128
interface e1/0
ipv6 address 2406:6400:000E:0020::2/64
interface e1/1
ipv6 address 2406:6400:000E:0022::1/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0020::1      [!!!!!]
ping 2406:6400:000E:0022::2      [!!!!!]

```

IPv4 Interface Conf Router8:

```
config t
interface loopback 0
description Router8 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.15.8 255.255.255.255
no shutdown
interface e1/0
description WAN R8-R7
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.49 255.255.255.252
no shutdown
interface e1/1
description WAN R8-R9
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.53 255.255.255.252
no shutdown
interface fa0/0
description Purple Transport Link
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.12.3 255.255.255.0
no shutdown
interface fa0/1
description Green Transport Link
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.13.3 255.255.255.0
no shutdown
interface e1/3
description Router8 DC net
no ip redirects
```

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```
no ip directed-broadcast
no ip unreachable
ip address 172.16.4.1 255.255.255.224
no shutdown
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 172.16.10.50      [!!!!!]
ping 172.16.10.54      [!!!!!]

```

Verify transport link:

```
ping 172.16.12.1      [!!!!!]
ping 172.16.12.2      [!!!!!]
ping 172.16.12.4      [!!!!!]
ping 172.16.13.1      [!!!!!]
ping 172.16.13.2      [!!!!!]
ping 172.16.13.4      [!!!!!]

```

IPv6 Interface Conf Router8:

```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::8/128
interface e1/0
ipv6 address 2406:6400:000E:0020::1/64
interface e1/1
ipv6 address 2406:6400:000E:0021::1/64
ipv6 enable
interface fa0/0
ipv6 address 2406:6400:0002:0000::3/48
interface fa0/1
ipv6 address 2406:6400:0003:0000::3/48
interface e1/3
ipv6 address 2406:6400:0C00:0000::1/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0020::2      [!!!!!]
ping 2406:6400:000E:0021::2      [!!!!!]

```

Verify transport link:

```
ping 2406:6400:0002:0000::1      [!!!!!]
ping 2406:6400:0002:0000::2      [!!!!!]
ping 2406:6400:0002:0000::4      [!!!!!]
ping 2406:6400:0003:0000::1      [!!!!!]
ping 2406:6400:0003:0000::2      [!!!!!]
ping 2406:6400:0003:0000::4      [!!!!!]

```

**IPv4 Interface Conf Router9:**

```
config t
interface loopback 0
description Router9 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.15.9 255.255.255.255
no shutdown
interface e1/0
description WAN R9-R8
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.54 255.255.255.252
no shutdown
interface e1/1
description WAN R9-R7
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.58 255.255.255.252
no shutdown
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 172.16.10.57          [!!!!!]
ping 172.16.10.53          [!!!!!]

```

IPv6 Interface Conf Router9:

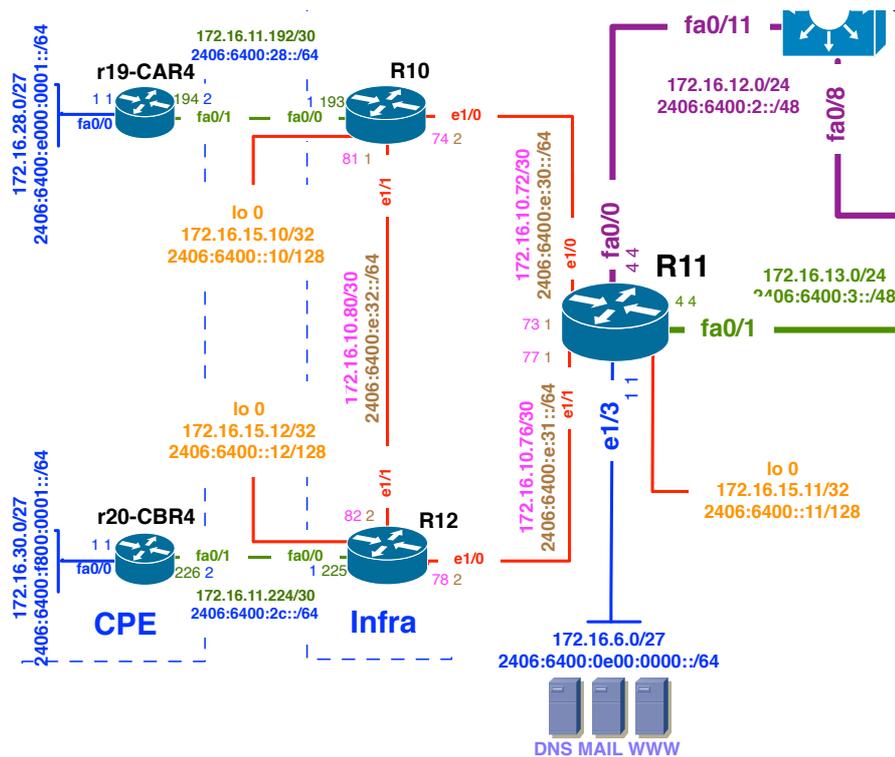
```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::9/128
interface e1/0
ipv6 address 2406:6400:000E:0021::2/64
interface e1/1
ipv6 address 2406:6400:000E:0022::2/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0021::1    [!!!!!]
ping 2406:6400:000E:0022::1    [!!!!!]

```

Interface configuration of training ISP network Region 4:



IPv4 Interface Conf Router10:

```

config t
interface loopback 0
description Router10 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.15.10 255.255.255.255
no shutdown
interface e1/0
description WAN R10-R11
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.74 255.255.255.252
no shutdown
interface e1/1
description WAN R10-R12
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.81 255.255.255.252
no shutdown
exit
exit
wr
    
```

Verify point-to-point connectivity:

```

ping 172.16.10.73      [!!!!!!]
ping 172.16.10.82     [!!!!!!]
    
```

**IPv6 Interface Conf Router10:**

```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::10/128
interface e1/0
ipv6 address 2406:6400:000E:0030::2/64
interface e1/1
ipv6 address 2406:6400:000E:0032::1/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0030::1          [!!!!!]
ping 2406:6400:000E:0032::2          [!!!!!]

```

IPv4 Interface Conf Router11:

```
config t
interface loopback 0
description Router11 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.15.11 255.255.255.255
no shutdown
interface e1/0
description WAN R11-R10
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.73 255.255.255.252
no shutdown
interface e1/1
description WAN R11-R12
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.77 255.255.255.252
no shutdown
interface fa0/0
description Purple Transport Link
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.12.4 255.255.255.0
no shutdown
interface fa0/1
description Green Transport Link
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.13.4 255.255.255.0
no shutdown
interface e1/3
description Router11 DC net
no ip redirects
```

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```
no ip directed-broadcast
no ip unreachable
ip address 172.16.6.1 255.255.255.224
no shutdown
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 172.16.10.74      [!!!!!!]
ping 172.16.10.78      [!!!!!!]
```

Verify transport link:

```
ping 172.16.12.1      [!!!!!!]
ping 172.16.12.2      [!!!!!!]
ping 172.16.12.3      [!!!!!!]
ping 172.16.13.1      [!!!!!!]
ping 172.16.13.2      [!!!!!!]
ping 172.16.13.3      [!!!!!!]
```

IPv6 Interface Conf Router11:

```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::11/128
interface e1/0
ipv6 address 2406:6400:000E:0030::1/64
interface e1/1
ipv6 address 2406:6400:000E:0031::1/64
interface fa0/0
ipv6 address 2406:6400:0002:0000::4/48
interface fa0/1
ipv6 address 2406:6400:0003:0000::4/48
interface e1/3
ipv6 address 2406:6400:0E00:0000::1/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0030::2      [!!!!!!]
ping 2406:6400:000E:0031::2      [!!!!!!]
```

Verify transport link:

```
ping 2406:6400:0002:0000::1      [!!!!!!]
ping 2406:6400:0002:0000::2      [!!!!!!]
ping 2406:6400:0002:0000::3      [!!!!!!]
ping 2406:6400:0003:0000::1      [!!!!!!]
ping 2406:6400:0003:0000::2      [!!!!!!]
ping 2406:6400:0003:0000::3      [!!!!!!]
```

**IPv4 Interface Conf Router12:**

```
config t
interface loopback 0
description Router12 Loopback
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.15.12 255.255.255.255
no shutdown
interface e1/0
description WAN R12-R11
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.78 255.255.255.252
no shutdown
interface e1/1
description WAN R12-R10
no ip redirects
no ip directed-broadcast
no ip unreachable
ip address 172.16.10.82 255.255.255.252
no shutdown
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 172.16.10.81      [!!!!!]
ping 172.16.10.77     [!!!!!]

```

IPv6 Interface Conf Router12:

```
config t
interface loopback 0
ipv6 address 2406:6400:0000:0000::12/128
interface e1/0
ipv6 address 2406:6400:000E:0031::2/64
interface e1/1
ipv6 address 2406:6400:000E:0032::2/64
exit
exit
wr
```

Verify point-to-point connectivity:

```
ping 2406:6400:000E:0031::1      [!!!!!]
ping 2406:6400:000E:0032::1      [!!!!!]

```