CCNP

CISCO CERTIFIED NETWORK PROFESSIONAL

LAB MANUAL

VER 2

PAPER 1

Routing

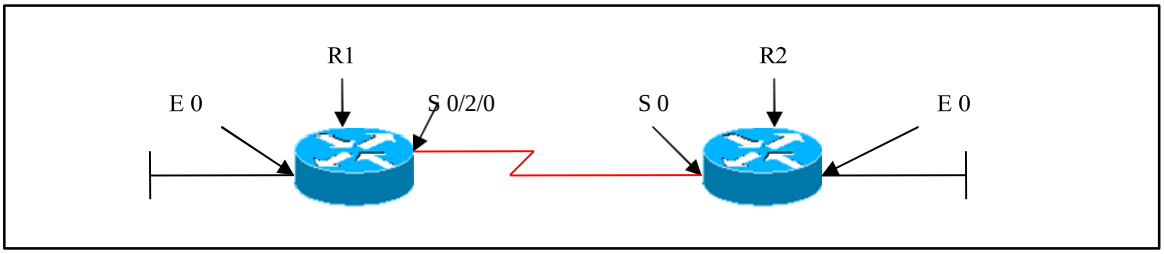
BUILDING SCALABLE CISCO INTERNETWORKS

BSCI (642–901)

Module 1 – EIGRP

EIGRP LABS INDEX

Lab 1 – Basic EIGRP Configuration



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
E 0	20.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure EIGRP on 2 routers in AS 100. Disable Auto-summary.

R1	R2
Router eigrp 100 Network 1.0.0.0 Network 10.0.0.0 No auto-summary	Router eigrp 100 Network 1.0.0.0 Network 20.0.0.0 No auto-summary

Verification :

R1#show ip route

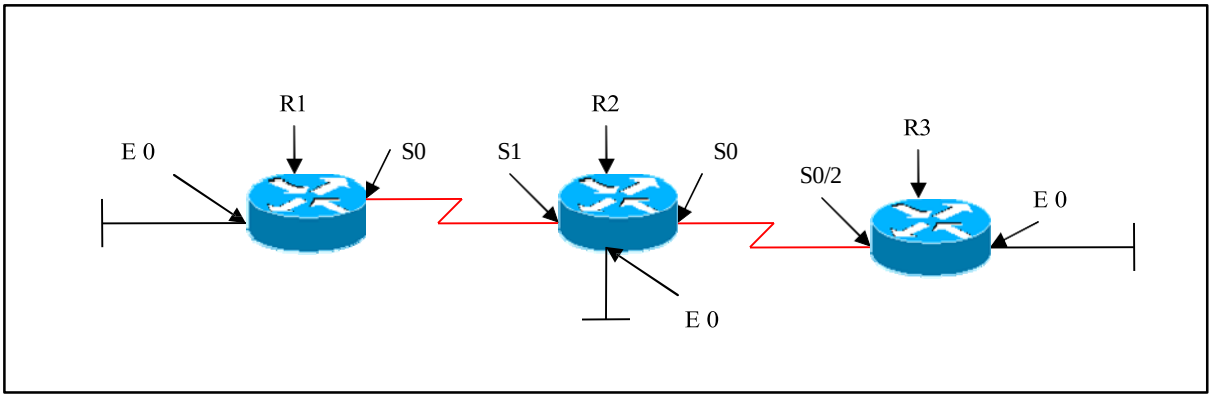
C 1.0.0.0/8 is directly connected, Serial0/2/0
D 20.0.0.0/8 [90/2195456] via 1.1.1.2, 00:43:52, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0

R1#show ip eigrp neighbors

IP-EIGRP neighbors for process 100

H	Address	Interface	Hold Uptime (sec)	SRTT (ms)	RTO	Q Cnt	Seq Num
0	1.1.1.2	Se0/2/0	13 00:45:08	355	2130	0	106

Lab 2 – Configuring ip default-network Command



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 1	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1	1.1.1.2	255.0.0.0
S0	2.2.2.1	255.0.0.0
E 0	30.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0/2	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure EIGRP according to the above scenario. Configure R1 (S0, E0), R2 (S1, S0, E0) in EIGRP AS 100 and R3 (S0/2) in EIGRP AS 200. Do not advertise network 30.0.0.0 in EIGRP process. R1 wants to send packets to network 30.0.0.0. Use the Ip default-network command to accomplish this task. Also disable auto-summary.

R1	R2
Router eigrp 100 Network 10.0.0.0 Network 1.0.0.0 No auto-summary	Router eigrp 100 Network 1.0.0.0 Network 20.0.0.0 Network 2.0.0.0 No auto-summary Ip route 30.0.0.0 255.0.0.0 2.2.2.2 Ip default-network 2.0.0.0
R3 Router eigrp 100 Network 2.0.0.0 No auto-summary.	

Verification :

R1#show ip route

Gateway of last resort is 1.1.1.2 to network 2.0.0.0

C 1.0.0.0/8 is directly connected, Serial0/2/0
D* 2.0.0.0/8 [90/2681856] via 1.1.1.2, 00:00:14, Serial0/2/0
D 20.0.0.0/8 [90/2195456] via 1.1.1.2, 00:04:43, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0

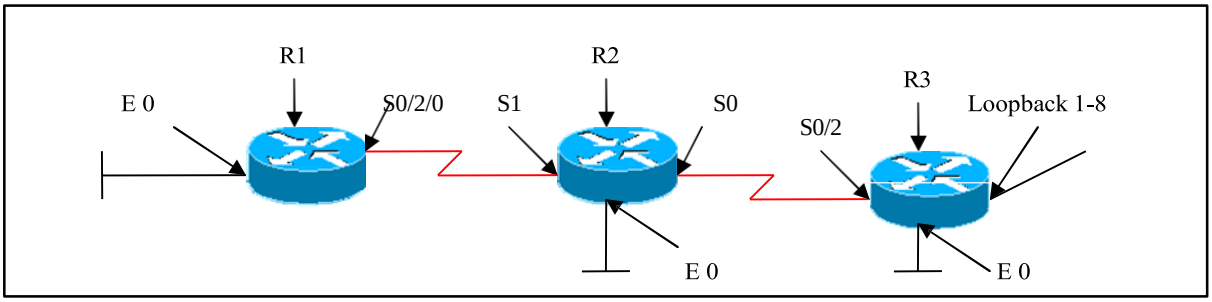
The output displays network 2.0.0.0 as a D* route in the routing table as this is candidate default-route established in R1 to reach network 30.0.0.0.

Note: When we ping from R1 to 30.1.1.1 network

R1 # ping 30.1.1.1

Result: 100% success

Lab 3 – Route Summarization with EIGRP



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1	1.1.1.2	255.0.0.0
S0	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0/2	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0
Loopback 1	172.168.0.1	255.255.255.0
Loopback 2	172.168.1.1	255.255.255.0
Loopback 3	172.168.2.1	255.255.255.0
Loopback 4	172.168.3.1	255.255.255.0
Loopback 5	172.168.4.1	255.255.255.0
Loopback 6	172.168.5.1	255.255.255.0
Loopback 7	172.168.6.1	255.255.255.0
Loopback 8	172.168.7.1	255.255.255.0

Lab Objective:

Task 1

Configure the following Loopback Interfaces on R3 and advertise them under EIGRP:

Loopback 1: 172.168.0.1/24
Loopback 2: 172.168.1.1/24
Loopback 3: 172.168.2.1/24
Loopback 4: 172.168.3.1/24
Loopback 5: 172.168.4.1/24
Loopback 6: 172.168.5.1/24
Loopback 7: 172.168.6.1/24
Loopback 8: 172.168.7.1/24

R3

```
Interface loopback 1
 Ip address 172.168.0.1 255.255.255.0
Interface loopback 2
 Ip address 172.168.1.1 255.255.255.0
Interface loopback 3
 Ip address 172.168.2.1 255.255.255.0
Interface loopback 4
 Ip address 172.168.3.1 255.255.255.0
Interface loopback 5
 Ip address 172.168.4.1 255.255.255.0
Interface loopback 6
 Ip address 172.168.5.1 255.255.255.0
Interface loopback 7
 Ip address 172.168.6.1 255.255.255.0
Interface loopback 8
 Ip address 172.168.7.1 255.255.255.0

Router eigrp 100
Network 2.0.0.0
Network30.0.0.0
Network 172.168.1.0 0.0.0.255
Network 172.168.2.0 0.0.0.255
Network 172.168.3.0 0.0.0.255
Network 172.168.4.0 0.0.0.255
Network 172.168.5.0 0.0.0.255
Network 172.168.6.0 0.0.0.255
Network 172.168.7.0 0.0.0.255
Network 172.168.0.0 0.0.0.255
No auto-summary
```

Task 2

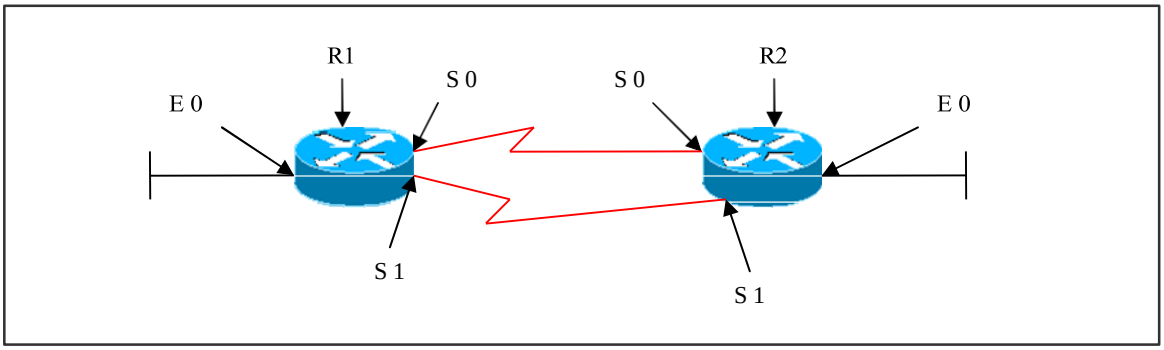
Configure EIGRP on R1 and R2. Advertise the directly connected networks in EIGRP in AS 100. Disable auto-summary. Also configure route summarization so that only one summary route is advertised to R1.

R1	R2
Router eigrp 100 Network 10.0.0.0 Network 1.0.0.0 No auto-summary	Router eigrp 100 Network 1.0.0.0 Network 20.0.0.0 Network 2.0.0.0 No auto-summary Int s0 Ip summary-address eigrp 100 172.168.0.0 255.255.248.0

Verification:

R1#show ip route
C 1.0.0.0/8 is directly connected, Serial0/2/0
D 2.0.0.0/8 [90/2681856] via 1.1.1.2, 00:00:02, Serial0/2/0
D 20.0.0.0/8 [90/2195456] via 1.1.1.2, 00:00:02, Serial0/2/0
172.168.0.0/21 is subnetted, 1 subnets
D 172.168.0.0 [90/2809856] via 1.1.1.2, 00:00:02, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0
D 30.0.0.0/8 [90/2707456] via 1.1.1.2, 00:00:02, Serial0/2/0
With route summarization on R2 a summary route is created pointing to null 0
R2#show ip route
C 1.0.0.0/8 is directly connected, Serial0
C 2.0.0.0/8 is directly connected, Serial1
C 20.0.0.0/8 is directly connected, Ethernet0
172.168.0.0/16 is variably subnetted, 9 subnets, 2 masks
D 172.168.4.0/24 [90/2297856] via 2.2.2.2, 00:07:13, Serial1
D 172.168.5.0/24 [90/2297856] via 2.2.2.2, 00:07:08, Serial1
D 172.168.6.0/24 [90/2297856] via 2.2.2.2, 00:07:04, Serial1
D 172.168.7.0/24 [90/2297856] via 2.2.2.2, 00:06:56, Serial1
D 172.168.0.0/24 [90/2297856] via 2.2.2.2, 00:06:49, Serial1
D 172.168.0.0/21 is a summary, 00:01:24, Null0
D 172.168.1.0/24 [90/2297856] via 2.2.2.2, 00:07:33, Serial1
D 172.168.2.0/24 [90/2297856] via 2.2.2.2, 00:07:25, Serial1
D 172.168.3.0/24 [90/2297856] via 2.2.2.2, 00:07:18, Serial1
D 10.0.0.0/8 [90/2172416] via 1.1.1.1, 00:01:30, Serial0
D 30.0.0.0/8 [90/2195456] via 2.2.2.2, 00:08:03, Serial1

Lab 4 – Load balancing across Equal Cost Path



Interface IP Address Configuration

R2

Interface	IP Address	Subnet Mask
S 0	2.2.2.1	255.0.0.0
S 1	1.1.1.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 1	1.1.1.2	255.0.0.0
S0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure EIGRP AS 100 as per the above scenario and verify load balancing using the traceroute command on R3 :

R2	R3
Router eigrp 100 Network 20.0.0.0	Router eigrp 100 Network 1.0.0.0

Network 1.0.0.0 Network 2.0.0.0 No auto-summary	Network 30.0.0.0 Network 2.0.0.0 No auto-summary

Verification:

R3#show ip route

C 1.0.0.0/8 is directly connected, Serial1
C 2.0.0.0/8 is directly connected, Serial0
D 20.0.0.0/8 [90/2195456] via 1.1.1.1, 00:07:42, Serial1
[90/2195456] via 2.2.2.1, 00:07:42, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0

First Traceroute packet going via 1.1.1.1

R3#traceroute 20.1.1.1

Type escape sequence to abort.
Tracing the route to 20.1.1.1

1 1.1.1.1 32 msec
2.2.2.1 20 msec *

Second Traceroute packet going via 2.2.2.1

R3#traceroute 20.1.1.1

Type escape sequence to abort.
Tracing the route to 20.1.1.1

1 2.2.2.1 20 msec
1.1.1.1 28 msec *

Lab 5 – Load balancing across Unequal Cost Path

(Scenario Based On Lab 4)
Interface IP Address Configuration

R2

Interface	IP Address	Subnet Mask
S 0	2.2.2.1	255.0.0.0
S 1	1.1.1.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 1	1.1.1.2	255.0.0.0
S0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure EIGRP AS 100 as per the above scenario. Make the links unequal cost paths using the bandwidth command in interface mode and verify load balancing.

Use the variance command to gain load balancing

R1	R2
Router eigrp 100 Network 20.0.0.0 Network 1.0.0.0 Network 2.0.0.0 No auto-summary	Router eigrp 100 Network 1.0.0.0 Network 30.0.0.0 Network 2.0.0.0 Variance 2 No auto-summary Interface S 0 Bandwidth 800

The variance multiplier set in the variance command when multiplied by the successor FD, must be greater than the feasible successor FD. Thus the feasible successors whose FD is less than the above calculated value are installed in the routing table.

Verification:

With out the variance command:

R2#sh ip eigrp topology

P 1.0.0.0/8, 1 successors, FD is 2169856
via Connected, Serial1
P 2.0.0.0/8, 1 successors, FD is 3712000
via Connected, Serial0
via 1.1.1.2 (2681856/2169856), Serial1
P 20.0.0.0/8, 1 successors, FD is 281600
via Connected, Ethernet0
P 30.0.0.0/8, 1 successors, FD is 2195456
via 1.1.1.2 (2195456/281600), Serial1
via 2.2.2.2 (3737600/281600), Serial0

The output displays 2 routes installed in the topology table with 2 different costs.

R2#show ip route

C 1.0.0.0/8 is directly connected, Serial1
C 2.0.0.0/8 is directly connected, Serial0
C 20.0.0.0/8 is directly connected, Ethernet0
D 30.0.0.0/8 [90/2195456] via 1.1.1.2, 00:01:42, Serial1

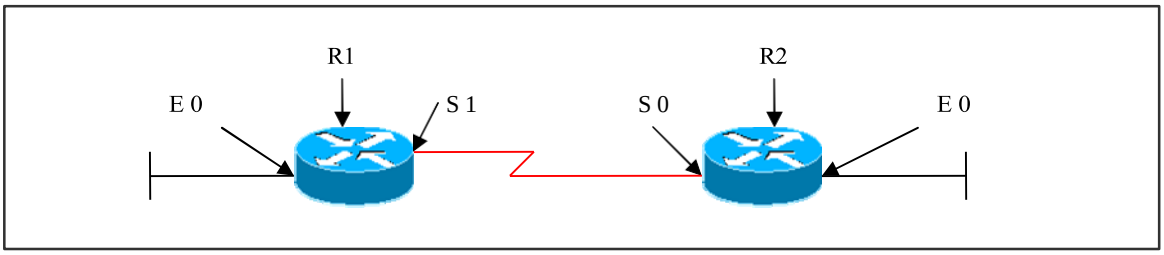
With the variance command:

R2#show ip route

C 1.0.0.0/8 is directly connected, Serial1
C 2.0.0.0/8 is directly connected, Serial0
C 20.0.0.0/8 is directly connected, Ethernet0
D 30.0.0.0/8 [90/2195456] via 1.1.1.2, 00:00:04, Serial1
[90/3737600] via 2.2.2.2, 00:00:04, Serial0

The output displays 2 routes installed in the routing table.

Lab 6 – EIGRP Authentication



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure MD5 authentication for the links. Use cisco123 as the key-string with a key-id of 1.

R1	R2
Int S1 Ip authentication mode eigrp 100 md5 Ip authentication key-chain eigrp 100 chain1 Key chain chain1 Key 1 Key-string cisco123	Int S 0 Ip authentication mode eigrp 100 md5 Ip authentication key-chain eigrp 100 chain 2 Key chain chain 2 Key 1 Key-string cisco123

Verification

With EIGRP Authentication:

R2#show ip eigrp neighbors

IP-EIGRP neighbors for process 100

H	Address	Interface	Hold Uptime (sec)	SRTT (ms)	RTO	Q Cnt	Seq Num
0	2.2.2.2	Se1	14 00:00:24	40	240	0	2

Verify authentication by using debug EIGRP packets

R2#debug eigrp packets

*Mar 1 02:52:50.895: EIGRP: Sending HELLO on Ethernet0
*Mar 1 02:52:50.899: AS 100, Flags 0x0, Seq 0/0 idbQ 0/0 iidbQ un/rely 0/0
*Mar 1 02:52:53.219: EIGRP: received packet with MD5 authentication, key id = 1

*Mar 1 02:52:53.223: EIGRP: Received HELLO on Serial1 nbr 2.2.2.2
*Mar 1 02:52:53.223: AS 100, Flags 0x0, Seq 0/0 idbQ 0/0 iidbQ un/rely 0/0 p

With authentication mismatch:

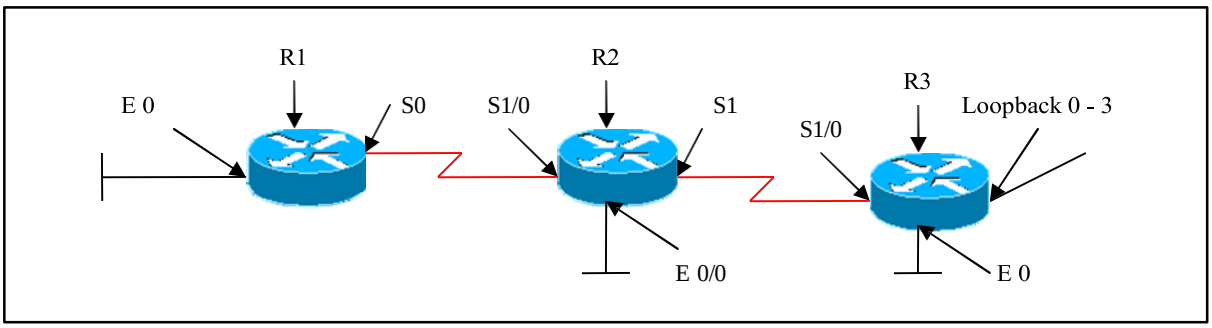
R2#show ip eigrp neighbors

IP-EIGRP neighbors for process 100
----------NIL----------

R2#debug eigrp packets

*Mar 1 02:58:05.895: EIGRP: Sending HELLO on Serial1
*Mar 1 02:58:05.895: AS 100, Flags 0x0, Seq 0/0 idbQ 0/0 iidbQ un/rely 0/0
*Mar 1 02:58:06.347: EIGRP: Sending HELLO on Ethernet0
*Mar 1 02:58:06.351: AS 100, Flags 0x0, Seq 0/0 idbQ 0/0 iidbQ un/rely 0/0
*Mar 1 02:58:08.471: EIGRP: pkt key id = 1, authentication mismatch
*Mar 1 02:58:08.475: EIGRP: Serial1: ignored packet from 2.2.2.2, opcode = 5 (invalid authentication)

Lab 7 – Configuring EIGRP STUB



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	2.2.2.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1/0	2.2.2.2	255.0.0.0
S1	3.3.3.1	255.0.0.0
E 0/0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 1/0	3.3.3.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0
Loopback 0	172.168.0.1	255.255.255.0
Loopback 1	172.168.1.1	255.255.255.0
Loopback 2	172.168.2.1	255.255.255.0
Loopback 3	172.168.3.1	255.255.255.0

Lab Objective:

Task 1

Configure EIGRP AS 100 as per the above scenario on R1, R2 and R3. Disable auto-summary. Only one summary route must be advertised to R2 and R1

R1	R2
Router eigrp 100 Network 2.0.0.0 Network 10.0.0.0 No auto-summary	Router eigrp 100 Network 2.0.0.0 Network 3.0.0.0 Network 20.0.0.0 No auto-summary
R3 Router eigrp 100 Network 3.0.0.0 Network 30.0.0.0 Network 172.168.0.0 No auto-summary Interface s 1/0 Ip summary-address eigrp 100 172.168.0.0 255.255.252.0	

Verification:

Without configuring stub in R3:

R2#show ip route

C 2.0.0.0/8 is directly connected, Serial1/0
C 3.0.0.0/8 is directly connected, Serial1/1
C 20.0.0.0/8 is directly connected, Ethernet0/0
172.168.0.0/22 is subnetted, 1 subnets
D 172.168.0.0 [90/20640000] via 3.3.3.2, Serial1/1
D 10.0.0.0/8 [90/20537600] via 2.2.2.1, Serial1/0
D 30.0.0.0/8 [90/20537600] via 3.3.3.2, Serial1/1

The output displays directly connected routes, summary route and Eigrp routes.

Task 2 :

Configure Eigrp Stub on R3, preventing R3 to send any routes to R2, but R2 receives routes from R1.

```
R3

Router eigrp 100
Eigrp stub receive-only
```

Verification:

R2#show ip route

C 2.0.0.0/8 is directly connected, Serial1/0
C 3.0.0.0/8 is directly connected, Serial1/1
C 20.0.0.0/8 is directly connected, Ethernet0/0
D 10.0.0.0/8 [90/20537600] via 2.2.2.1, Serial1/0

The output displays only network 10.0.0.0 (eigrp route) coming from R1 but no eigrp routes from R3.

Task 3 :

Configure Eigrp Stub on R3, allowing R3 to send only connected routes to R2, but R2 receives any routes from R1.

```
R3

Router eigrp 100
Eigrp stub connected
```

Verification:

R2#show ip route

C 2.0.0.0/8 is directly connected, Serial1/0
C 3.0.0.0/8 is directly connected, Serial1/1
C 20.0.0.0/8 is directly connected, Ethernet0/0
   172.168.0.0/24 is subnetted, 4 subnets
D   172.168.0.0 [90/20640000] via 3.3.3.2, Serial1/1
D   172.168.1.0 [90/20640000] via 3.3.3.2, Serial1/1
D   172.168.2.0 [90/20640000] via 3.3.3.2, Serial1/1
D   172.168.3.0 [90/20640000] via 3.3.3.2, Serial1/1
D 10.0.0.0/8 [90/20537600] via 2.2.2.1, Serial1/0

D 30.0.0.0/8 [90/20537600] via 3.3.3.2, Serial1/1

The output displays only connected eigrp routes from R3 to R2, but receives all routes from R1.

Task 4 :

Configure Eigrp Stub on R3, allowing only summary routes from R3 to R2, but R2 receives any routes from R1.

```
R3

Router eigrp 100
Eigrp stub summary
```

Verification:

R2#show ip route

C 2.0.0.0/8 is directly connected, Serial1/0
C 3.0.0.0/8 is directly connected, Serial1/1
C 20.0.0.0/8 is directly connected, Ethernet0/0
172.168.0.0/22 is subnetted, 1 subnets
D 172.168.0.0 [90/20640000] via 3.3.3.2, Serial1/1
D 10.0.0.0/8 [90/20537600] via 2.2.2.1, Serial1/0

The output displays only summary route from R3, and also all routes from R1.

Task 5 :

Configure Eigrp Stub on R3, allowing connected and summary routes from R3 to R2, but R2 receives any routes from R1.

```
R3

Router eigrp 100
Eigrp stub
```

Verification:

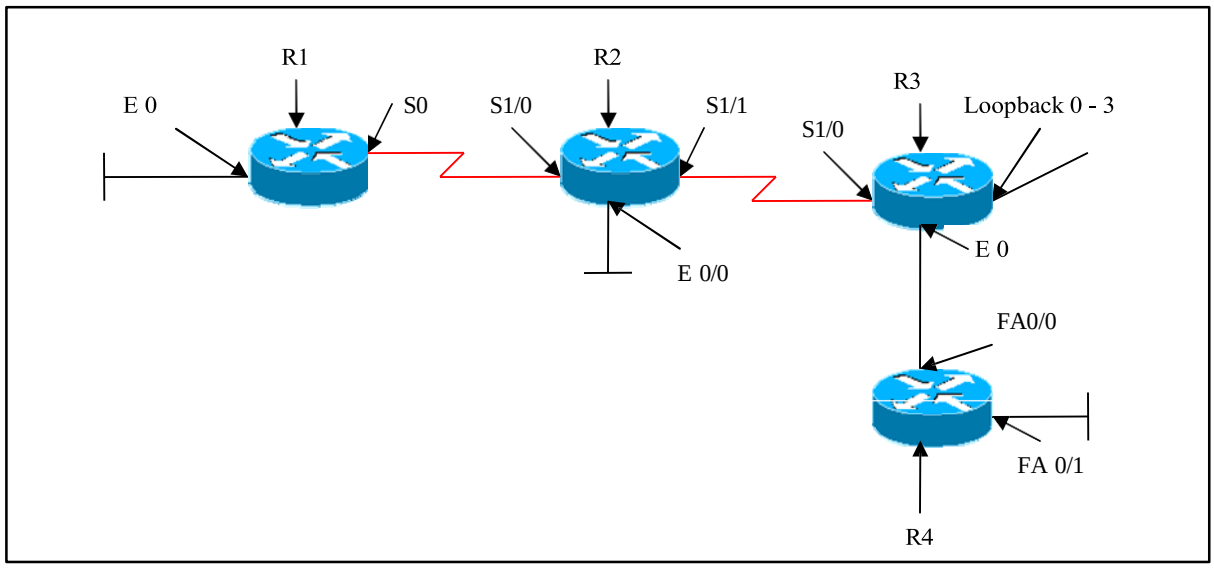
R2#show ip route

C 2.0.0.0/8 is directly connected, Serial1/0

C 3.0.0.0/8 is directly connected, Serial1/1
C 20.0.0.0/8 is directly connected, Ethernet0/0
172.168.0.0/22 is subnetted, 1 subnets
D 172.168.0.0 [90/20640000] via 3.3.3.2, Serial1/1
D 10.0.0.0/8 [90/20537600] via 2.2.2.1, Serial1/0
D 30.0.0.0/8 [90/20537600] via 3.3.3.2, Serial1/1

The output displays both connected and summary routes from R3 , as the command eigrp stub defaults to ”eigrp stub connected summary”.

Task 6 :



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	2.2.2.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1/0	2.2.2.2	255.0.0.0
S1/1	3.3.3.1	255.0.0.0
E 0/0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 1/0	3.3.3.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0
Loopback 0	172.168.0.1	255.255.255.0
Loopback 1	172.168.1.1	255.255.255.0
Loopback 2	172.168.2.1	255.255.255.0
Loopback 3	172.168.3.1	255.255.255.0

R4

Interface	IP Address	Subnet Mask
Fa 0/0	30.1.1.2	255.0.0.0
Fa 0/1	40.1.1.1	255.0.0.0

Lab Objective:

Configure EIGRP in AS 100 on R1, R2, R3. Advertise only interface fa0/0 on R4 in EIGRP AS 100. Configure static route in R3 to reach network 40.0.0.0 via 30.1.1.1. Redistribute the static route in EIGRP AS 100.

```
R3

Ip route 40.0.0.0 255.0.0.0 30.1.1.2

Router eigrp 100
Redistribute static metric 10 10 10 10 10
Eigrp stub static
```

Verification:

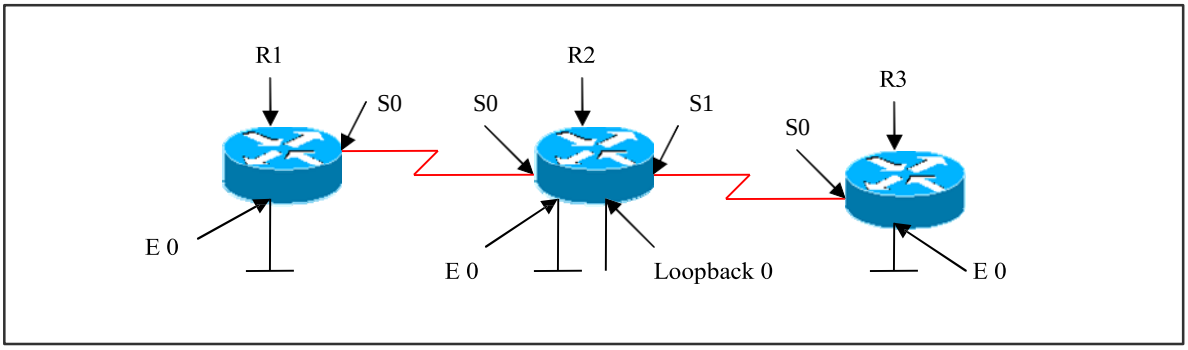
R2#show ip route

C 2.0.0.0/8 is directly connected, Serial1/0
C 3.0.0.0/8 is directly connected, Serial1/1
C 20.0.0.0/8 is directly connected, Ethernet0/0
D EX 40.0.0.0/8 [170/256514560] via 3.3.3.2, Serial1/1
D 10.0.0.0/8 [90/20537600] via 2.2.2.1, Serial1/0

The output displays only directly connected of R1, R2 and redistributed static route from R3, but blocking connected routes and summary routes from R3.

The output also displays the redistributed route as an external EIGRP route with AD 170

Lab 8– Redistribute EIGRP with RIPv2



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0
Loopback 0	40.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Task 1

Configure EIGRP AS 100 on R1 (S0, E0), R2 (S0, E0) and RIPv2 on R2 (S1, Loopback 0) and R3 (S0, E0) as per the above scenario. Mutually redistribute both protocols.

R1	R3
Router eigrp 100 Network 1.0.0.0 Network 10.0.0.0 No auto-summary	Router rip Version 2 Network 2.0.0.0 Network 30.0.0.0 No auto-summary

R2
Router eigrp 100 Network 1.0.0.0 Network 20.0.0.0 No auto-summary Redistribute rip metric 10 10 10 10 10 Router rip Version 2 Network 2.0.0.0 Network 40.0.0.0 No auto-summary Redistribute eigrp 100 metric 10

Verification :

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
D EX 2.0.0.0/8 [170/256514560] via 1.1.1.2, 00:01:24, Serial0/2/0
D 20.0.0.0/8 [90/2195456] via 1.1.1.2, 00:12:18, Serial0/2/0
D EX 40.0.0.0/8 [170/256514560] via 1.1.1.2, 00:01:24, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0
D EX 30.0.0.0/8 [170/256514560] via 1.1.1.2, 00:01:24, Serial0/2/0

R2#show ip route

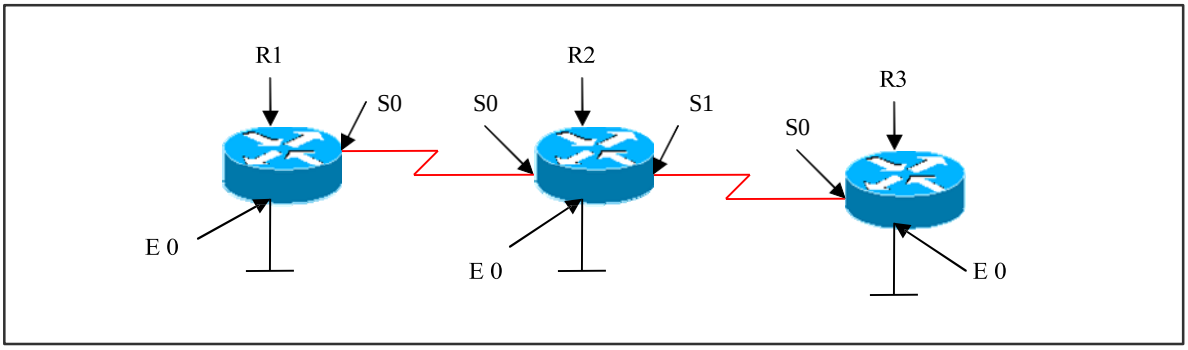
C 1.0.0.0/8 is directly connected, Serial0
C 2.0.0.0/8 is directly connected, Serial1
C 20.0.0.0/8 is directly connected, Ethernet0
C 40.0.0.0/8 is directly connected, Loopback0
D 10.0.0.0/8 [90/2172416] via 1.1.1.1, 00:14:29, Serial0
R 30.0.0.0/8 [120/1] via 2.2.2.2, 00:00:15, Serial1

R3#show ip route

R 1.0.0.0/8 [120/10] via 2.2.2.1, 00:00:23, Serial0
C 2.0.0.0/8 is directly connected, Serial0
R 20.0.0.0/8 [120/10] via 2.2.2.1, 00:00:23, Serial0
R 40.0.0.0/8 [120/1] via 2.2.2.1, 00:00:23, Serial0
R 10.0.0.0/8 [120/10] via 2.2.2.1, 00:00:23, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0

The output displays that RIP routes are advertised in R1 EIGRP AS 100 as 'D EX' routes. EIGRP routes are advertised in RIP as 'R' routes.

Lab 9 – Redistributing EIGRP with OSPF



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Task 1:

Configure EIGRP AS 100 on R1 (S0, E0), R2 (S0) and OSPF area 0 on R2 (S1, E0), R3 (S0) and OSPF area 1 on R3 (E0) as per the above scenario. Mutually redistribute both protocols.

R1	R3 Router ospf 1

Router eigrp 100 Network 1.0.0.0 Network 10.0.0.0 No auto-summary	Network 2.2.2.2 0.0.0.0 area 0 Network 30.0.0.0 0.255.255.255 area 1

R2

Router eigrp 100
Network 1.0.0.0
No auto-summary
Redistribute ospf 1 metric 10 10 10 10 10

Router ospf 1
Network 2.2.2.1 0.0.0.0 area 0
Network 20.0.0.0 0.255.255.255 area 0
Redistribute eigrp 100 metric 10 subnets

Verification :

R1#show ip route

1.0.0.0/8 is directly connected, Serial0/2/0
D EX 2.0.0.0/8 [170/256514560] via 1.1.1.2, 00:00:57, Serial0/2/0
D EX 20.0.0.0/8 [170/256514560] via 1.1.1.2, 00:00:57, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0
D EX 30.0.0.0/8 [170/256514560] via 1.1.1.2, 00:00:57, Serial0/2/0

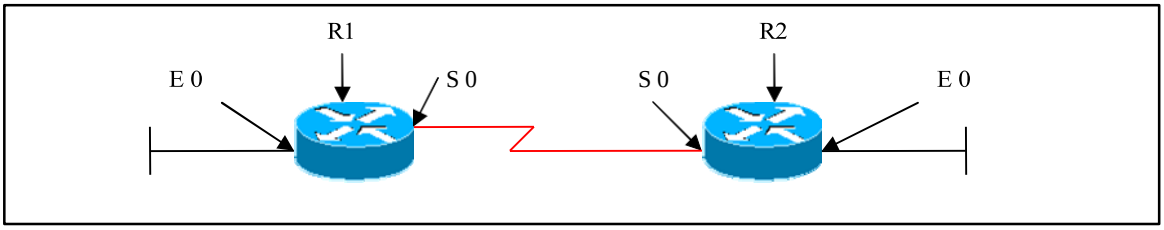
R2#show ip route

C 1.0.0.0/8 is directly connected, Serial0
C 2.0.0.0/8 is directly connected, Serial1
C 20.0.0.0/8 is directly connected, Ethernet0
D 10.0.0.0/8 [90/2172416] via 1.1.1.1, 00:11:11, Serial0
O IA 30.0.0.0/8 [110/74] via 2.2.2.2, 00:00:42, Serial1

R3#show ip route

O E2 1.0.0.0/8 [110/10] via 2.2.2.1, 00:01:05, Serial0
C 2.0.0.0/8 is directly connected, Serial0
O 20.0.0.0/8 [110/74] via 2.2.2.1, 00:01:05, Serial0
O E2 10.0.0.0/8 [110/10] via 2.2.2.1, 00:01:05, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0

Lab 10 – Configuring EIGRP with Redistribute Connected



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
E 0	20.1.1.1	255.0.0.0

Task 1 :

Configure EIGRP AS 100 and do not advertise network 10.0.0.0 and network 20.0.0.0 and redistribute network 10.0.0.0 and 20.0.0.0 into EIGRP.

R1	R2
Router eigrp 100 Network 1.0.0.0 No auto-summary Redistribute connected metric 10 10 10 10 10	Router eigrp 100 Network 1.0.0.0 No auto-summary Redistribute connected metric 10 10 10 10 10

Verification :

R1#show ip route
C 1.0.0.0/8 is directly connected, Serial0/2/0
D EX 20.0.0.0/8 [170/256514560] via 1.1.1.2, 00:00:40, Serial0/2/0

C 10.0.0.0/8 is directly connected, FastEthernet0/0

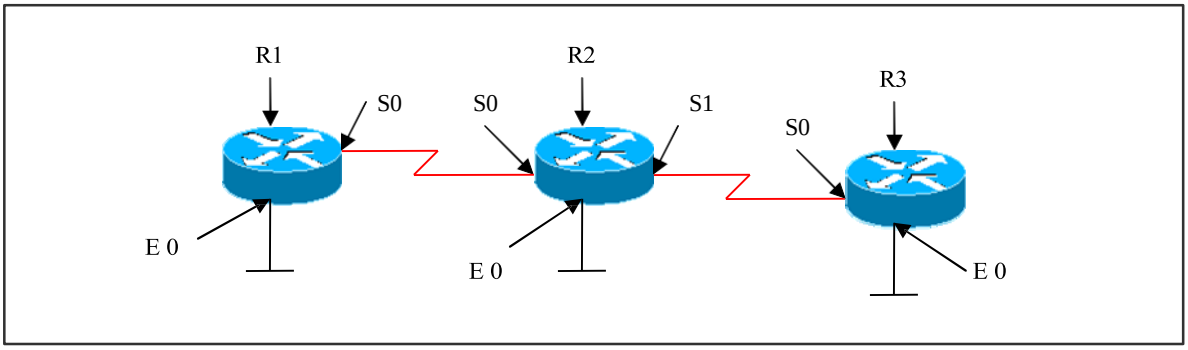
R2#show ip route

C 1.0.0.0/8 is directly connected, Serial0
C 20.0.0.0/8 is directly connected, Ethernet0
D EX 10.0.0.0/8 [170/256514560] via 1.1.1.1, 00:00:33, Serial0
The output displays 'D EX' routes for both networks 10.0.0.0 and 20.0.0.0 in the routing tables.

Module 2 – OSPF

OSPF LAB INDEX

Lab 1 – Configuring OSPF in a Single Area



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S0	1.1.1.2	255.0.0.0
S1	2.2.2.1	255.0.0.0
E0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Configure the Interface IP addresses based on the above table

Task 1

Configure OSPF in Area 0. Advertise all networks on all routers.

R1	R2
Router ospf 1 Network 1.1.1.1 0.0.0.0 area 0 Network 10.0.0.0 0.255.255.255 area 0	Router ospf 1 Network1.1.1.2 0.0.0.0 area 0 Network 2.2.2.1 0.0.0.0 area 0 Network 20.0.0.0 0.255.255.255 area 0
R3 Router ospf 1 Network 2.2.2.2 0.0.0.0 area 0 Network 30.0.0.0 0.255.255.255 area 0	

Verification :

R1 # show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
O 2.0.0.0/8 [110/128] via 1.1.1.2, 00:03:58, Serial0/2/0
O 20.0.0.0/8 [110/74] via 1.1.1.2, 00:03:58, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0
O 30.0.0.0/8 [110/138] via 1.1.1.2, 00:03:58, Serial0

OSPF routes are displayed as “O” routes in the routing table.

R1 # show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
30.1.1.1	0	FULL/ -	00:00:32	2.2.2.2	Serial1
10.1.1.1	0	FULL/ -	00:00:33	1.1.1.1	Serial0

The symbol indicated by a dash [-] represents that the neighbor is on the serial interface and DR and BDR are not used on point-to-point interfaces.

R1 # show ip ospf

Routing Process "OSPF 1" with ID 10.1.1.1
---output omitted---

This command displays the OSPF router-id.

Task 2

Configure OSPF in Area 0. Advertise all networks on all routers. Hard Code the Router-id based on the following Loop back ip address:

R1 Loopback 0 6.6.6.6
R2 Loopback 0 7.7.7.7
R3 Loopback 0 8.8.8.8

R1	R2
int loopback 0 ip address 6.6.6.6 255.255.255.255 Router ospf 1 Network 6.6.6.6 0.0.0.0 area 0	int loopback 0 ip address 7.7.7.7 255.255.255.255 Router ospf 1 Network 7.7.7.7 0.0.0.0 area 0
R3 int loopback 0 ip address 8.8.8.8 255.255.255.255 Router ospf 1 Network 8.8.8.8 0.0.0.0 area 0	

Verification:

R1# show ip ospf

Routing Process "OSPF 1" with ID 6.6.6.6
---output omitted---

This output displays that router-id chosen is 6.6.6.6 as it is the loopback address.

Repeat the same on router2 with loopback address as 7.7.7.7 and on router 3 with loopback as 8.8.8.8 and verify using show ip OSPF command

Task 3

Configure OSPF in Area 0. Advertise all networks on all routers. Hard Code the Router-id based on the following :

R1 3.3.3.3
R2 4.4.4.4
R3 5.5.5.5

R1	R2
Router ospf 1 Router-id 3.3.3.3 Network 1.1.1.1 0.0.0.0 area 0 Network 10.0.0.0 0.255.255.255 area 0 Network 6.6.6.6 0.0.0.0 area 0	Router ospf 1 Router-id 4.4.4.4 Network 1.1.1.2 0.0.0.0 area 0 Network 2.2.2.1 0.0.0.0 area 0 Network 20.0.0.0 0.255.255.255 area 0 Network 7.7.7.7 0.0.0.0 area 0
R3 Router ospf 1 Router-id 5.5.5.5 Network 2.2.2.2 0.0.0.0 area 0 Network 30.0.0.0 0.255.255.255 area 0 Network 8.8.8.8 0.0.0.0 area 0	

Verification :-

R1#show ip ospf

Routing Process "ospf 1" with ID 3.3.3.3

This output displays that 3.3.3.3 router-id takes preference over physical and loopback interface.

Lab 2 – Configuring OSPF in Multiple Areas

(Sceanrio Based on Lab 1)

Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S0	1.1.1.2	255.0.0.0
S1	2.2.2.1	255.0.0.0
E0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Task 1

Configure OSPF in Area 0 on R1 (S0), R2 (S0, E0).
Configure OSPF in Area 1 on R1 (E0).
Configure OPSF in Area 2 on R2 (S1), R3 (S0, E0)

R1 Router ospf 1 Network 1.1.1.1 0.0.0.0 area 0 Network 10.0.0.0 0.255.255.255 area 1	R2 Router ospf 1 Network 1.1.1.2 0.0.0.0 area0 Network 2.2.2.1 0.0.0.0 area2 Network 20.0.0.0 0.255.255.255 area0
R3 Router ospf 1 Network 2.2.2.2 0.0.0.0 area2 Network 30.0.0.0 0.255.255.255 area2	

Verification:

R1# show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
O IA 2.0.0.0/8 [110/128] via 1.1.1.2, 00:07:11, Serial0/2/0
O 20.0.0.0/8 [110/74] via 1.1.1.2, 00:07:11, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0
O IA 30.0.0.0/8 [110/138] via 1.1.1.2, 00:07:11, Serial0/2/0

The output displays 'O', 'O IA' routes.

The ABR can be verified by using the following command

R1# show ip ospf border-routers

OSPF Process 1 internal Routing Table
Codes: i - Intra-area route, I - Inter-area route
i 20.1.1.1 [64] via 1.1.1.2, Serial0/2/0, ABR, Area 0, SPF 2

R2#show ip route

C 1.0.0.0/8 is directly connected, Serial0
C 2.0.0.0/8 is directly connected, Serial1
C 20.0.0.0/8 is directly connected, Ethernet0
O IA 10.0.0.0/8 [110/65] via 1.1.1.1, 00:11:06, Serial0
O 30.0.0.0/8 [110/74] via 2.2.2.2, 00:11:54, Serial1

R2#show ip ospf border-routers

OSPF Process 1 internal Routing Table
Codes: i - Intra-area route, I - Inter-area route
i 10.1.1.1 [64] via 1.1.1.1, Serial0, ABR, Area 0, SPF 6

R3#show ip route

O IA 1.0.0.0/8 [110/128] via 2.2.2.1, 00:12:44, Serial0
C 2.0.0.0/8 is directly connected, Serial0
O IA 20.0.0.0/8 [110/74] via 2.2.2.1, 00:12:43, Serial0
O IA 10.0.0.0/8 [110/129] via 2.2.2.1, 00:11:55, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0

Task 2

Configure OSPF as per task 1 and manipulate the Hello-interval time on R1

```
R1

int s0
ip ospf hello-interval 5
```

Verification:

Default hello-interval time:

R1#show ip ospf interface serial 0/2/0

Serial0/2/0 is up, line protocol is up
Internet Address 1.1.1.1/8, Area 0
Process ID 1, Router ID 10.1.1.1, Network Type POINT_TO_POINT, Cost: 64
Transmit Delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5

R1#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
20.1.1.1	0	FULL/ -	00:00:35	1.1.1.2	Serial0/2/0

Verifying ospf neighbors after manipulating the hello-interval time in R1.

R1#show ip ospf neighbor

-------Nil------
There will be no neighbor relationship because of hello-interval mismatch.

This can be verified by using 'debug ip ospf events' command, where the output displays a mismatch hello parameter statement.

R1#debug ip ospf events

*May 28 09:20:31.403: OSPF: Rcv hello from 20.1.1.1 area 0 from Serial0/2/0 1.1.
1.2
*May 28 09:20:31.403: OSPF: Mismatched hello parameters from 1.1.1.2
*May 28 09:20:31.403: OSPF: Dead R 40 C 20, Hello R 10 C 5
The output displays a mismatch hello parameter statement.

Lab 3 – Configuring ABR and ASBR

(Scenario Based on Lab 1)

Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S0	1.1.1.2	255.0.0.0
S1	2.2.2.1	255.0.0.0
E0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Task 1

Configure OSPF in Area 0 on R1 (S0/2/0, E0), R2 (S0)
Configure OSPF in Area 1 on R2 (S1), R3 (S0, E 0).
Configure EIGRP AS 100 on R2 (E0) and redistribute into OSPF.

R1	R2
Router ospf 1 Network 1.1.1.1 0.0.0.0 area 0 Network 10.0.0.0 0.255.255.255 area 0 R3 Router ospf 1 Network 2.2.2.2 0.0.0.0 area 1 Network 30.0.0.0 0.255.255.255 area 1	Router ospf 1 Network 2.2.2.1 0.0.0.0 area 1 Network 1.1.1.2 0.0.0.0 area 0 Router eigrp 100 Network 20.0.0.0 No auto-summary Router ospf 1 Redistribute eigrp 100 metric 10 subnets

Verification:

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
O IA 2.0.0.0/8 [110/128] via 1.1.1.2, 00:12:21, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0
O IA 30.0.0.0/8 [110/138] via 1.1.1.2, 00:11:13, Serial0/2/0

The output displays 'O' and 'O IA' routes.
The output also shows that network 20.0.0.0 is missing in the routing table.
As EIGRP is a NON-OSPF routing protocol, we need to redistribute EIGRP into OSPF

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
O IA 2.0.0.0/8 [110/128] via 1.1.1.2, 00:00:04, Serial0/2/0
O E2 20.0.0.0/8 [110/10] via 1.1.1.2, 00:00:04, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0
O IA 30.0.0.0/8 [110/138] via 1.1.1.2, 00:00:04, Serial0/2/0

Note: If we want OE1 routes then the redistribute command should be configured using metric-type

R2 Router ospf 1 Redistribute eigrp 100 metric-type 1 metric 10 subnets

.R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
O IA 2.0.0.0/8 [110/128] via 1.1.1.2, 00:01:43, Serial0/2/0
O E1 20.0.0.0/8 [110/74] via 1.1.1.2, 00:00:12, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0
O IA 30.0.0.0/8 [110/138] via 1.1.1.2, 00:01:43, Serial0/2/0

To verify which router is ABR / ASBR : -

R1 # show ip ospf border-routers

OSPF Process 1 internal Routing Table
Codes: i - Intra-area route, I - Inter-area route
i 20.1.1.1 [64] via 1.1.1.2, Serial0/2/0, ABR/ASBR, Area 0, SPF

Lab 4 – Configure OSPF Stub Area

(Scenario Based on Lab 1)

Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S0	1.1.1.2	255.0.0.0
S1	2.2.2.1	255.0.0.0
E0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Task 1

Configure OSPF in Area 0 on R1 (S0/2/0, E0), R2 (S0)
Configure OSPF in Area 1 on R2 (S1), R3 (S0, E 0).

R1	R2
Router ospf 1 Network 1.1.1.1 0.0.0.0 area 0 Network 10.0.0.0 0.255.255.255 area 1	Router ospf 1 Network 1.1.1.2 0.0.0.0 area0 Network 2.2.2.1 0.0.0.0 area2
R3 Router ospf 1 Network 2.2.2.2 0.0.0.0 area2 Network 30.0.0.0 0.255.255.255 area2	

Task 2 : Configure EIGRP AS 100 on R2 (E0) and redistribute into OSPF.

```
R2

Router eigrp100
Network 20.0.0.0
No auto-summary

Router ospf 1
Redistribute eigrp 100 metric 10 subnets
```

Verification :

R3#show ip route

O IA 1.0.0.0/8 [110/128] via 2.2.2.1, 00:01:08, Serial0
C 2.0.0.0/8 is directly connected, Serial0
O E2 20.0.0.0/8 [110/10] via 2.2.2.1, 00:00:03, Serial0
O IA 10.0.0.0/8 [110/129] via 2.2.2.1, 00:01:08, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0

The output displays inter-area routes (O IA) and OSPF external type 2 (O E2).

R3#show ip ospf database

OSPF Router with ID (30.1.1.1) (Process ID 1)

Router Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
20.1.1.1	20.1.1.1	243	0x8000000A	0x00B788	2
30.1.1.1	30.1.1.1	243	0x80000008	0x0034CD	3

Summary Net Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
1.0.0.0	20.1.1.1	277	0x80000004	0x002FB2
10.0.0.0	20.1.1.1	277	0x80000004	0x00C314

Type-5 AS External Link States

Link ID	ADV Router	Age	Seq#	Checksum	Tag
20.0.0.0	20.1.1.1	172	0x80000007	0x00A8D0	0

The output displays Type-5 external link-states.

Task 3

Configure OSPF Area 1 as Stub.

R2	R3
Router ospf 1 Area 1 stub	Router ospf 1 Area 1 stub

After configuring stub, verify the routing table on R3

R2#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.1.1.1	0	FULL/ -	00:00:30	1.1.1.1	Serial0
30.1.1.1	0	FULL/ -	00:00:38	2.2.2.2	Serial1

R3#show ip route

O IA 1.0.0.0/8 [110/128] via 2.2.2.1, 00:00:03, Serial0
C 2.0.0.0/8 is directly connected, Serial0
O IA 10.0.0.0/8 [110/129] via 2.2.2.1, 00:00:03, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0
O*IA 0.0.0.0/0 [110/65] via 2.2.2.1, 00:00:03, Serial0

The output displays default route and inter-area routes, both designated with (OIA) in the routing table.
Default route is denoted as (O* IA).

R3#show ip ospf database

OSPF Router with ID (30.1.1.1) (Process ID 1)

Router Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
20.1.1.1	20.1.1.1	543	0x8000000C	0x00CB76	2
30.1.1.1	30.1.1.1	543	0x8000000A	0x004EB3	3

Summary Net Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.0	20.1.1.1	552	0x80000001	0x00E73F
1.0.0.0	20.1.1.1	552	0x80000005	0x004B97
10.0.0.0	20.1.1.1	552	0x80000005	0x00DFF8

The output does not display the 'Type 5 External LSA.

Note: If stub is not configured on both routers OSPF neighborship will not establish. It can be verified by the following commands.

R2#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.1.1.1	0	FULL/ -	00:00:35	1.1.1.1	Serial0
30.1.1.1	0	DOWN/ -	-	2.2.2.2	Serial1

R2#debug ip ospf events

Mar 1 03:12:42.491: OSPF: Rcv hello from 30.1.1.1 area 1 from Serial1 2.2.2.2
*Mar 1 03:12:42.491: OSPF: Hello from 2.2.2.2 with mismatched Stub/Transit area option bit

The output displays mismatched Stub/Transit area option bit .

Lab 5 – Configuring Totally Stub Area

(Scenario Based on Lab 1)

Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S0	1.1.1.2	255.0.0.0
S1	2.2.2.1	255.0.0.0
E0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Task 1

Configure OSPF in Area 0 on R1 (S0/2/0, E0), R2 (S0)
Configure OSPF in Area 1 on R2 (S1), R3 (S0, E 0).

R1 Router ospf 1 Network 1.1.1.1 0.0.0.0 area 0 Network 10.0.0.0 0.255.255.255 area 1	R2 Router ospf 1 Network 1.1.1.2 0.0.0.0 area0 Network 2.2.2.1 0.0.0.0 area2
R3 Router ospf 1 Network 2.2.2.2 0.0.0.0 area2 Network 30.0.0.0 0.255.255.255 area2	

Task 2 : Configure EIGRP AS 100 on R2 (E0) and redistribute into OSPF.

```
R2

Router eigrp100
Network 20.0.0.0
No auto-summary

Router ospf 1
Redistribute eigrp 100 metric 10 subnets
```

Verification :

Verify the routing table on R3:

R3#show ip route

```
O IA 1.0.0.0/8 [110/128] via 2.2.2.1, 00:01:08, Serial0
C       2.0.0.0/8 is directly connected, Serial0
O E2 20.0.0.0/8 [110/10] via 2.2.2.1, 00:00:03, Serial0
O IA  10.0.0.0/8 [110/129] via 2.2.2.1, 00:01:08, Serial0
C       30.0.0.0/8 is directly connected, Ethernet0
```

The output displays inter-area (O IA) and external type 2 (O E2) routes.

The OSPF database on R3 can be verified using the following command :

R3#show ip ospf database

OSPF Router with ID (30.1.1.1) (Process ID 1)

Router Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
20.1.1.1	20.1.1.1	243	0x8000000A	0x00B788	2
30.1.1.1	30.1.1.1	243	0x80000008	0x0034CD	3

Summary Net Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
1.0.0.0	20.1.1.1	277	0x80000004	0x002FB2
10.0.0.0	20.1.1.1	277	0x80000004	0x00C314

Type-5 AS External Link States

Link ID	ADV Router	Age	Seq#	Checksum	Tag
20.0.0.0	20.1.1.1	172	0x80000007	0x00A8D0	0

The output displays summary net link states and type-5 AS external link-states.

Now, to block both the summary net link-states and type-5 external link-states, configure Area 1 as total stub .

Task 3

Configure R2 and R3 as total stub .

R2	R3
Router ospf 1 Area 1 stub no-summary	Router ospf 1 Area 1 stub no-summary

Verifying the routing table on R3

R3#show ip route

C 2.0.0.0/8 is directly connected, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0
O*IA 0.0.0.0/0 [110/65] via 2.2.2.1, 00:00:30, Serial0

Inter-area and external routes are not visible in the routing table, but they are accessible via the inter-area default route (O * IA).

Verify the OSPF database

R3#show ip ospf database

OSPF Router with ID (30.1.1.1) (Process ID)
----------Output has been omitted for brevity----------

Summary Net Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.0	20.1.1.1	125	0x80000003	0x00E341

No Type-5 External LSA and Summary Net Link Type 3, but you can see a default route.

Lab 6 – Configuring NSSA

(Scenario Based on Lab 1)

Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S0	1.1.1.2	255.0.0.0
S1	2.2.2.1	255.0.0.0
E0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Task 1

Configure OSPF in Area 0 on R1 (S0/2/0), R2 (S0).
Configure OSPF in Area 1 on R2 (S1), R3 (S0).

R1 Router ospf 1 Network 1.1.1.1 0.0.0.0 area 0	R2 Router ospf 1 Network 1.1.1.2 0.0.0.0 area0 Network 2.2.2.1 0.0.0.0 area2
R3 Router ospf 1 Network 2.2.2.2 0.0.0.0 area2	

Task 2: Configure EIGRP AS 100 on R2 (E0) and redistribute into OSPF.

R2
Router eigrp100 Network 20.0.0.0 No auto-summary Router ospf 1 Redistribute eigrp 100 metric 10 subnets

Task 3: Configure RIPv2 on R1 (E0), R3 (E0) and redistribute into OSPF.

R1	R3
Router rip Net 10.0.0.0 No auto-summary Version 2 Router ospf 1 Redistribute rip metric 10 subnets	Router rip Net 30.0.0.0 No auto-summary Version 2 Router ospf 1 Redistribute rip metric 10 subnets

Verification :

R3#show ip route

O IA 1.0.0.0/8 [110/128] via 2.2.2.1, 00:00:22, Serial0
C 2.0.0.0/8 is directly connected, Serial0
O E2 20.0.0.0/8 [110/10] via 2.2.2.1, 00:00:22, Serial0
O E2 10.0.0.0/8 [110/10] via 2.2.2.1, 00:00:22, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0

The output displays inter-area (O IA), external type2 (O E2) routes.

R3#show ip ospf database

OSPF Router with ID (30.1.1.1) (Process ID 1)

Router Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
20.1.1.1	20.1.1.1	141	0x80000013	0x00A591	2
30.1.1.1	30.1.1.1	141	0x80000010	0x00939C	2

Summary Net Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
1.0.0.0	20.1.1.1	149	0x80000001	0x0035AF

Summary ASB Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
10.1.1.1	20.1.1.1	149	0x80000001	0x009047

Type-5 AS External Link States

Link ID	ADV Router	Age	Seq#	Checksum	Tag
10.0.0.0	10.1.1.1	328	0x80000001	0x009102	0
20.0.0.0	20.1.1.1	1830	0x80000008	0x00A6D1	0

The OSPF database displays summary net link states, type-5 external net link states.

Now, configure NSSA on R2 & R3, where R3 acts as NSSA ASBR that generates type-7 LSA and R2 acts as NSSA ABR that converts the type-7 LSA into type-5 LSA, when it leaves the NSSA area.

Task 4

Configure R2 and R3 as NSSA .

R2	R3
Router ospf 1 Area 1 nssa default-information-originate	Router ospf 1 Area 1 nssa default-information-originate

R3#show ip route

O IA 1.0.0.0/8 [110/128] via 2.2.2.1, 00:00:06, Serial0
C 2.0.0.0/8 is directly connected, Serial0
O N2 20.0.0.0/8 [110/10] via 2.2.2.1, 00:00:06, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0
O*N2 0.0.0.0/0 [110/1] via 2.2.2.1, 00:00:06, Serial0

The output displays ‘O N2’ and ‘O* N2’ routes in the routing table.

R3#show ip ospf database

OSPF Router with ID (30.1.1.1) (Process ID 1)

Router Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
20.1.1.1	20.1.1.1	428	0x80000015	0x0047E7	2
30.1.1.1	30.1.1.1	428	0x80000012	0x0035F2	2

Summary Net Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
1.0.0.0	20.1.1.1	435	0x80000002	0x00D805

Type-7 AS External Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Tag
0.0.0.0	20.1.1.1	435	0x80000001	0x0099F9	0
20.0.0.0	20.1.1.1	434	0x80000001	0x00EE87	0
30.0.0.0	30.1.1.1	458	0x80000001	0x00A7B1	0

No Type-5 External Link States but allows Special Type-7 External Link State

R2#show ip route

C 1.0.0.0/8 is directly connected, Serial0
C 2.0.0.0/8 is directly connected, Serial1
C 20.0.0.0/8 is directly connected, Ethernet0
O E2 10.0.0.0/8 [110/10] via 1.1.1.1, 00:02:33, Serial0
O N2 30.0.0.0/8 [110/10] via 2.2.2.2, 00:02:33, Serial1

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
O IA 2.0.0.0/8 [110/128] via 1.1.1.2, 00:14:38, Serial0/2/0
O E2 20.0.0.0/8 [110/10] via 1.1.1.2, 00:03:23, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0
O E2 30.0.0.0/8 [110/10] via 1.1.1.2, 00:03:16, Serial0/2/0

R1#show ip ospf database

OSPF Router with ID (10.1.1.1) (Process ID 1)

Router Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
10.1.1.1	10.1.1.1	145	0x8000000B	0x001250	2
20.1.1.1	20.1.1.1	133	0x8000000B	0x00FF56	2

Summary Net Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum
2.0.0.0	20.1.1.1	1429	0x80000005	0x0020BF

Type-5 AS External Link States

Link ID	ADV Router	Age	Seq#	Checksum	Tag
10.0.0.0	10.1.1.1	145	0x80000002	0x008F03	0
20.0.0.0	20.1.1.1	1429	0x80000009	0x00A4D2	0
30.0.0.0	20.1.1.1	1263	0x80000001	0x0096D6	0

Lab 7 – Configure NSSA Total Stub

(Scenario Based on Lab 1)

Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S0	1.1.1.2	255.0.0.0
S1	2.2.2.1	255.0.0.0
E0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Task 1

Configure OSPF in Area 0 on R1 (S0/2/0), R2 (S0).
Configure OSPF in Area 1 on R2 (S1), R3 (S0).

R1 Router ospf 1 Network 1.1.1.1 0.0.0.0 area 0	R2 Router ospf 1 Network 1.1.1.2 0.0.0.0 area0 Network 2.2.2.1 0.0.0.0 area2
R3 Router ospf 1 Network 2.2.2.2 0.0.0.0 area2	

Task 2: Configure EIGRP AS 100 on R2 (E0) and redistribute into OSPF.

R2
Router eigrp100 Network 20.0.0.0 No auto-summary Router ospf 1 Redistribute eigrp 100 metric 10 subnets

Task 3: Configure RIPv2 on R1 (E0), R3 (E0) and redistribute into OSPF.

R1	R3
Router rip Net 10.0.0.0 No auto-summary Version 2 Router ospf 1 Redistribute rip metric 10 subnets	Router rip Net 30.0.0.0 No auto-summary Version 2 Router ospf 1 Redistribute rip metric 10 subnets

Verification:

R3#show ip route

O IA 1.0.0.0/8 [110/128] via 2.2.2.1, 00:00:22, Serial0
C 2.0.0.0/8 is directly connected, Serial0
O E2 20.0.0.0/8 [110/10] via 2.2.2.1, 00:00:22, Serial0
O E2 10.0.0.0/8 [110/10] via 2.2.2.1, 00:00:22, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0

The output displays inter-area (O IA), external type2 (O E2) routes.

R3#show ip ospf database

OSPF Router with ID (30.1.1.1) (Process ID 1)

Router Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
20.1.1.1	20.1.1.1	141	0x80000013	0x00A591	2
30.1.1.1	30.1.1.1	141	0x80000010	0x00939C	2

Summary Net Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
1.0.0.0	20.1.1.1	149	0x80000001	0x0035AF

Summary ASB Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
10.1.1.1	20.1.1.1	149	0x80000001	0x009047

Type-5 AS External Link States

Link ID	ADV Router	Age	Seq#	Checksum	Tag
10.0.0.0	10.1.1.1	328	0x80000001	0x009102	0
20.0.0.0	20.1.1.1	1830	0x80000008	0x00A6D1	0

The OSPF database displays summary net link states, type-5 external net link states.

Task 4 :

Configure R2 and R3 as NSSA Total Stub .

R2	R3
Router ospf 1 Area 1 nssa no-summary	Router ospf 1 Area 1 nssa no-summary

R3#show ip route

C 2.0.0.0/8 is directly connected, Serial0
O N2 20.0.0.0/8 [110/10] via 2.2.2.1, 00:00:15, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0
O*IA 0.0.0.0/0 [110/65] via 2.2.2.1, 00:00:15, Serial0
The output displays O N2 and O* IA routes only.

R3#show ip ospf database

OSPF Router with ID (30.1.1.1) (Process ID 1)

Router Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
20.1.1.1	20.1.1.1	177	0x80000017	0x0043E9	2
30.1.1.1	30.1.1.1	118	0x80000015	0x002FF5	2

Summary Net Link States (Area 1)

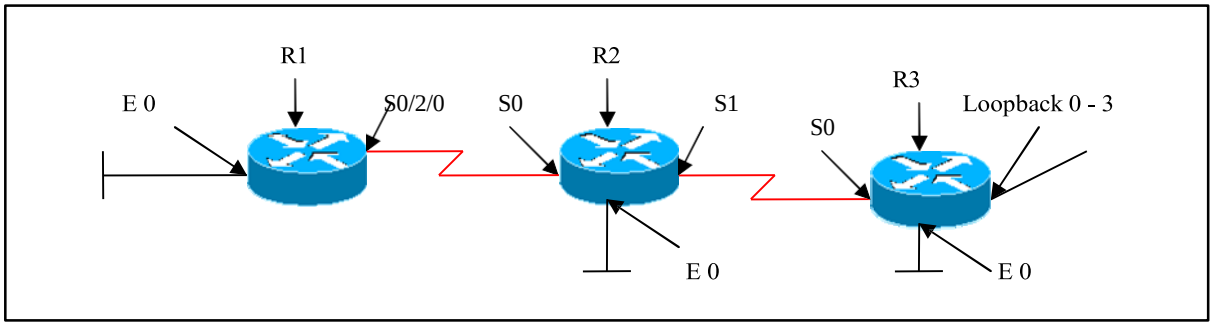
Link ID	ADV Router	Age	Seq#	Checksum
0.0.0.0	20.1.1.1	187	0x80000001	0x006FAF

Type-7 AS External Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Tag
20.0.0.0	20.1.1.1	186	0x80000001	0x00EE87	0
30.0.0.0	30.1.1.1	118	0x80000002	0x00A5B2	0

No Type-5 External Link States, no Type-3 Summary link but allows Special Type-7 External Link State .

Lab 8 – Configure OSPF Route Summarization



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S0	1.1.1.2	255.0.0.0
S1	2.2.2.1	255.0.0.0
E0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0
Loopback 0	172.168.0.1	255.255.255.0
Loopback 1	172.168.1.1	255.255.255.0
Loopback 2	172.168.2.1	255.255.255.0
Loopback 3	172.168.3.1	255.255.255.0

Task 1 : Configure Route Summarization at ABR

Configure OSPF in Area 0 on R1 (S0/2/0, E0), R2 (S0).
Configure OSPF in Area 1 on R2 (S1), R3 (S0, E0, Loopback 0 – 3).

Create the following Loopbacks on R3:

Loopback 0 – 172.168.0.1/24
Loopback 1 – 172.168.1.1/24
Loopback 2 – 172.168.2.1/24
Loopback 3 – 172.168.3.1/24

Advertise these newly created loopbacks in OSPF using the network command. Make sure they appear in the routing table using a /24 mask. These routes should be seen as a single summarized route outside of area 1.

R3	R2
Int loopback 0 Ip add 172.168.0.1 255.255.255. 0 Ip ospf network point-to-point Int loopback 1 Ip add 172.168.1.1 255.255.255. 0 Ip ospf network point-to-point Int loopback 2 Ip add 172.168.2.1 255.255.255. 0 Ip ospf network point-to-point Int loopback 3 Ip add 172.168.3.1 255.255.255. 0 Ip ospf network point-to-point Router ospf 1 Network 172.168.0.0 0.0.255.255 area 1 Network 2.2.2.2 0.0.0.0 area 1 Network 30.0.0.0 0.255.255 area 1	Router ospf 1 Area 1 range172.168.0.0 255.255.252.0

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
O IA 2.0.0.0/8 [110/128] via 1.1.1.2, 00:17:26, Serial0/2/0
O IA 20.0.0.0/8 [110/74] via 1.1.1.2, 00:17:26, Serial0/2/0
172.168.0.0/22 is subnetted, 1 subnets
O IA 172.168.0.0 [110/129] via 1.1.1.2, 00:00:11, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0

The output displays a smaller routing table by displaying only one summarized route for the contiguous networks.

Task 2 : Configure Route Summarization At ASBR

(Scenario Based On Task 1)

Configure OSPF on the routers as per the above scenario.
Create the following Loopbacks on R3:

Loopback 0 – 172.168.0.1/24
Loopback 1 – 172.168.1.1/24
Loopback 2– 172.168.2.1/24
Loopback 3 – 172.168.3.1/24

Advertise these newly created loopbacks in EIGRP AS 100 using the network command and redistribute these networks into OSPF Area 1. These routes should be seen as a single summarized route.

```
R3

Int loopback 0
Ip add 172.168.0.1 255.255.255. 0
Ip ospf network point-to-point

Int loopback 1
Ip add 172.168.1.1 255.255.255. 0
Ip ospf network point-to-point

Int loopback 2
Ip add 172.168.2.1 255.255.255. 0
Ip ospf network point-to-point

Int loopback 3
Ip add 172.168.3.1 255.255.255. 0
Ip ospf network point-to-point

Router ospf 1
Network 2.2.2.2 0.0.0.0 area 1
Network 30.0.0.0 0.255.255 area 1

Router eigrp 100
Network 172.168.0.0
No auto-summary

Router ospf 1
Redistribute eigrp 100 metric 10 subnets
Summary-address 172.168.0.0 255.255.252.0
```

Verification:

R2#show ip route

C 1.0.0.0/8 is directly connected, Serial0
C 2.0.0.0/8 is directly connected, Serial1
C 20.0.0.0/8 is directly connected, Ethernet0
   172.168.0.0/22 is subnetted, 1 subnets
O E2 172.168.0.0 [110/10] via 2.2.2.2, 00:00:45, Serial1
O 10.0.0.0/8 [110/65] via 1.1.1.1, 00:07:28, Serial0
O 30.0.0.0/8 [110/74] via 2.2.2.2, 00:07:28, Serial1

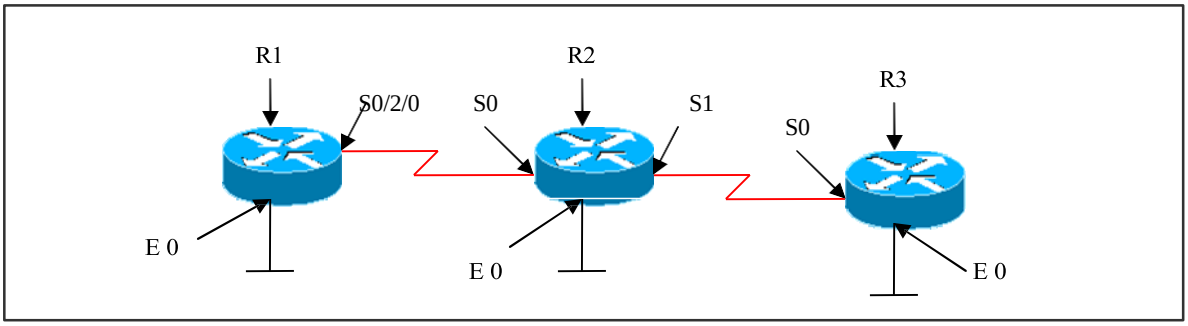
The output displays a smaller routing table.

R3#show ip route

O IA 1.0.0.0/8 [110/128] via 2.2.2.1, 00:12:14, Serial0
C 2.0.0.0/8 is directly connected, Serial0
O 20.0.0.0/8 [110/74] via 2.2.2.1, 00:12:14, Serial0
   172.168.0.0/16 is variably subnetted, 5 subnets, 2 masks
C   172.168.0.0/24 is directly connected, Loopback0
O   172.168.0.0/22 is a summary, 00:03:01, Null0
C   172.168.1.0/24 is directly connected, Loopback1
C   172.168.2.0/24 is directly connected, Loopback2
C   172.168.3.0/24 is directly connected, Loopback3
O IA 10.0.0.0/8 [110/129] via 2.2.2.1, 00:12:14, Serial0
C 30.0.0.0/8 is directly connected, Ethernet0

The output displays a summary route pointing to interface null 0 on R3 routing table. This is automatically generated by default, when manual summarization is configured so as to prevent routing loops.

Lab 9 – Configuring OSPF Virtual Links



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S0	1.1.1.2	255.0.0.0
S1	2.2.2.1	255.0.0.0
E0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Task 1 :

Configure OSPF in Area 0 on R1 (S0/2/0, E0), R2 (S0, E0).
Configure OSPF in Area 1 on R2 (S1), R3 (S0).
Configure OSPF in Area 2 on R3 (E0).

R1	R2
Router ospf 1 Network 1.1.1.1 0.0.0.0 area 0	Router ospf 1 Network 1.1.1.2 0.0.0.0 area0

Network 10.0.0.0 0.255.255.255 area 0	Network 2.2.2.1 0.0.0.0 area1 Network 20.0.0.0 0.255.255.255 area 0
R3 Router ospf 1 Network 2.2.2.2 0.0.0.0 area1 Network 30.0.0.0 0.255.255.255 area 2	

Verification:

Verifying the routing table on R1 in area0:

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
O IA 2.0.0.0/8 [110/128] via 1.1.1.2, 00:22:43, Serial0/2/0
O 20.0.0.0/8 [110/74] via 1.1.1.2, 00:22:43, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0

The output displays net 20.0.0.0 as 'O' and net 2.0.0.0 as 'O IA', but there is no net 30.0.0.0, as it is not connected to area0.

We need to configure virtual links between R2 & R3 and this area that connects to area0 is called the transit area.

Each router R2 & R3 point at the router-id of the other router.

Task 2:

Configure Virtual Link between R2 and R3:

R2	R3
Router ospf 1 Area 1 virtual-link 30.1.1.1	Router ospf 1 Area 1 virtual-link 20.1.1.1

Verifying the routing table on R1 :

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
O IA 2.0.0.0/8 [110/128] via 1.1.1.2, 00:00:00, Serial0/2/0
O 20.0.0.0/8 [110/74] via 1.1.1.2, 00:00:00, Serial0/2/0

C   10.0.0.0/8 is directly connected, FastEthernet0/0
O IA 30.0.0.0/8 [110/138] via 1.1.1.2, 00:00:00, Serial0/2/0

The output displays network 30.0.0.0 as 'O' route because of the virtual link configured, the router1 assumes that net 30.0.0.0 is in the same area0.

R2#show ip ospf virtual-links

Virtual Link OSPF_VL0 to router 30.1.1.1 is up
  Run as demand circuit
  DoNotAge LSA allowed.
  Transit area 1, via interface Serial1, Cost of using 64
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:00
    Adjacency State FULL (Hello suppressed)
    Index 2/3, retransmission queue length 0, number of retransmission 1
    First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
    Last retransmission scan length is 1, maximum is 1
    Last retransmission scan time is 0 msec, maximum is 0 msec

The output displays virtual-link to other router and as well, 'DoNotAge' option set.

Task 3: Configure Virtual Link when area connecting two backbone areas.

(Scenario Based on Task 1)

Configure OSPF in Area 0 on R1 (E0).
Configure OSPF in Area 1 on R1 (S0/2/0), R2 (S0).
Configure OSPF in Area 2 on R2 (E0, S1), R3 (S0, E0).

R1	R2
Router ospf 1 Network 1.1.1.1 0.0.0.0 area 1 Network 10.0.0.0 0.255.255.255 area 0	Router ospf 1 Network 1.1.1.2 0.0.0.0 area 1 Network 2.2.2.1 0.0.0.0 area 0 Network 20.0.0.0 0.255.255.255 area 0
R3 Router ospf 1 Network 2.2.2.2 0.0.0.0 area 0 Network 30.0.0.0 0.255.255.255 area 0	

Verification:

Verify the routing table on R1

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
O IA 2.0.0.0/8 [110/128] via 1.1.1.2, 00:00:43, Serial0/2/0
O IA 20.0.0.0/8 [110/74] via 1.1.1.2, 00:00:43, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0
O IA 30.0.0.0/8 [110/138] via 1.1.1.2, 00:00:34, Serial0/2/0

The output displays network 2.0.0.0, 20.0.0.0 and 30.0.0.0 as O IA routes.

R2#show ip route

C 1.0.0.0/8 is directly connected, Serial0
C 2.0.0.0/8 is directly connected, Serial1
C 20.0.0.0/8 is directly connected, Ethernet0
O 30.0.0.0/8 [110/74] via 2.2.2.2, 00:05:26, Serial 1
O IA 10.0.0.0/8[110/74]via 1.1.1.2, 00:07:43, Serial 0/2/0

R3#show ip route

O IA 1.0.0.0/8 [110/128] via 2.2.2.1, 00:08:27, Serial1
C 2.0.0.0/8 is directly connected, Serial1
O 20.0.0.0/8 [110/74] via 2.2.2.1, 00:08:27, Serial1
C 30.0.0.0/8 is directly connected, Ethernet0

When we check the routing table on R3, the output does not have network 10.0.0.0 in the routing table.

Task 4 :

Configure Virtual Link between R1 and R2 :

R1	R2
Router ospf 1 Area 1 virtual-link 20.1.1.1	Router ospf 1 Area 1 virtual-link 10.1.1.1

After Configuring Virtual Link:

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
O 2.0.0.0/8 [110/128] via 1.1.1.2, 00:00:45, Serial0/2/0
O 20.0.0.0/8 [110/74] via 1.1.1.2, 00:00:45, Serial0/2/0
C 10.0.0.0/8 is directly connected, FastEthernet0/0
O 30.0.0.0/8 [110/138] via 1.1.1.2, 00:00:45, Serial0/2/0

R2#show ip route

C 1.0.0.0/8 is directly connected, Serial0
C 2.0.0.0/8 is directly connected, Serial1
C 20.0.0.0/8 is directly connected, Ethernet0
O 10.0.0.0/8 [110/65] via 1.1.1.1, 00:02:10, Serial0
O 30.0.0.0/8 [110/74] via 2.2.2.2, 00:02:10, Serial1

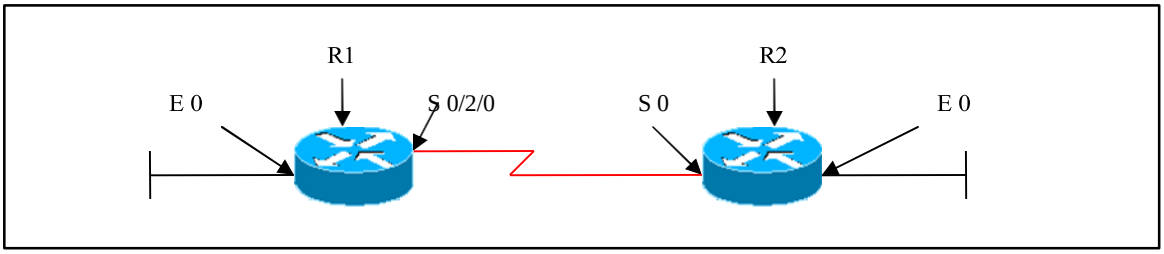
R3#show ip route

O IA 1.0.0.0/8 [110/128] via 2.2.2.1, 00:05:37, Serial1
C 2.0.0.0/8 is directly connected, Serial1
O 20.0.0.0/8 [110/74] via 2.2.2.1, 00:05:37, Serial1
O 10.0.0.0/8 [110/129] via 2.2.2.1, 00:05:37, Serial1
C 30.0.0.0/8 is directly connected, Ethernet0

Now, when we verify the routing table on R1, R2, R3, we see that all O IA routes are advertised as 'O' routes as the routers assume that the networks belong to the same area because of the virtual link.

Also we can see network 10.0.0.0 in R3 routing table as O route.

Lab 10 – Configuring OSPF Authentication



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S0	1.1.1.2	255.0.0.0
E0	20.1.1.1	255.0.0.0

Lab Objective:

Task 1

All routers should Authenticate Routing updates using the simple password authentication method. Use a key-string of cisco123.

R1

```
Router ospf 1
Network 1.1.1.1 0.0.0.0 area 0
Network 10.0.0.0 0.255.255.255 area 0

Int s 0/2/0
Ip ospf authentication-key cisco123
Ip ospf authentication
```

R2

```
Router ospf 1
Network 1.1.1.2 0.0.0.0 area 0
Network 20.0.0.0 0.255.255.255 area 0

Int s0
Ip ospf authentication-key cisco123
Ip ospf authentication
```

Verification :

R1#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
20.1.1.1	0	FULL/ -	00:00:34	1.1.1.2	Serial0/2/0

The output displays neighbor in full state.

If there is a mismatch in the password, there will be no OSPF neighbor relationship established.

R1#show ip route

```
C    1.0.0.0/8 is directly connected, Serial0/2/0
O    20.0.0.0/8 [110/74] via 1.1.1.2, 00:09:23, Serial0/2/0
C    10.0.0.0/8 is directly connected, FastEthernet0/0
```

Simple authentication on R1 and R2, but different passwords:

R1#debug ip ospf adj

*May 29 06:29:03.966: OSPF: Rcv pkt from 1.1.1.2, Serial0/2/0 : Mismatch Authentication Key - Clear Text

Simple authentication on R1, no authentication on R2:

R1#debug ip ospf adj

*May 29 06:37:03.982: OSPF: Rcv pkt from 1.1.1.2, Serial0/2/0 : Mismatch Authentication type. Input packet specified type 0, we use type 1

R2#debug ip ospf adj
*Mar 1 01:14:09.311: OSPF: Rcv pkt from 1.1.1.1, Serial0 : Mismatch Authentication type. Input packet specified type 1, we use type 0

Task 2
(Scenario based on Task 1)

All routers should Authenticate Routing updates using the most secure authentication method. Use Key 1 with a key-string of cisco123. Do not use wide authentication.

R1

```
Router ospf 1
Network 1.1.1.1 0.0.0.0 area 0
Network 10.0.0.0 0.255.255.255 area 0

Int S0/2/0
Ip ospf message-digest-key 1 md5 cisco123
Ip ospf authentication message-digest
```

R2

```
Router ospf 1
Network 1.1.1.2 0.0.0.0 area 0
Network 20.0.0.0 0.255.255.255 area 0

Int S0
Ip ospf message-digest-key 1 md5 cisco123
Ip ospf authentication message-digest
```

Verification :

R1#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
20.1.1.1	0	FULL/ -	00:00:34	1.1.1.2	Serial0/2/0

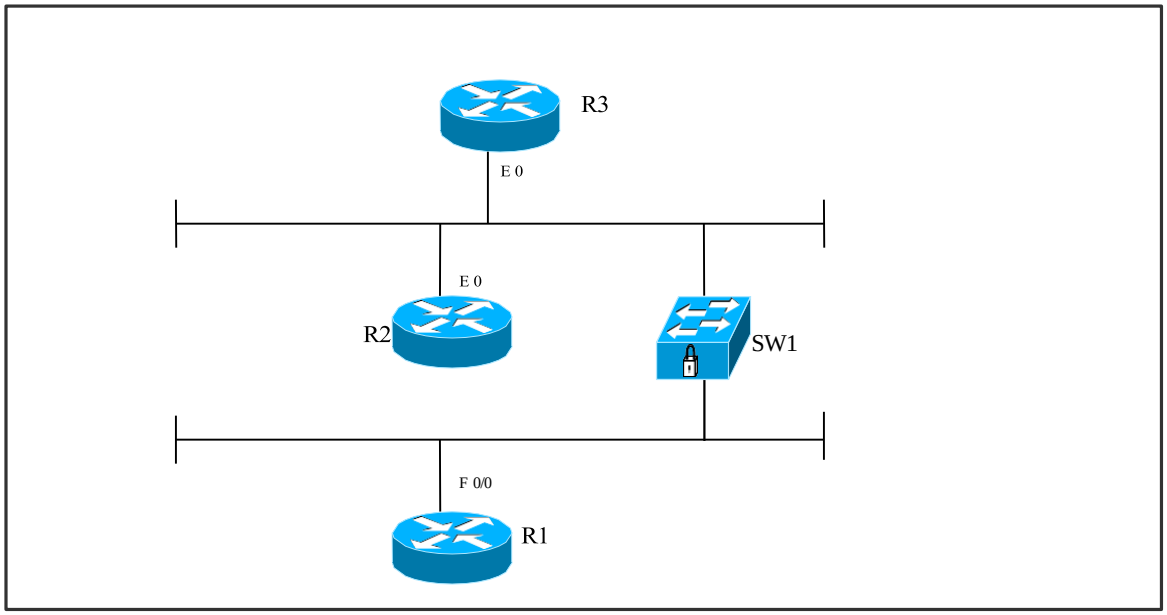
If there is mismatch in key or password, there will not be OSPF neighbor relationship established between the two routers.

R1#show ip route

```
C    1.0.0.0/8 is directly connected, Serial0/2/0
O    20.0.0.0/8 [110/74] via 1.1.1.2, 00:09:23, Serial0/2/0
C    10.0.0.0/8 is directly connected, FastEthernet0/0
```

MD5 authentication on R1, no authentication on R2:
*May 29 06:50:02.162: OSPF: Send with youngest Key 1
*May 29 06:50:04.054: OSPF: Rcv pkt from 1.1.1.2, Serial0/2/0 : Mismatch Authentication type. Input packet specified type 0, we use type 2

Lab 11 – OSPF on Broadcast Multiaccess



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
Fa0/0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
E0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
E0	30.1.1.1	255.0.0.0

Lab Objective:

Task

Configure OSPF as per the above scenario.

R1 Router ospf 1 Network 10.0.0.0 0.255.255.255 area 0	R2 Router ospf 1 Network 20.0.0.0 0.255.255.255 area 0
R3 Router ospf 1 Network 30.0.0.0 0.255.255.255 area 0	

Verification :

The DR & BDR election can be verified by using the following commands

R2#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
10.1.1.2	1	FULL/BDR	00:00:35	10.1.1.1	Ethernet1
10.1.1.3	1	FULL/DR	00:00:30	10.1.1.3	Ethernet1

R3#show ip ospf interface

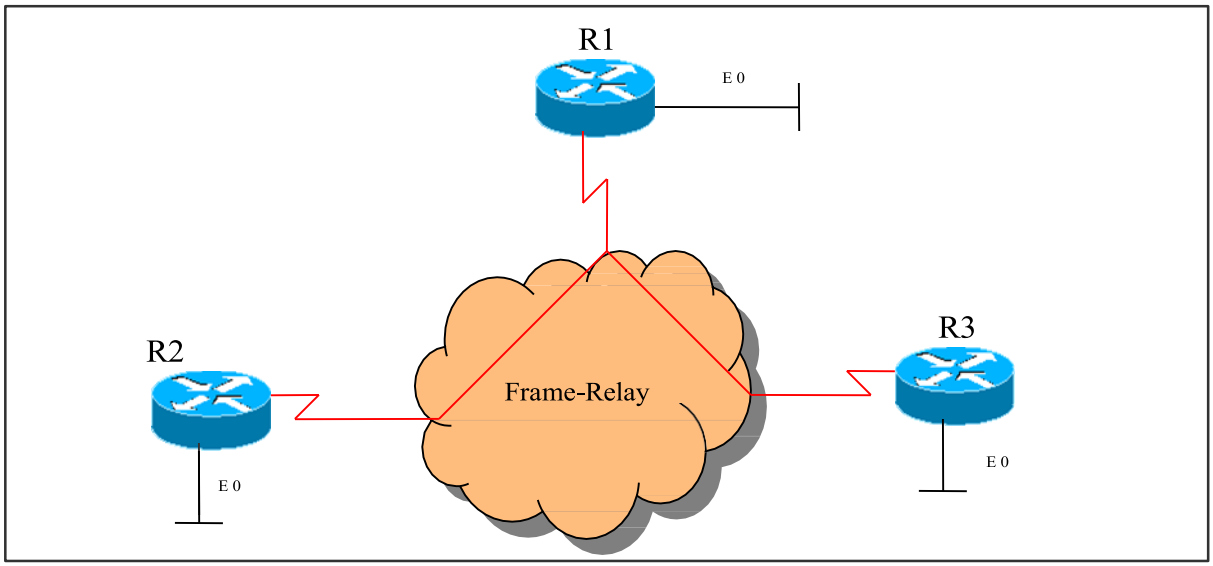
```
Ethernet0 is up, line protocol is up
  Internet Address 10.1.1.3/8, Area 0
  Process ID 1, Router ID 10.1.1.3, Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 10.1.1.3, Interface address 10.1.1.3
  Backup Designated router (ID) 10.1.1.2, Interface address 10.1.1.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:00
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 4 msec
  Neighbor Count is 2, Adjacent neighbor count is 2
    Adjacent with neighbor 10.1.1.2  (Backup Designated Router)
    Adjacent with neighbor 10.1.1.1
```

- Routers notify DR on 224.0.0.6
- DR notifies others on 224.0.0.5.
- Router with highest priority value is the DR
- Router with second highest priority value is BDR
- Default for interface OSPF priority is 1
- In case of a tie, router-id (highest) is preferred
- A router with priority set to 0 cannot become the DR/BDR and is called DR other
- DR election is non-preemptive

Setting priority for DR election

(config-if) # ip ospf priority number
-Default is 1
-Range is 0-255.

Lab 12 – OSPF over Frame-Relay Point-to-Point Subinterfaces



IP addressing and DLCI information Chart			
Routers	IP address	Local DLCI	Connecting to:
R1	S 0.1 : 1.1.1.1 /8 S 0.2 : 2.2.2.1 /8 E 0 : 10.1.1.1 / 8	100 200	R2 R3
R2	S 0: 1.1.1.2 /8 E 0 : 20.1.1.1 / 8	300	R1
R3	S 0: 2.2.2.2 /8 E 0 : 30.1.1.1 / 8	400	R1

Task 1

Configure the frame-relay cloud in a hub and spoke topology without using frame-relay map statements. These routers should reply to inverse-arp inquiries. Routers should be configured in a point-to-point configuration.

R1	R2
Int S0 No ip address No shutdown Encapsulation frame-relay Int serial 0.1 point-to-point Ip add 1.1.1.1 255.0.0.0 Frame-relay interface-dlci 100 No shutdown Int serial 0.2 point-to-point Ip add 2.2.2.1 255.0.0.0 Frame-relay interface-dlci 200 No shutdown	Int S0 Ip add 1.1.1.2 255.0.0.0 Encapsulation frame-relay Frame-relay interface-dlci 300 No shutdown
R3 Int S0 Ip add 2.2.2.2 255.0.0.0 Encapsulation frame-relay Frame-relay interface-dlci 400	FRS Frame-relay switching Int S0 No ip add Encapsulation frame-relay Frame-relay intf-type dce Clock rate 64000 Frame-relay route 100 interface serial 1 300 Frame-relay route 200 interface serial 2 400 No shutdown Int S1 No ip address Encapsulation frame-relay Frame-relay intf-type dce Clock rate 64000 Frame-relay route 300 interface serial 0 100 No shutdown Int S2 No ip address Encapsulation frame-relay Frame-relay route 400 interface serial 0 200 No shutdown

Verify frame-relay connectivity:

R3 # show frame-relay pvc

The output displays pvc-status = active
When we ping to a network, the rate is 100% successful

Task 2 :

Configure OSPF Over Frame- Relay on R1 , R2 and R3.

R1	R2
Router ospf 1 Network 1.1.1.1 0.0.0.0 area 0 Network 2.2.2.1 0.0.0.0 area 0 Network 10.0.0.0 0.255.255.255 area 0	Router ospf 1 Network 1.1.1.2 0.0.0.0 area 0 Network 20.0.0.0 0.255.255.255 area 0
R3	
Router ospf 1 Network 2.2.2.2 0.0.0.0 area 0 Network 30.0.0.0 0.255.255.255 area 0	

Verify OSPF neighbors:

The output displays no neighbors as the hello-intervals did not match on the routers.

The reason is, as follows:

When R1 - FR was configured on sub-interface, the OSPF default mode is point-to-point (hello 10 seconds)

When R2 & R3 - FR was configured on physical interface, the OSPF default mode is non-broadcast (hello 30 sec)

Therefore, we need to manually change the hello-interval time or change the network type on R2 and R3 interfaces.

R2	R3
Int s0 ip ospf network point-to-point	Int s0 ip ospf network point-to-point

Now verify OSPF neighbors:

-The output displays neighbors in full state.

-The routing table can also be verified where the output displays all 'O' routes as in the same area 0.

Verification:

Default mode of ospf on a point-to-point frame-relay physical interface:

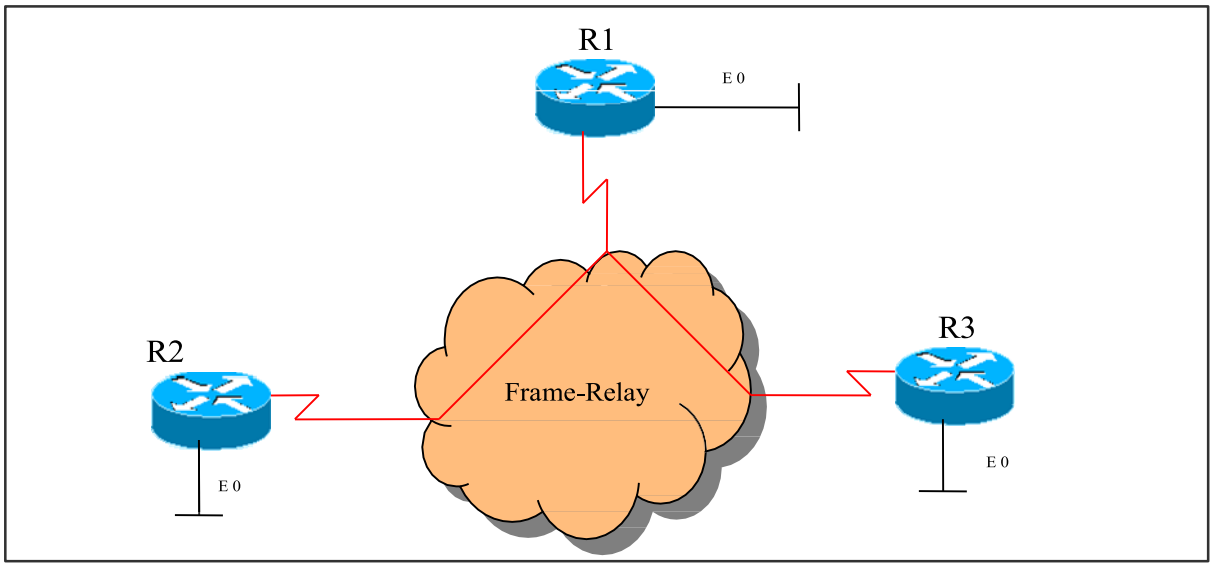
R2#show ip ospf interface S0

Serial0 is up, line protocol is up
Internet Address 1.1.1.2/8, Area 0
Process ID 1, Router ID 20.1.1.1, Network Type NON_BROADCAST, Cost: 64
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 20.1.1.1, Interface address 1.1.1.2
No backup designated router on this network
Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5

R2#show ip route

C 1.0.0.0/8 is directly connected, Serial0
O 2.0.0.0/8 [110/128] via 1.1.1.1, 00:00:00, Serial0
C 20.0.0.0/8 is directly connected, Ethernet0
O 10.0.0.0/8 [110/74] via 1.1.1.1, 00:00:00, Serial0
O 30.0.0.0/8 [110/138] via 1.1.1.1, 00:00:00, Serial0

Lab 13 – OSPF over Frame-Relay Point-to-Multipoint (Physical Interfaces)



IP addressing and DLCI information Chart			
Routers	IP address	Local DLCI	Connecting to:
R1	S 0 : 1.1.1.1 /8 E 0 : 10.1.1.1 / 8	100 200	R2 R3
R2	S 0 : 1.1.1.2 /8 E 0 : 20.1.1.1 / 8	300	R1
R3	S 0 : 1.1.1.3 /8 E 0 : 30.1.1.1 / 8	400	R1

Task 1

Configure the frame-relay cloud in a hub and spoke topology using frame-relay map statements. These routers should NOT reply to inverse-arp inquiries.

R1	R2
Int S0 Ip add 1.1.1.1 255.0.0.0 Encapsulation frame-relay Frame-relay map ip 1.1.1.2 100 Frame-relay map ip 1.1.1.3 200 No shutdown	Int S0 Ip add 1.1.1.2 255.0.0.0 Encapsulation frame-relay Frame-relay map ip 1.1.1.1 300 No shutdown
R3 Int S0 Ip add 1.1.1.3 255.0.0.0 Encapsulation frame-relay Frame-relay map ip 1.1.1.1 400 No shutdown	FRS Frame-relay switching Int S0 No ip add Encapsulation frame-relay Frame-relay intf-type dce Clock rate 64000 Frame-relay route 100 interface serial 2 300 Frame-relay route 200 interface serial 1 400 No shutdown Int S2 No ip address Encapsulation frame-relay Frame-relay intf-type dce Clock rate 64000 Frame-relay route 300 interface serial 0 100 No shutdown Int S1 No ip address Encapsulation frame-relay Frame-relay intf-type dce Frame-relay route 400 interface serial 0 200 No shutdown

Verify frame-relay connectivity :

R3 # show frame-relay pvc

The output displays pvc-status = active
When we ping to a network, the rate is 100% successful

Task 2 :

Configure OSPF Over Frame- Relay on R1 , R2 and R3.

R1	R2
Router ospf 1 Network 1.1.1.1 0.0.0.0 area 0 Network 10.0.0.0 0.255.255.255 area 0	Router ospf 1 Network 1.1.1.2 0.0.0.0 area 0 Network 20.0.0.0 0.255.255.255 area 0
R3 Router ospf 1 Network 1.1.1.3 0.0.0.0 area 0 Network 30.0.0.0 0.255.255.255 area 0	

If we don't use broadcast option in the frame-relay map command, the pvc will not allow broadcast through them so that the neighbors should be statically configured.

Configure neighbor statement manually on R1 :

R1
Router ospf 1 Neighbor 1.1.1.2 priority 0 Neighbor 1.1.1.3 priority 0

Verify OSPF neighbors:

R1 # show ip ospf neighbors

The output displays neighbor state attempt and then full state when completely established

Attempt state is when neighbors are statically configured.

If we use broadcast option, the neighbors are dynamically detected as with the broadcast option the pvc allows broadcast.

Default mode of ospf on a point-to-multipoint frame-relay physical interface:

R2#show ip ospf interface S0

Serial0 is up, line protocol is up
  Internet Address 1.1.1.2/8, Area 0
  Process ID 1, Router ID 20.1.1.1, Network Type NON_BROADCAST, Cost: 64
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 20.1.1.1, Interface address 1.1.1.2
  No backup designated router on this network
  Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5

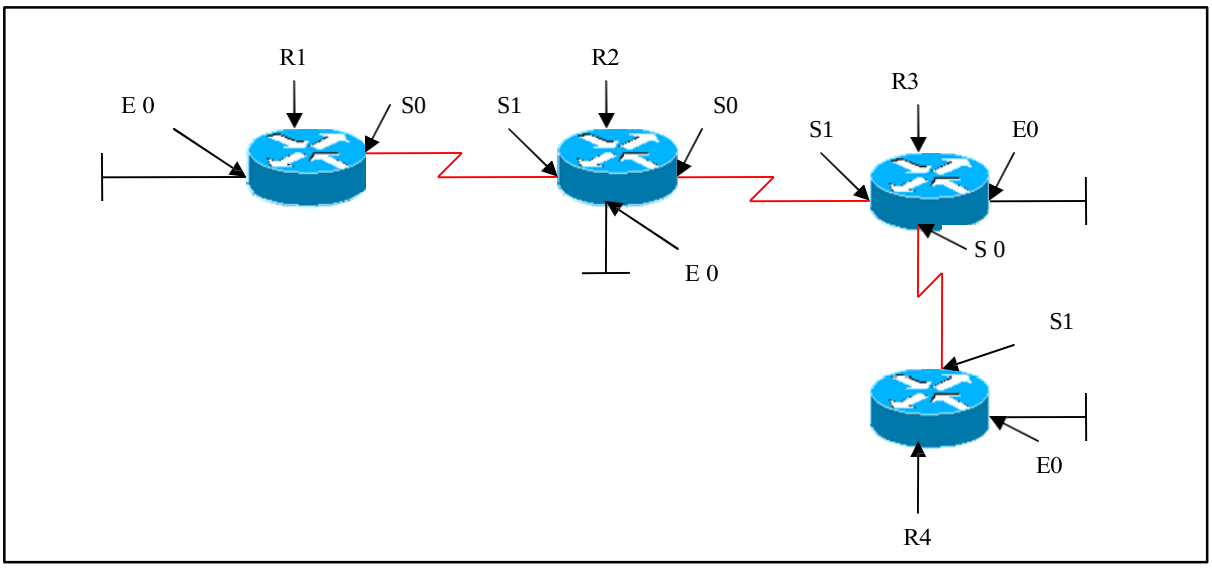
R2#show ip route

C   1.0.0.0/8 is directly connected, Serial0
O   2.0.0.0/8 [110/128] via 1.1.1.1, 00:00:00, Serial0
C   20.0.0.0/8 is directly connected, Ethernet0
O   10.0.0.0/8 [110/74] via 1.1.1.1, 00:00:00, Serial0
O   30.0.0.0/8 [110/138] via 1.1.1.1, 00:00:00, Serial0

Module 3 – RIP

RIP LAB INDEX

Lab 1 – Configure Passive Interface in RIP



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	192.168.1.2	255.255.255.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1	192.168.1.1	255.255.255.0
S 0	172.168.1.1	255.255.255.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 1	172.168.1.2	255.255.255.0
S 0	172.168.2.1	255.255.255.0
E 0	30.1.1.1	255.0.0.0

R4

Interface	IP Address	Subnet Mask
S 1	172.168.2.2	255.255.255.0
E 0	40.1.1.1.	255.0.0.0

Lab Objective:

Task 1

Configure RIP on all the routers. Do not advertise network 172.168.1.1 in RIP process on R2.

The requirement in the above scenario is to stop RIP broadcasts from R3 being sent to R2. To accomplish this task configure passive-interface on R3 (S1 interface).

R2	R3
Router rip Network 20.0.0.0 Network 192.168.0.0	Router rip Network 172.168.0.0 Passive-interface s1 Network 30.0.0.0

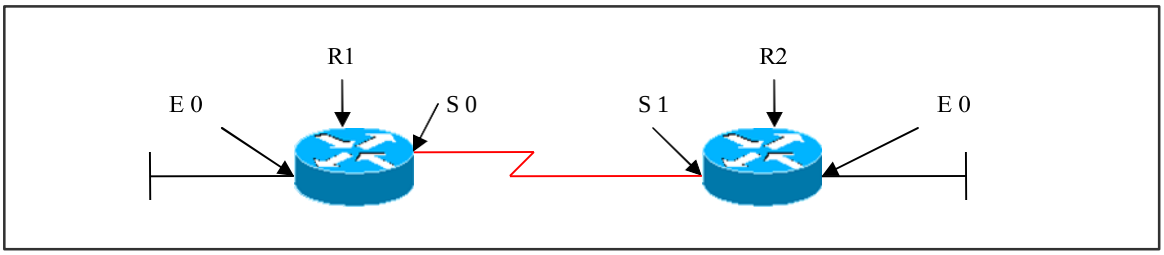
Verification :

R3#debug ip rip

RIP protocol debugging is on
00:42:09: RIP: received v1 update from 172.168.2.2 on Serial0
00:42:09: 40.0.0.0 in 1 hops
00:42:33: RIP: sending v1 update to 255.255.255.255 via Serial0 (172.168.2.1)
00:42:33: subnet 172.168.1.0, metric 1 no updated are sending via s1

The output displays updates received from 172.168.2.2 on S 0 and updates sent via S 0 (172.168.2.1) but does not send updates via S 1 (172.168.1.2).

Lab 2 – Configure Authentication in RIP



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1	1.1.1.2	255.0.0.0
E 0	20.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure MD5 Authentication between R1 and R2 using a password of cisco123.

R1	R2
Int s0 Ip rip authentication mode md5 Ip rip authentication key-chain chain1 Key chain chain1 Key 1 Key-string cisco123	Int s1 Ip rip authentication mode md5 Ip rip authentication key-chain chain Key chain chain2 Key 1 Key-string cisco123

Verification :

R2#show ip protocol

Routing Protocol is "rip"
  Sending updates every 30 seconds, next due in 4 seconds
  Invalid after 180 seconds, hold down 180, flushed after 240
  Default version control: send version 2, receive version 2
  Interface   Send Recv Triggered RIP Key-chain
  Ethernet0   2   2
  Serial1   2   2   chain2
  ---output omitted---

R2#debug ip rip

01:03:53: RIP: sending v2 update to -224.0.0.9 via Serial1 (1.1.1.2)
01:03:53: RIP: build update entries
01:03:53: 20.0.0.0/8 via 0.0.0.0, metric 1, tag 0

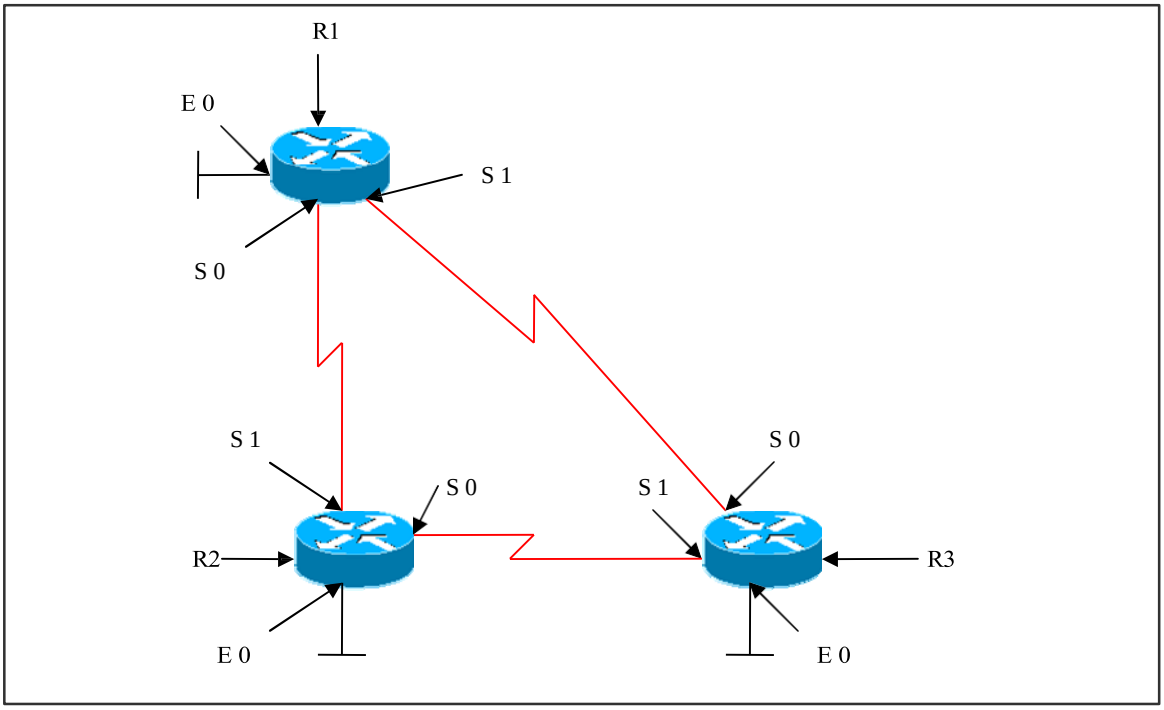
Authentication mismatch in R1 & R2:

R2#debug ip rip events

01:38:27: RIP: sending v2 update to 224.0.0.9 via Ethernet0 (20.1.1.1)
01:38:27: RIP: Update contains 1 routes
01:38:27: RIP: Update queued
01:38:27: RIP: sending v2 update to 224.0.0.9 via Serial1 (1.1.1.2)
01:38:27: RIP: Update contains 1 routes
01:38:27: RIP: Update queued
01:38:27: RIP: Update sent via Ethernet0
01:38:27: RIP: Update sent via Serial1
01:38:28: RIP: ignored v2 packet from 1.1.1.1 (invalid authentication)

If key-identifier and key-string does not match on neighbor end, then there will be an error message stating invalid authentication and updates will not be sent to peers.

Lab 3 – Manipulating RIP Metrics using Offset-List



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
S 1	3.3.3.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1	1.1.1.2	255.0.0.0
S 0	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 1	2.2.2.2	255.0.0.0
S 0	3.3.3.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1

RIP metric is hop-count.

R1 reaches 30.0.0.0 network via 3.3.3.2, but the requirement is R1 should reach 30.0.0.0 network via R2 .

R3 reaches 10.0.0.0 network via 3.3.3.1, but the requirement is R3 should reach 10.0.0.0 network via R2 .

R1	R3
Access-list 30 permit 30.0.0.0 0.255.255.255 Router rip Network 10.0.0.0 Network 1.0.0.0 Network 3.0.0.0 Version 2 No auto-summary Offset-list 30 in 2 serial 1	Access-list 10 permit 10.0.0.0 0.255.255.255 Router rip Network 30.0.0.0 Network 2.0.0.0 Network 3.0.0.0 Version 2 No auto-summary Offset-list 10 in 2 serial 0

Verification:

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0
R 2.0.0.0/8 [120/1] via 1.1.1.2, 00:00:19, Serial0
[120/1] via 3.3.3.2, 00:00:22, Serial1
C 3.0.0.0/8 is directly connected, Serial1
R 20.0.0.0/8 [120/1] via 1.1.1.2, 00:00:19, Serial0
C 10.0.0.0/8 is directly connected, Ethernet0
R 30.0.0.0/8 [120/2] via 1.1.1.2, 00:00:19, Serial0

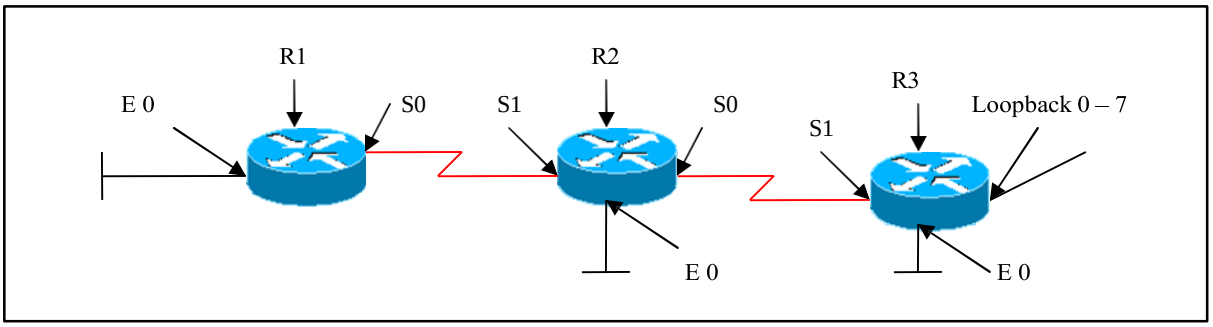
R3#show ip route

R 1.0.0.0/8 [120/1] via 3.3.3.1, 00:00:04, Serial0
[120/1] via 2.2.2.1, 00:00:26, Serial1
C 2.0.0.0/8 is directly connected, Serial1
C 3.0.0.0/8 is directly connected, Serial0
R 20.0.0.0/8 [120/1] via 2.2.2.1, 00:00:27, Serial1
R 10.0.0.0/8 [120/2] via 2.2.2.1, 00:00:27, Serial1
C 30.0.0.0/8 is directly connected, Ethernet0

R3#debug ip rip
02:08:39: RIP: received v2 update from 3.3.3.1 on Serial0
02:08:39: 1.0.0.0/8 -> 0.0.0.0 in 1 hops
02:08:39: 10.0.0.0/8 -> 0.0.0.0 in 3 hops
02:08:39: 20.0.0.0/8 -> 0.0.0.0 in 2 hops
02:08:39: 30.0.0.0/8 -> 0.0.0.0 in 3 hops

The offset-list value ‘2’ is added to the default-metric (1) and applied to incoming routes via S1 in the R1 and S0 in R3.Thus, the routes travel via R2, as that being least in hop count.

Lab 4 – Route filtering using Distribute-List



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1	1.1.1.2	255.0.0.0
S 0	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 1	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0
Loopback 0	192.168.0.1	255.255.255.0
Loopback 1	192.168.1.1	255.255.255.0
Loopback 2	192.168.2.1	255.255.255.0
Loopback 3	192.168.3.1	255.255.255.0
Loopback 4	192.168.4.1	255.255.255.0
Loopback 5	192.168.5.1	255.255.255.0
Loopback 6	192.168.6.1	255.255.255.0
Loopback 7	192.168.7.1	255.255.255.0

Lab Objective:

Task 1

Configure RIP on all the routers as per the scenario . The Requirement is to block networks belonging to 192.168.0.0/22 (192.168.0.0, 192.168.1.0,192.168.2.0, 192.168.3.0) to R1 from R3 using Distribute-List.

R2

```
Access-list 16 deny 192.168.0.0 0.0.3.255
Access-list 16 permit any

Router rip
Distribute-list 16 out serial 1
```

Verification:

R1#show ip route

```
C    1.0.0.0/8 is directly connected, Serial0
R    2.0.0.0/8 [120/1] via 1.1.1.2, 00:00:09, Serial0
R    20.0.0.0/8 [120/1] via 1.1.1.2, 00:00:09, Serial0
R    192.168.4.0/24 [120/2] via 1.1.1.2, 00:00:09, Serial0
R    192.168.5.0/24 [120/2] via 1.1.1.2, 00:00:09, Serial0
C    10.0.0.0/8 is directly connected, Ethernet0
R  192.168.6.0/24 [120/2] via 1.1.1.2, 00:00:09, Serial0
R  192.168.7.0/24 [120/2] via 1.1.1.2, 00:00:09, Serial0
R    30.0.0.0/8 [120/2] via 1.1.1.2, 00:00:09, Serial0
```

The output does not display 192.168.0.0/22 range of networks, but does not block other routes .

Lab 5 – Route Filtering using Prefix-List

(Scenario Based on Lab 4)

Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1	1.1.1.2	255.0.0.0
S 0	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 1	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0
Loopback 0	192.168.0.1	255.255.255.0
Loopback 1	192.168.1.1	255.255.255.0
Loopback 2	192.168.2.1	255.255.255.0
Loopback 3	192.168.3.1	255.255.255.0
Loopback 4	192.168.4.1	255.255.255.0
Loopback 5	192.168.5.1	255.255.255.0
Loopback 6	192.168.6.1	255.255.255.0
Loopback 7	192.168.7.1	255.255.255.0

Lab Objective:

Task 1

Configure RIP on all the routers as per the scenario . The Requirement is to block networks belonging to 192.168.0.0/22 (192.168.0.0, 192.168.1.0,192.168.2.0, 192.168.3.0) to R1 from R3 using Prefix-List.

R2

```
Ip prefix-list ccnp seq 5 deny 192.168.0.0/22 ge 24 le 24
Ip prefix-list ccnp seq 10 permit 0.0.0.0/0 le 32

Router rip
Distribute-list prefix ccnp out serial 1
```

Verification:

R1#show ip route

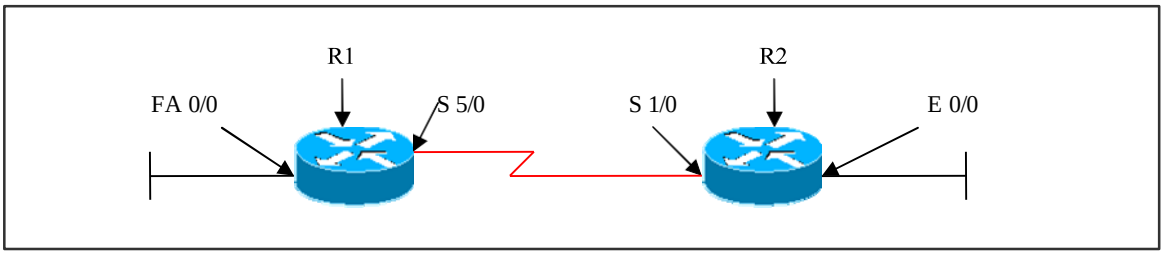
```
C    1.0.0.0/8 is directly connected, Serial0
R    2.0.0.0/8 [120/1] via 1.1.1.2, 00:00:13, Serial0
R    20.0.0.0/8 [120/1] via 1.1.1.2, 00:00:13, Serial0
R    192.168.4.0/24 [120/2] via 1.1.1.2, 00:00:13, Serial0
R    192.168.5.0/24 [120/2] via 1.1.1.2, 00:00:13, Serial0
C    10.0.0.0/8 is directly connected, Ethernet0
R  192.168.6.0/24 [120/2] via 1.1.1.2, 00:00:13, Serial0
R  192.168.7.0/24 [120/2] via 1.1.1.2, 00:00:13, Serial0
R    30.0.0.0/8 [120/2] via 1.1.1.2, 00:00:13, Serial0
```

The output does not display 192.168.0.0/22 range of networks, but does not block other routes.

Module 4 – IS-IS

IS-IS LAB INDEX

Lab 1– Configure IS-IS in Single Area



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 5/0	2.2.2.1	255.0.0.0
Fa 0/0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1/0	2.2.2.2	255.0.0.0
E 0/0	20.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure IS-IS in single area on both the routers.

R1	R2
Int fa0/0 Ip router isis Isis circuit-type level-1 Int s5/0 Ip router isis Isis circuit-type level-1 Router isis Net 49.0001.0000.0000.0001.00	Int e0/0 Ip router isis Isis circuit-type level-1 Int s1/0 Ip router isis Isis circuit-type level-1 Router isis Net 49.0001.0000.0000.0002.00

Is-type level-1	Is-type level-1

Verification:

```
R1#show ip route
C    2.0.0.0/8 is directly connected, Serial5/0
i L1 20.0.0.0/8 [115/20] via 2.2.2.2, Serial5/0
C    10.0.0.0/8 is directly connected, FastEthernet0/0
```

The output displays that network 20.0.0.0 is the route from level 1 as indicated by the "i L1" tag.

```
R2#show ip route

C    2.0.0.0/8 is directly connected, Serial1/0
C    20.0.0.0/8 is directly connected, Ethernet0/0
i L1 10.0.0.0/8 [115/20] via 2.2.2.1, Serial1/0
```

```
R1#show ip protocol
Routing Protocol is "isis"
  Invalid after 0 seconds, hold down 0, flushed after 0
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Redistributing: isis
  Address Summarization:
    None
  Maximum path: 4
  Routing for Networks:
    FastEthernet0/0
    Serial5/0
  Routing Information Sources:
    Gateway         Distance      Last Update
    2.2.2.2              115      00:04:17
  Distance: (default is 115)
```

```
R1#show isis topology
IS-IS paths to level-1 routers
System Id           Metric     Next-Hop            Interface   SNPA
R1                  --
0000.0000.0002      10         0000.0000.0002      Se5/0       *HDLC*
```

This command displays the level 1 topology table, which shows the least cost IS – IS paths to the IS's.

Lab 2 – Configure IS-IS in Multiple Areas

(Scenario Based on Lab 1)

Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 5/0	2.2.2.1	255.0.0.0
Fa 0/0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1/0	2.2.2.2	255.0.0.0
E 0/0	20.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure IS-IS in multiple areas. Configure R1 (S5/0, FA0/0) in ISIS Area 1 and R2 (S1/0, E0/0) in ISIS Area 2.

R1	R2
Int fa0/0 Ip router isis Isis circuit-type level-1 Int s5/0 Ip router isis Isis circuit-type level-1-2 Router isis Net 49.0001.0000.0000.0001.00 Is-type level-1-2	Int e0/0 Ip router isis Isis circuit-type level-1 Int s1/0 Ip router isis Isis circuit-type level-1-2 Router isis Net 49.0002.0000.0000.0002.00 Is-type level-1-2

Verification:

R1#show ip route

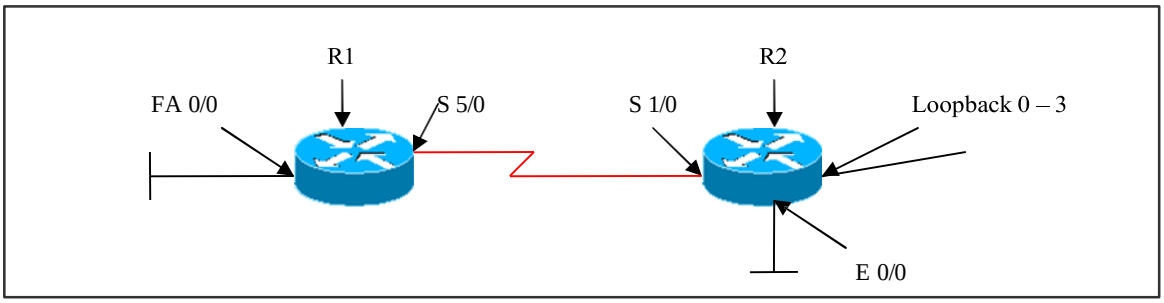
C   2.0.0.0/8 is directly connected, Serial5/0
i L2 20.0.0.0/8 [115/20] via 2.2.2.2, Serial5/0
C   10.0.0.0/8 is directly connected, FastEthernet0/0

The output displays that network 20.0.0.0 is the route from level 2 as indicated by the "i L2" tag.

R2#show ip route

C   2.0.0.0/8 is directly connected, Serial1/0
C   20.0.0.0/8 is directly connected, Ethernet0/0
i L2 10.0.0.0/8 [115/20] via 2.2.2.1, Serial1/0

Lab 3 – Configure IS-IS Summarization



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 5/0	2.2.2.1	255.0.0.0
Fa 0/0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1/0	2.2.2.2	255.0.0.0
E 0/0	20.1.1.1	255.0.0.0
Loopback 0	192.168.0.1	255.255.255.0
Loopback 1	192.168.1.1	255.255.255.0
Loopback 2	192.168.2.1	255.255.255.0
Loopback 3	192.168.3.1	255.255.255.0

Lab Objective:

Task 1

Configure IS-IS in multiple areas. Configure R1 (S5/0, FA0/0) in ISIS Area 1 and R2 (S1/0, E0/0) in ISIS Area 2.

Configure Loopbacks on R2 and only summarized route should be sent to R1.

R1

```
Int fa0/0
Ip router isis
```

```
Isis circuit-type level-1

Int s5/0
Ip router isis
Isis circuit-type level-1-2

Router isis
Net 49.0001.0000.0000.0001.00
Is-type level-1-2
```

```
R2

Int e0/0
Ip router isis
Isis circuit-type level-1

Int s1/0
Ip router isis
Isis circuit-type level-1-2

Int Loopback 0
Ip address 192.168.0.1 255.255.255.0
Ip router isis
Isis circuit-type level-1

Int Loopback 1
Ip address 192.168.1.1 255.255.255.0
Ip router isis
Isis circuit-type level-1

Int Loopback 2
Ip address 192.168.2.1 255.255.255.0
Ip router isis
Isis circuit-type level-1

Int Loopback 3
Ip address 192.168.3.1 255.255.255.0
Ip router isis
Isis circuit-type level-1

Router isis
Net 49.0002.0000.0000.0002.00
Is-type level-1-2
Summary-address 192.168.0.0 255.255.252.0 level-2
```

Verification:

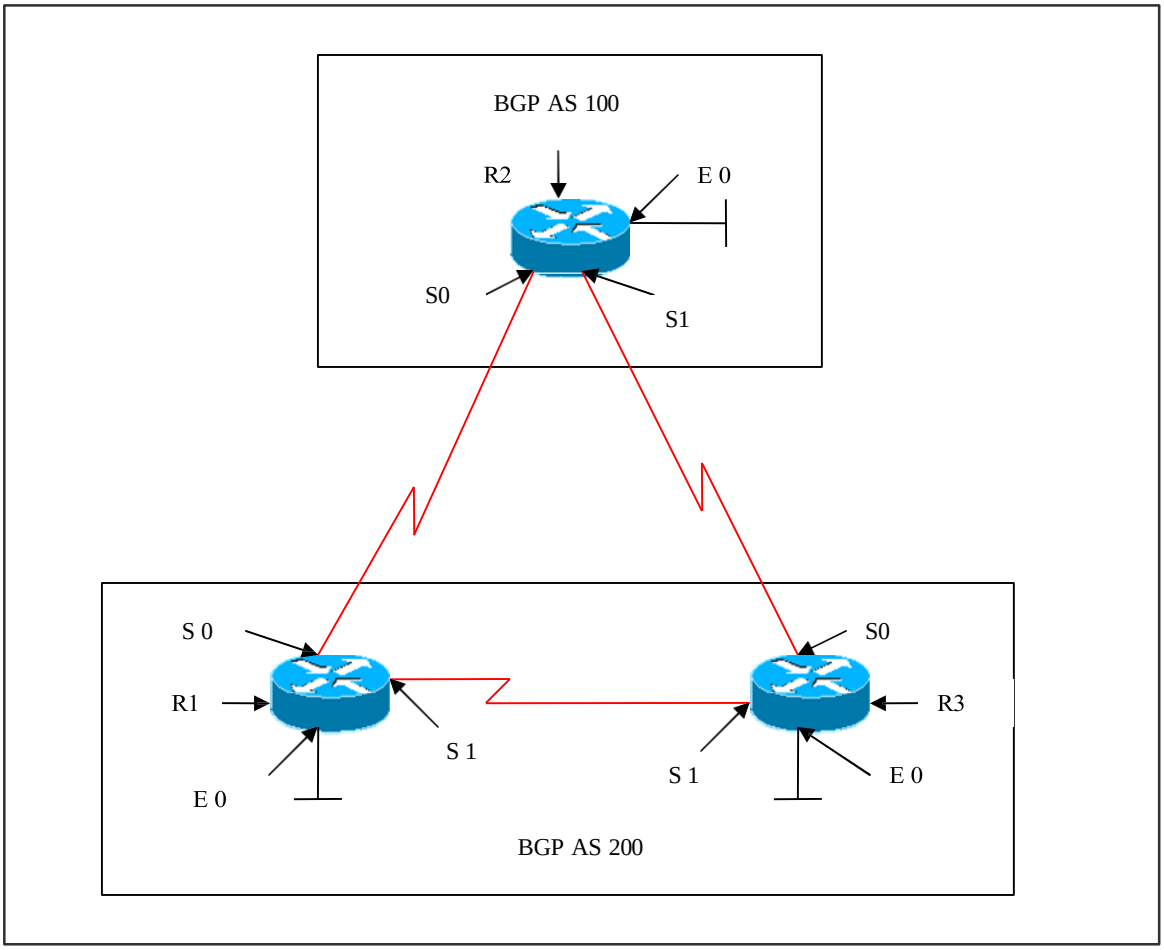
R1#show ip route

C   2.0.0.0/8 is directly connected, Serial5/0
i L2 20.0.0.0/8 [115/20] via 2.2.2.2, Serial5/0
C   10.0.0.0/8 is directly connected, FastEthernet0/0
i L2 192.168.0.0/22 [115/20] via 2.2.2.2, Serial5/0
The output displays a reduced routing table which displays only the summarized route of loopback addresses from level-2 as indicated by “i L2” tag.

Module 5 – BGP

BGP LAB INDEX

Lab 1 – Basic BGP Configuration



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
S 1	3.3.3.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
S 1	3.3.3.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure a BGP neighbor relationship between R1, R2 and R3. R1 should be in AS 200, R2 should be in AS 100 and R3 should be in AS 200.

R1	R2
Router bgp 200 Neighbor 1.1.1.2 remote-as 100 Neighbor 3.3.3.2 remote-as 200 Network 1.0.0.0 Network 3.0.0.0 Network 10.0.0.0 No synchronization	Router bgp 100 Neighbor 1.1.1.1 remote-as 200 Neighbor 2.2.2.2 remote-as 200 Network 1.0.0.0 Network 2.0.0.0 Network 20.0.0.0 No synchronization
R3 Router bgp 200 Neighbor 3.3.3.1 remote-as 200 Neighbor 2.2.2.1 remote-as 100 Network 2.0.0.0 Network 3.0.0.0 Network 30.0.0.0 No synchronization	

Verification:

R1#show ip bgp summary

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	state/PfxRcd
1.1.1.2	4	100	10	12	8	0	0	00:04:54	3
3.3.3.2	4	200	12	11	8	0	0	00:06:57	4

The output displays that BGP neighbors have established a TCP connection.

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0/2/0
B 2.0.0.0/8 [200/0] via 3.3.3.2, 00:08:31
C 3.0.0.0/8 is directly connected, Serial0/2/1
B 20.0.0.0/8 [20/0] via 1.1.1.2, 00:07:17
C 10.0.0.0/8 is directly connected, FastEthernet0/0
B 30.0.0.0/8 [200/0] via 3.3.3.2, 00:08:31

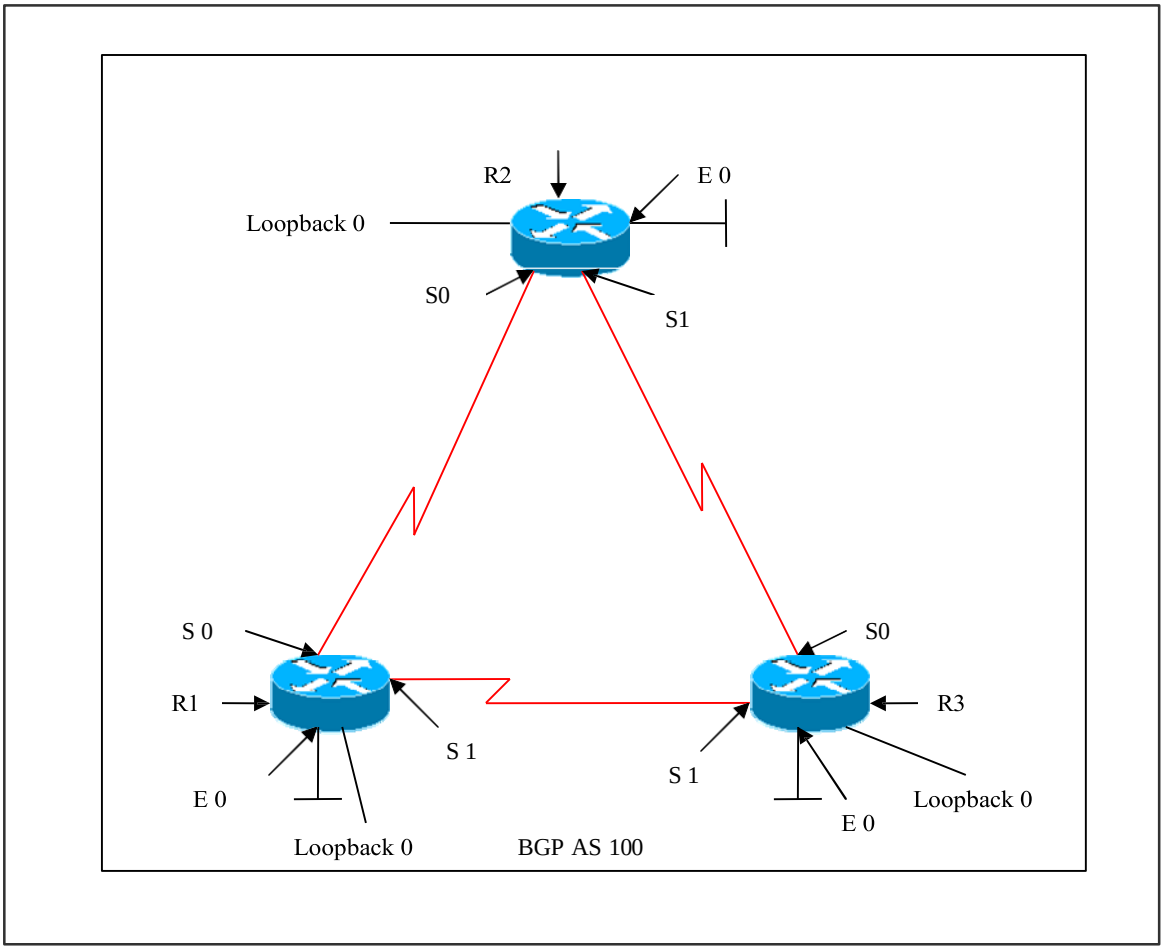
The output states that the BGP routes denoted as 'B' in the routing table.

R1#show ip bgp

Network	Next Hop	Metric	LocPrf	Weight	Path
* 1.0.0.0	1.1.1.2	0		0	100 i
*>	0.0.0.0	0		32768	i
* 2.0.0.0	1.1.1.2	0		0	100 i
*>i	3.3.3.2	0	100	0	i
* i3.0.0.0	3.3.3.2	0	100	0	i
*>	0.0.0.0	0		32768	i
*> 10.0.0.0	0.0.0.0	0		32768	i
*> 20.0.0.0	1.1.1.2	0		0	100 i
* i	2.2.2.1	0	100	0	100 i
*>i30.0.0.0	3.3.3.2	0	100	0	i

The output displays the BGP table.

Lab 2 – Connecting BGP using Loopback



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
S 1	3.3.3.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0
Loopback 0	50.50.50.50	255.255.255.255

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0
Loopback 0	75.75.75.75	255.255.255.255

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
S 1	3.3.3.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0
Loopback 0	100.100.100.100	255.255.255.255

Lab Objective:

Task 1

Configure a BGP neighbor relationship between R1, R2 and R3. All routers should be configured in AS 100. Establish the neighbor relationship based on Loopback 0 addresses. Configure EIGRP as the routing protocol in AS 100. Advertise all loopback networks under EIGRP.

R1	R2
Router eigrp 100 Network 1.0.0.0 Network 3.0.0.0 Network 10.0.0.0 Network 50.0.0.0 No auto-summary Router bgp 100 Neighbor 75.75.75.75 remote-as 100 Neighbor 75.75.75.75 update-source loopback 0 Neighbor 100.100.100.100 remote-as 100 Neighbor 100.100.100.100 update-source loopback 0 No synchronization	Router eigrp 100 Network 1.0.0.0 Network 2.0.0.0 Network 20.0.0.0 Network 75.0.0.0 No auto-summary Router bgp 100 Neighbor 50.50.50.50 remote-as 100 Neighbor 50.50.50.50 update-source loopback 0 Neighbor 100.100.100.100 remote-as 100 Neighbor 100.100.100.100 update-source loopback 0 No synchronization

R3

```
Router eigrp 100
Network 2.0.0.0
Network 3.0.0.0
Network 30.0.0.0
Network 100.0.0.0
No auto-summary

Router bgp 100
Neighbor 50.50.50.50 remote-as 100
Neighbor 50.50.50.50 update-source loopback 0
Neighbor 75.75.75.75 remote-as 100
Neighbor 75.75.75.75 update-source loopback 0
No synchronization
```

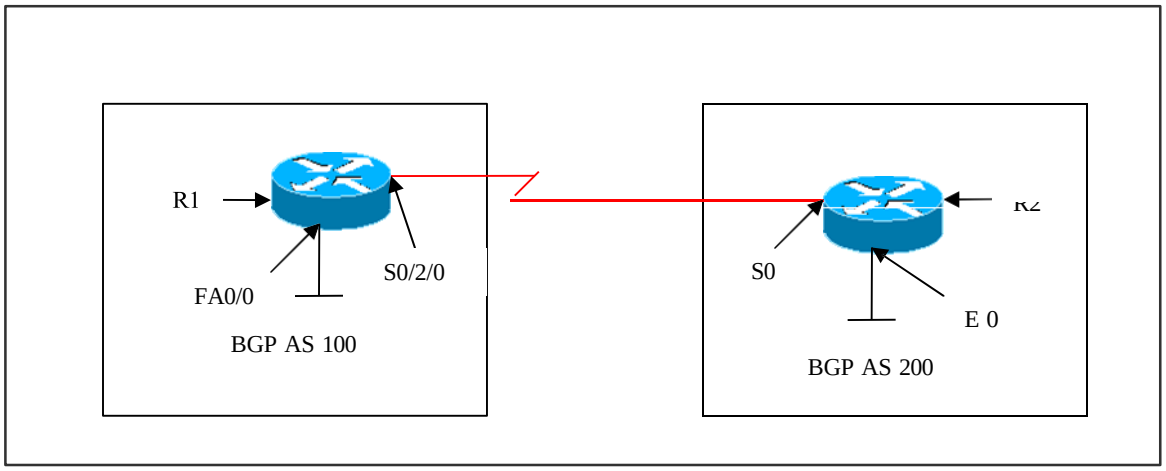
Verification:

R1#show ip bgp summary

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
75.75.75.75	4	100	10	10	1	0	0	00:06:48	0
100.100.100.100	4	100	10	10	1	0	0	00:06:50	0

The output displays that neighbors established a TCP connection between them.

Lab 3 – ebgp-Multihop



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
E 0	20.1.1.1	255.0.0.0

Lab Objective:

Task 1 :

Configure a BGP neighbor relationship between R1 and R2. R1 should be configured in AS 100 and R2 should be in AS 200. Establish the neighbor relationship between peers that are not directly connected. You are allowed to create a static route on each router to accomplish this task.

R1	R2
Ip route 20.1.1.1 255.0.0.0 1.1.1.2 Router bgp 100 Network 1.0.0.0 Neighbor 20.1.1.1 remote-as 200 Neighbor 20.1.1.1 ebgp-multihop No synchronization	Ip route 10.1.1.1 255.0.0.0 1.1.1.1 Router bgp 200 Network 1.0.0.0 Neighbor 10.1.1.1 remote-as 100 Neighbor 10.1.1.1 ebgp-multihop No synchronization

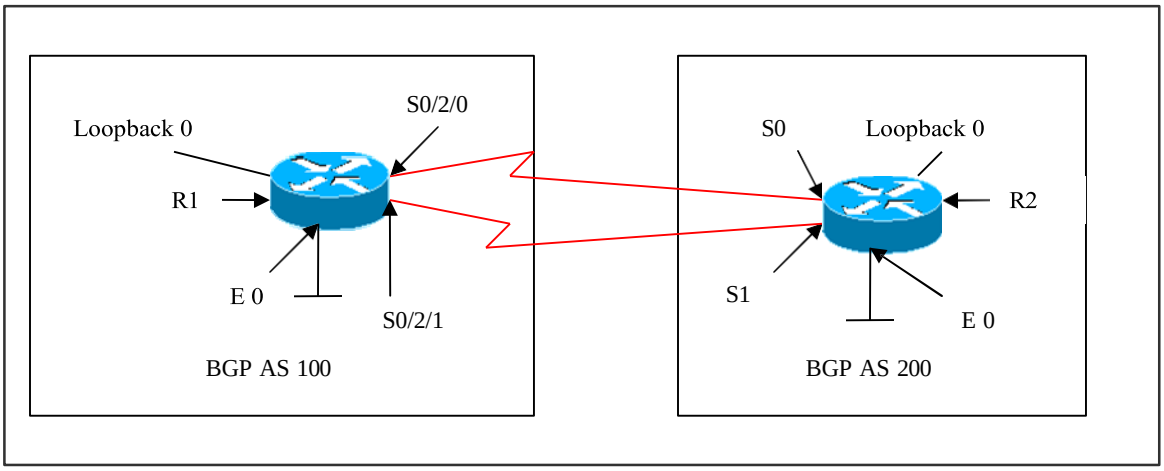
Verification:

R1#show ip bgp summary

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
20.1.1.1	4	200	18	18	1	0	0	00:08:23	0

The output displays neighborship as established.

Lab 4 – ebgp-Multihop (Load Balancing)



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0/2/0	1.1.1.1	255.0.0.0
S 0/2/1	2.2.2.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0
Loopback 0	50.50.50.50	255.255.255.255

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.2	255.0.0.0
E 0	20.1.1.1	255.0.0.0
Loopback 0	75.75.75.75	255.255.255.255

Lab Objective:

Task 1:

Configure a BGP neighbor relationship between R1 and R2. R1 should be configured in AS 100 and R2 should be in AS 200. Establish the neighbor relationship between peers using loopbacks. Create a static route on each router to accomplish this task.

R1	R2
Ip route 75.75.75.75 255.255.255.255 1.1.1.2 Ip route 75.75.75.75 255.255.255.255 2.2.2.2 Router bgp 100 Neighbor 75.75.75.75 remote-as 200 Neighbor 75.75.75.75 update-source loopback 0 Neighbor 75.75.75.75 ebgp-multihop Network 1.0.0.0 Network 2.0.0.0 No synchronization	Ip route 50.50.50.50 255.255.255.255 1.1.1.1 Ip route 50.50.50.50 255.255.255.255 2.2.2.1 Router bgp 200 Neighbor 50.50.50.50 remote-as 100 Neighbor 50.50.50.50 update-source loopback 0 Neighbor 50.50.50.50 ebgp-multihop Network 1.0.0.0 Network 2.0.0.0 No synchronization

Verification:

R1#show ip bgp summary

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
75.75.75.75	4	200	16	16	1	0	0	00:12:01	0

R1#show ip route

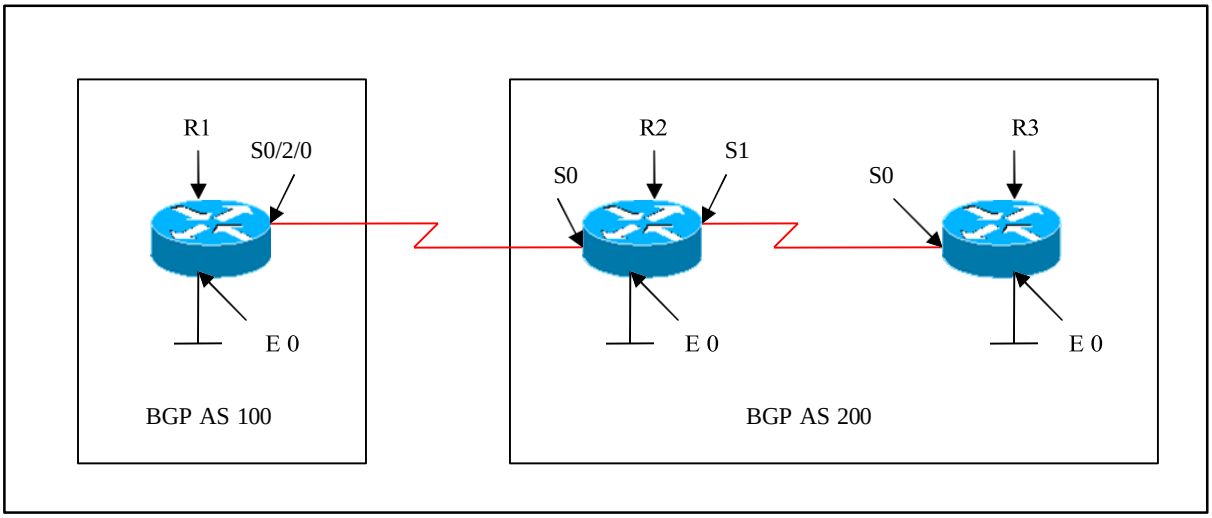
```
C    1.0 0.0/8 is directly connected, Serial0/2/0
     50.0.0.0/32 is subnetted, 1 subnets
C       50.50 50.50 is directly connected, Loopback0
C    2.0 0.0/8 is directly connected, Serial0/2/1
C    10.0 0.0/8 is directly connected, FastEthernet0/0
     75.0.0.0/32 is subnetted, 1 subnets
S       75.75 75.75 [1/0] via 2.2.2.2
                    [1/0] via 1.1.1.2
```

Routing table displays two choices to reach the next hop 75.75.75.75, one via 2.2.2.2 and the other via 1.1.1.2.

The load balancing can be verified by issuing the traceroute command:

```
R1#traceroute  75.75.75.75

Type escape sequence to abort.
Tracing the route to 75.75.75.75

  1 2.2.2.2 16 msec
    1.1.1.2 16 msec *

R1#traceroute  75.75.75.75

Type escape sequence to abort.
Tracing the route to 75.75.75.75

  1 1.1.1.2 24 msec
    2.2.2.2 16 msec
```

Lab 5 – BGP Next Hop Attribute



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1:

Configure BGP on the routers as per the above scenario.

R1	R2
Router bgp 100 Neighbor 1.1.1.2 remote-as 200 Network 1.0.0.0 Network 10.0.0.0 No synchronization	Router bgp 200 Neighbor 2.2.2.2 remote-as 200 Neighbor 1.1.1.1 remote-as 100 Network 1.0.0.0 Network 2.0.0.0 Network 20.0.0.0 No synchronization
R3 Router bgp 200 Neighbor 2.2.2.1 remote-as 200 Network 2.0.0.0 Network 30.0.0.0 No synchronization	

R1 advertises network 10.0.0.0 to R2 with the next hop of 1.1.1.1 and R2 advertises network 20.0.0.0 to R1 with the next hop of 1.1.1.2.

For iBGP, the protocol states that the next hop that eBGP advertises, should be carried into iBGP, because of this rule, R2 advertises network 10.0.0.0 to its iBGP peer R3 with a next hop of 1.1.1.1. Therefore for R3, the next hop to reach network 10.0.0.0 is via 1.1.1.1 and not 2.2.2.1.

Make sure that R3 can reach network 10.0.0.0 via IGP, otherwise R3 drops packets with the destination of 10.0.0.0 or advertise via network commands in BGP.

Verification:

R3#show ip route

B 1.0.0.0/8 [200/0] via 2.2.2.1, 00:08:24
C 2.0.0.0/8 is directly connected, Serial0
B 20.0.0.0/8 [200/0] via 2.2.2.1, 00:09:11

B 10.0.0.0/8 [200/0] via 1.1.1.1, 00:08:11
C 30.0.0.0/8 is directly connected, Ethernet0

The output on R3 displays that the network 10.0.0.0 can be reached via 1.1.1.1.

Task 2:

Configure BGP such that R2 advertises its updates to iBGP peers via 2.2.2.1 instead of 1.1.1.1. You can use the next-hop-self command to accomplish this task.

```
R2

Router bgp 200
Neighbor 2.2.2.2 remote-as 200
Neighbor 2.2.2.2 next-hop-self
Neighbor 1.1.1.1 remote-as 100
Neighbor 1.1.1.1 next-hop-self
Network 1.0.0.0
Network 2.0.0.0
Network 20.0.0.0
No synchronization
```

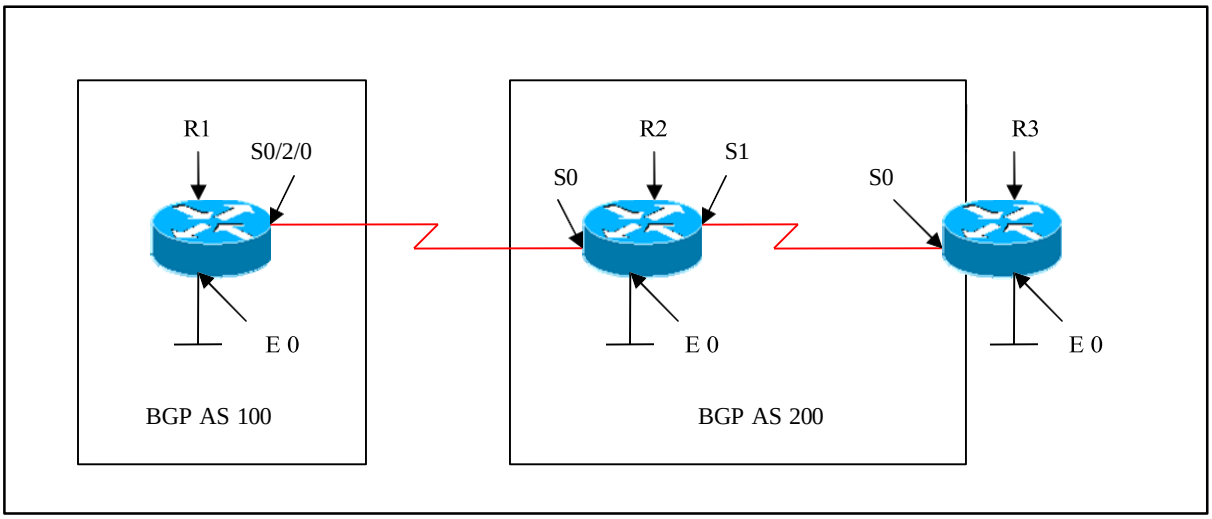
Verification:

R3#show ip route

B 1.0.0.0/8 [200/0] via 2.2.2.1, 00:00:05
C 2.0.0.0/8 is directly connected, Serial0
B 10.0.0.0/8 [200/0] via 2.2.2.1, 00:00:05
C 30.0.0.0/8 is directly connected, Ethernet0

The output displays that for R3 to reach network 10.0.0.0 is via 2.2.2.1 because of the next-hop-self command. R2 advertises network 10.0.0.0 via 2.2.2.1 to R3, instead of carrying the next-hop advertised by eBGP.

Lab 6 – Origin Attribute



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0/2/0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1:

Configure BGP on all the three routers. Do not advertise network 30.0.0.0 on R3 in BGP, instead create static route on R2 to reach 30.0.0.0 via 2.2.2.2 and redistribute this static route into BGP.

R1	R3
Router bgp 100 Neighbor 1.1.1.2 remote-as 200 Network 1.0.0.0 Network 10.0.0.0 No synchronization	Router bgp 200 Neighbor 2.2.2.1 remote-as 200 Network 2.0.0.0 No synchronization
R2 ip route 30.1.1.1 255.0.0.0 2.2.2.2 Router bgp 200 Neighbor 2.2.2.2 remote-as 200 Neighbor 1.1.1.1 remote-as 100 Network 1.0.0.0 Network 2.0.0.0 Network 20.0.0.0 Redistribute static No synchronization	

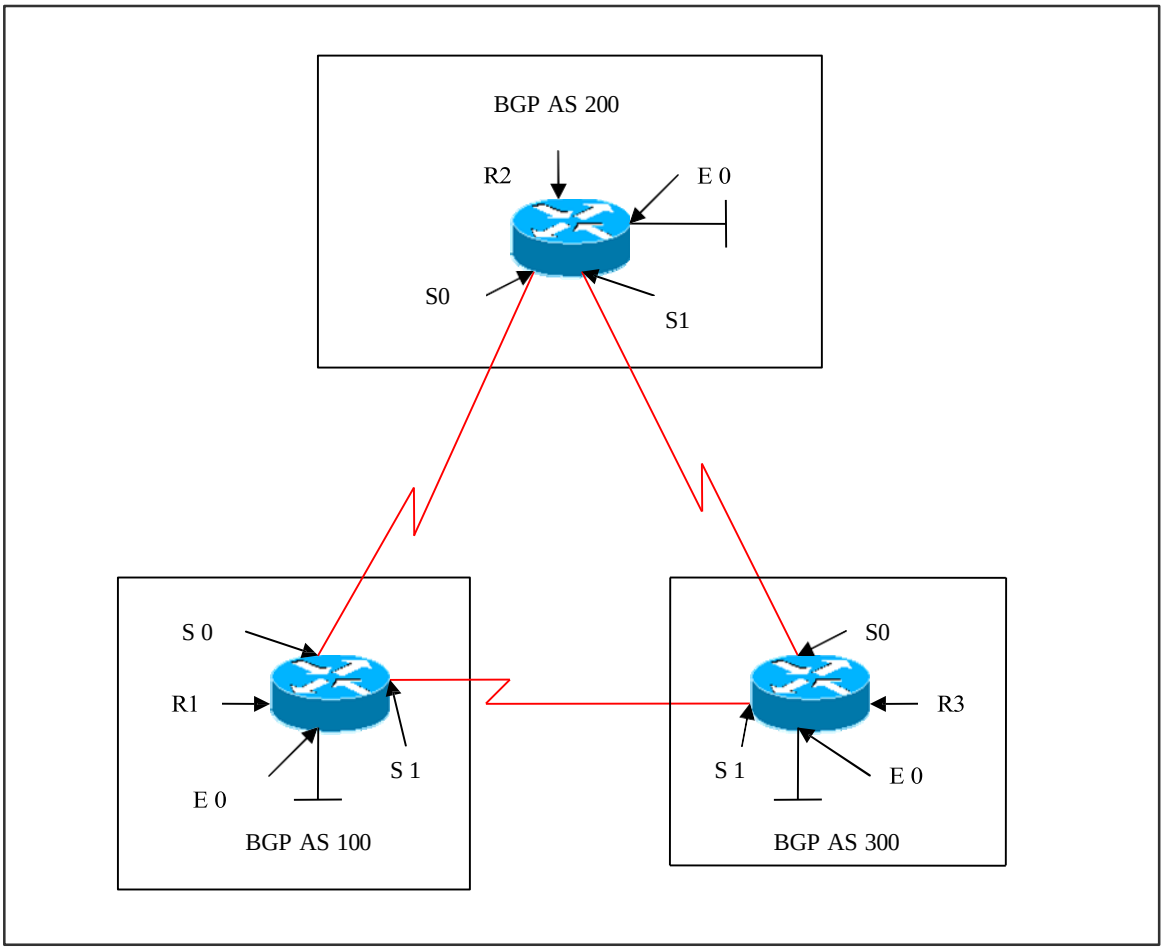
Verification:

R1#show ip bgp

Network	Next Hop	Metric	LocPrf	Weight	Path
* 1.0.0.0	1.1.1.2	0		0	200 i
*>	0.0.0.0	0		32768	i
*> 2.0.0.0	1.1.1.2	0		0	200 i
*> 10.0.0.0	0.0.0.0	0		32768	i
*> 20.0.0.0	1.1.1.2	0		0	200 i
*> 30.1.1.0/24	1.1.1.2	0		0	200 ?

R1 reaches 2.0.0.0 via '200 i' means that the next AS path is 200 and the origin of the route is IGP.
R1 also reaches 30.0.0.0 via '200 ?', means that the next AS is 200 and that the origin is incomplete and is a redistributed static route.

Lab 7 – Setting Cisco Weight Attribute



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
S 1	3.3.3.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
S 1	3.3.3.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1:

Configure AS 200 such that all traffic destined for network 3.0.0.0 should go through R3. Use the Weight attribute to accomplish this task.

R1	R3
Router bgp 100 Neighbor 1.1.1.2 remote-as 200 Neighbor 3.3.3.2 remote-as 300 Network 1.0.0.0 Network 3.0.0.0 Network 10.0.0.0 No synchronization	Router bgp 300 Neighbor 2.2.2.1 remote-as 200 Neighbor 3.3.3.1 remote-as 100 Network 2.0.0.0 Network 3.0.0.0 Network 30.0.0.0 No synchronization
R2 Router bgp 200 Neighbor 1.1.1.1 remote-as 100 Neighbor 1.1.1.1 weight 500 Neighbor 2.2.2.2 remote-as 300 Neighbor 2.2.2.2 weight 1000 Network 1.0.0.0 Network 2.0.0.0 Network 20.0.0.0 Redistribute static	

No synchronization

Verification:

R2#show ip route

C 1.0.0.0/8 is directly connected, Serial0
C 2.0.0.0/8 is directly connected, Serial1
B 3.0.0.0/8 [20/0] via 2.2.2.2, 00:00:04
C 20.0.0.0/8 is directly connected, Ethernet0
B 10.0.0.0/8 [20/0] via 2.2.2.2, 00:00:04
B 30.0.0.0/8 [20/0] via 2.2.2.2, 00:00:04

The output displays that R2 has been forced to use R3 as the next-hop to reach network 3.0.0.0

R2#show ip bgp 3.0.0.0

BGP routing table entry for 3.0.0.0/8, version 4
Paths: (2 available, best #2, table Default-IP-Routing-Table)
Advertised to non peer-group peers:
1.1.1.1
100
1.1.1.1 from 1.1.1.1 (10.1.1.1)
Origin IGP, metric 0, localpref 100, weight 500, valid, external
300
2.2.2.2 from 2.2.2.2 (30.1.1.1)
Origin IGP, metric 0, localpref 100, weight 1000, valid, external, best

The output displays two paths and shows the path via 2.2.2.2 as the best path choosen because of the highest weight set to that path.

R2#show ip bgp 10.0.0.0

BGP routing table entry for 10.0.0.0/8, version 5
Paths: (2 available, best #2, table Default-IP-Routing-Table)
Advertised to non peer-group peers:
1.1.1.1
100
1.1.1.1 from 1.1.1.1 (10.1.1.1)
Origin IGP, metric 0, localpref 100, weight 500, valid, external
300 100
2.2.2.2 from 2.2.2.2 (30.1.1.1)
Origin IGP, localpref 100, weight 1000, valid, external, best

The output displays two paths and shows the path via 2.2.2.2 as the best path choosen because of the highest weight set to that path.

Task 2:

Configure route-map using weight attribute to manipulate the routing information on R2.

```
R2

Access-list 1 permit 30.0.0.0 0.255.255.255
Access-list 2 permit 10.0.0.0 0.255.255.255

Route-map list 1 permit 10
Match ip address 1
Set weight 1000

Route-map list 1 permit 20

Route-map list 2 permit 10
Match ip add 2
Set weight 1000

Route-map list 2 permit 20

Router bgp 200
Neighbor 1.1.1.1 route-map list 1 in
Neighbor 2.2.2.2 route-map list 2 in
```

Verification:

R2#sh ip route

C 1.0.0.0/8 is directly connected, Serial0
C 2.0.0.0/8 is directly connected, Serial1
B 3.0.0.0/8 [20/0] via 1.1.1.1, 00:00:02
C 20.0.0.0/8 is directly connected, Ethernet0
B 10.0.0.0/8 [20/0] via 2.2.2.2, 00:00:02
B 30.0.0.0/8 [20/0] via 1.1.1.1, 00:00:02

The routing table displays that R2 is learning network 10.0.0.0 via 2.2.2.2 and network 30.0.0.0 via 1.1.1.1

R2#show ip bgp 30.0.0.0

BGP routing table entry for 30.0.0.0/8, version 7
Paths: (2 available, best #2, table Default-IP-Routing-Table)
  Advertised to non peer-group peers:
  2.2.2.2
  300
    2.2.2.2 from 2.2.2.2 (30.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, external
  100 300
    1.1.1.1 from 1.1.1.1 (10.1.1.1)
      Origin IGP, localpref 100, weight 1000, valid, external, best

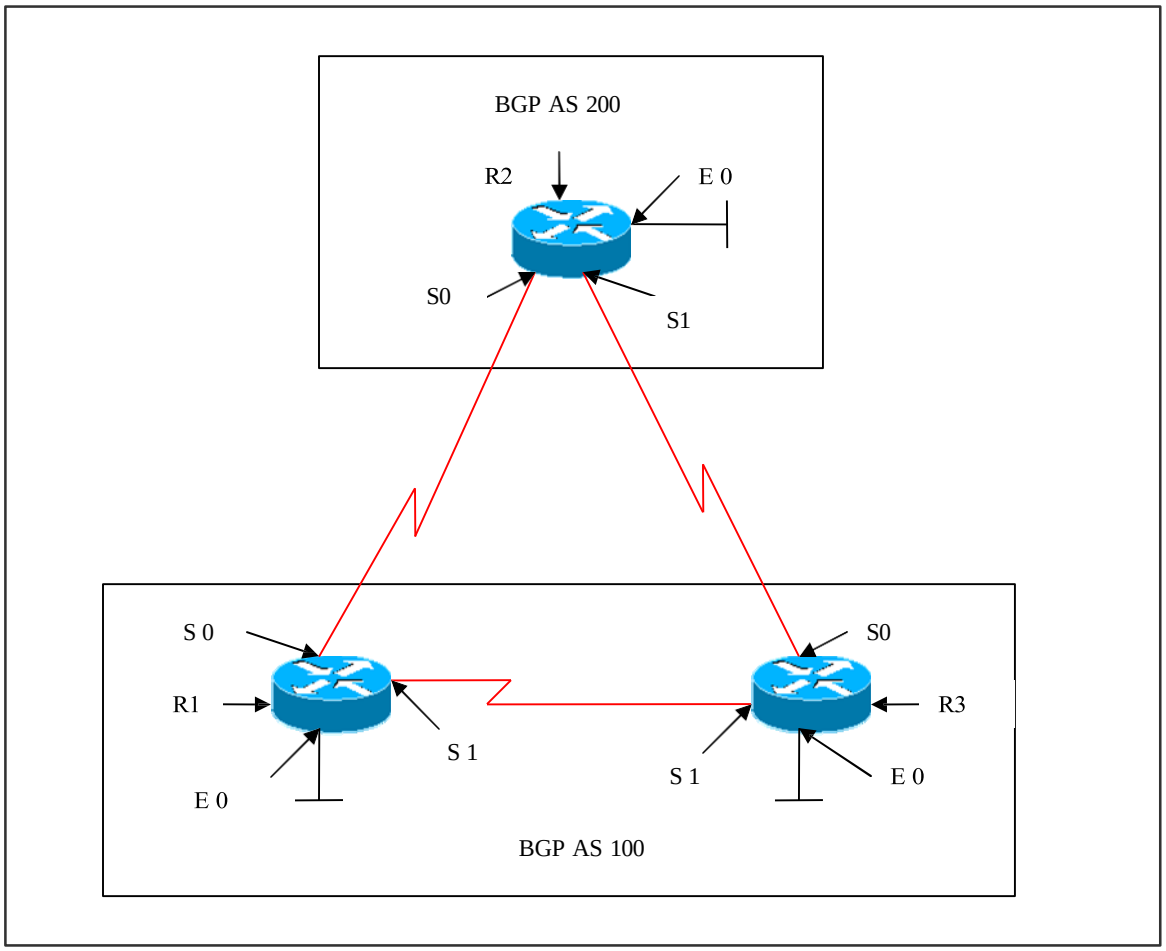
The output displays the best path to reach network 30.0.0.0 from R2 is via 1.1.1.1, because of the highest weight attribute set to that path.

R2#show ip bgp 10.0.0.0

BGP routing table entry for 10.0.0.0/8, version 8
Paths: (2 available, best #1, table Default-IP-Routing-Table)
  Advertised to non peer-group peers:
  1.1.1.1
  300 100
    2.2.2.2 from 2.2.2.2 (30.1.1.1)
      Origin IGP, localpref 100, weight 1000, valid, external, best
  100
    1.1.1.1 from 1.1.1.1 (10.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, external

The output displays the best path to reach network 10.0.0.0 from R2 is via 2.2.2.2, because of the highest weight attribute set to that path.

Lab 8 – Setting Local Preference



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
S 1	3.3.3.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
S 1	3.3.3.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1:

Configure AS 100 such that all traffic destined for AS 200 should go through R2. Use Local-Preference Attribute to accomplish this task.

R1 Router bgp 100 Neighbor 1.1.1.2 remote-as 200 Neighbor 3.3.3.2 remote-as 100 Network 1.0.0.0 Network 3.0.0.0 Network 10.0.0.0 No synchronization	R3 Router bgp 100 Neighbor 2.2.2.1 remote-as 200 Neighbor 3.3.3.1 remote-as 100 Bgp default-preference 500 Network 2.0.0.0 Network 3.0.0.0 Network 30.0.0.0 No synchronization
R2 Router bgp 200 Neighbor 1.1.1.1 remote-as 100 Neighbor 2.2.2.2 remote-as 100 Network 1.0.0.0 Network 2.0.0.0 Network 20.0.0.0 No synchronization	

Verification:

R3#show ip route

B 1.0.0.0/8 [20/0] via 2.2.2.1, 00:00:01
C 2.0.0.0/8 is directly connected, Serial0
C 3.0.0.0/8 is directly connected, Serial1
B 20.0.0.0/8 [20/0] via 2.2.2.1, 00:00:01
B 10.0.0.0/8 [200/0] via 3.3.3.1, 00:00:01
C 30.0.0.0/8 is directly connected, Ethernet0

The output displays that R3 learns network 1.0.0.0 via 2.2.2.1.

R3#show ip bgp 1.0.0.0

200
  2.2.2.1 from 2.2.2.1 (20.1.1.1)
    Origin IGP, metric 0, localpref 500, valid, external, best
Local
  3.3.3.1 from 3.3.3.1 (10.1.1.1)
    Origin IGP, metric 0, localpref 100, valid, internal

The output displays that path 2.2.2.1 is the best path, because of the highest local preference value over the other path.

Task 2:

Configure route-map using local-preference attribute to manipulate the routing information on R3.

R3

Access-list 1 permit 20.0.0.0 0.255.255.255

Route-map list 1 permit 10
Match ip address 1
Set local preference 50

Route-map list 1 permit 20

Router bgp 200
Neighbor 2.2.2.1 remote-as 200
Neighbor 2.2.2.1 route-map list1 in
Neighbor 3.3.3.1 remote-as 100
Network 3.0.0.0

```
Network 2.0.0.0
Network 30.0.0.0
No synchronization
```

Verification:

```
R3#show ip route
B    1.0.0.0/8 [200/0] via 3.3.3.1, 00:02:17
C    2.0.0.0/8 is directly connected, Serial0
C    3.0.0.0/8 is directly connected, Serial1
B    20.0.0.0/8 [200/0] via 1.1.1.2, 00:01:41
B    10.0.0.0/8 [200/0] via 3.3.3.1, 00:02:17
C    30.0.0.0/8 is directly connected, Ethernet0

R3#show ip bgp 20.0.0.0
  200
    2.2.2.1 from 2.2.2.1 (20.1.1.1)
      Origin IGP, metric 0, localpref 50, valid, external
  200
    1.1.1.2 from 3.3.3.1 (10.1.1.1)
      Origin IGP, metric 0, localpref 100, valid, internal, best
```

The output displays that path 1.1.1.2 is the best path, because of the highest local preference value over the other path.

Lab 10 – Configuring MED

(Scenario Based On Lab 9)

Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
S 1	3.3.3.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
S 1	3.3.3.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1:

All ingress (incoming) traffic to AS 200 should use the path through R3 using the MED attribute. Configure the MED on R1 to 100 and Configure the MED on R3 to 50. Lower MED will be preferred.

R1	R3
Access-list 1 permit 10.0.0.0 0.255.255.255 Route-map list 1 permit 10 Match ip add 1 Set metric 200 Route-map list 1 permit 20 Set metric 100 Router bgp 100 Neighbor 1.1.1.2 route-map list 1 out	Access-list 1 permit 30.0.0.0 0.255.255.255 Route-map list 1 permit 10 Match ip add 1 Set metric 50 Route-map list 1 permit 20 Set metric 100 Router bgp 100 Neighbor 2.2.2.1 route-map list 1 out

Verification:

R2#show ip route

C 1.0.0.0/8 is directly connected, Serial0
C 2.0.0.0/8 is directly connected, Serial1
B 3.0.0.0/8 [20/100] via 1.1.1.1, 00:00:04
C 20.0.0.0/8 is directly connected, Ethernet0
B 10.0.0.0/8 [20/100] via 2.2.2.2, 00:00:04
B 30.0.0.0/8 [20/50] via 2.2.2.2, 00:00:04

The output displays that network 10.0.0.0 & 30.0.0.0 are learnt via 2.2.2.2 because of the lowest MED value set to this path.

R2#show ip bgp 10.0.0.0

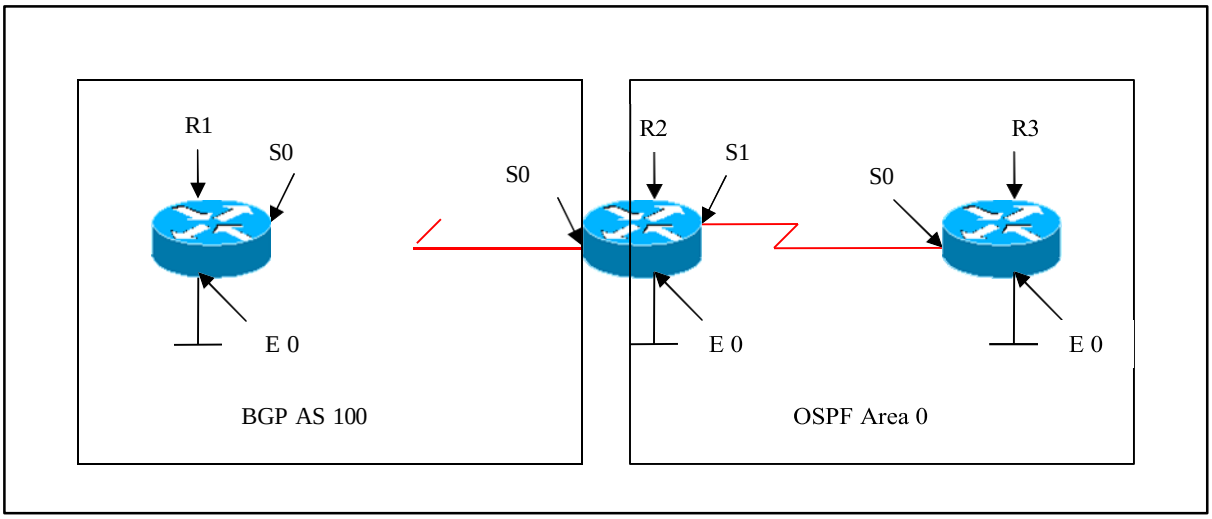
BGP routing table entry for 10.0.0.0/8, version 5
Paths: (2 available, best #1, table Default-IP-Routing-Table)
Advertised to non peer-group peers:
1.1.1.1
100
2.2.2.2 from 2.2.2.2 (30.1.1.1)
Origin IGP, metric 100, localpref 100, valid, external, best
100
1.1.1.1 from 1.1.1.1 (10.1.1.1)
Origin IGP, metric 200, localpref 100, valid, external

R2#show ip bgp 30.0.0.0

BGP routing table entry for 30.0.0.0/8, version 7
Paths: (2 available, best #1, table Default-IP-Routing-Table)
  Advertised to non peer-group peers:
  1.1.1.1
  100
    2.2.2.2 from 2.2.2.2 (30.1.1.1)
      Origin IGP, metric 50, localpref 100, valid, external, best
  100
    1.1.1.1 from 1.1.1.1 (10.1.1.1)
      Origin IGP, metric 100, localpref 100, valid, external

The output displays best path 2.2.2.2 with a metric 50 lower than other path.

Lab 11 – Configuring MED using default-metric command



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1:

Configure BGP and OSPF as per the above scenario. Redistribute OSPF into BGP and verify the metric values displayed in the output by default.

R1 Router bgp 100 Neighbor 1.1.1.2 remote-as 100 Network 1.0.0.0 Network 10.0.0.0 No synchronization	R2 Router ospf 1 Network 2.2.2.1 0.0.0.0 area 0 Network 20.0.0.0 0.255.255.255 area 0 Router bgp 100 Neighbor 1.1.1.1 remote-as 100 Network 1.0.0.0 No synchronization Redistribute ospf 1
R3 Router ospf 1 Network 2.2.2.1 0.0.0.0 area 0 Network 30.0.0.0 0.255.255.255 area 0	

Verification:

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0
B 2.0.0.0/8 [200/0] via 1.1.1.2, 00:03:10
B 20.0.0.0/8 [200/0] via 1.1.1.2, 00:03:10
C 10.0.0.0/8 is directly connected, Ethernet0
B 30.0.0.0/8 [200/74] via 2.2.2.2, 00:02:35

The output displays routes 2.0.0.0 and 20.0.0.0 with a metric of '0' as they are directly connected to R2 and when passed to R1 travel with a metric of '0'.

Task 2:

Configure BGP and OSPF as per the above scenario. Redistribute OSPF into BGP using a metric value of 5.

```
R2

Router ospf 1
Network 2.2.2.1 0.0.0.0 area 0
Network 20.0.0.0 0.255.255.255 area 0

Router bgp 100
Neighbor 1.1.1.1 remote-as 100
Network 1.0.0.0
No synchronization
Redistribute ospf 1 metric 5
```

Verification:

R1#show ip route

```
C    1.0.0.0/8 is directly connected, Serial0
B    2.0.0.0/8 [200/0] via 1.1.1.2, 00:02:39
B    20.0.0.0/8 [200/0] via 1.1.1.2, 00:02:39
C    10.0.0.0/8 is directly connected, Ethernet0
B    30.0.0.0/8 [200/5] via 2.2.2.2, 00:02:07
```

The output displays network 30.0.0.0 changed to metric of 5. But observe that network 2.0.0.0 and 20.0.0.0 still remain with a metric of '0' as they are not displayed as redistributed routes instead they are learn't as connected routes on R2.

Task 3:

Configure BGP and OSPF as per the above scenario. Redistribute OSPF into BGP using a metric value of 5 and also redistribute connected routes with a metric set to 50.

```
R2

Router ospf 1
Network 2.2.2.1 0.0.0.0 area 0
Network 20.0.0.0 0.255.255.255 area 0

Router bgp 100
Neighbor 1.1.1.1 remote-as 100
Network 1.0.0.0
No synchronization
Redistribute ospf 1 metric 5
Redistribute connected metric 50
```

Verification:

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0
B 2.0.0.0/8 [200/50] via 1.1.1.2, 00:02:39
B 20.0.0.0/8 [200/50] via 1.1.1.2, 00:02:39
C 10.0.0.0/8 is directly connected, Ethernet0
B 30.0.0.0/8 [200/5] via 2.2.2.2, 00:02:07

The output displays network 30.0.0.0 changed to metric of '5'. Also network 2.0.0.0 and 20.0.0.0 with a metric of '50'.

Task 4:

Configure BGP and OSPF as per the above scenario. Redistribute OSPF into BGP and use the default-metric command to change the metric.

R2

Router ospf 1
Network 2.2.2.1 0.0.0.0 area 0
Network 20.0.0.0 0.255.255.255 area 0

Router bgp 100
Neighbor 1.1.1.1 remote-as 100
Network 1.0.0.0
No synchronization
Redistribute ospf 1
Default-metric 75

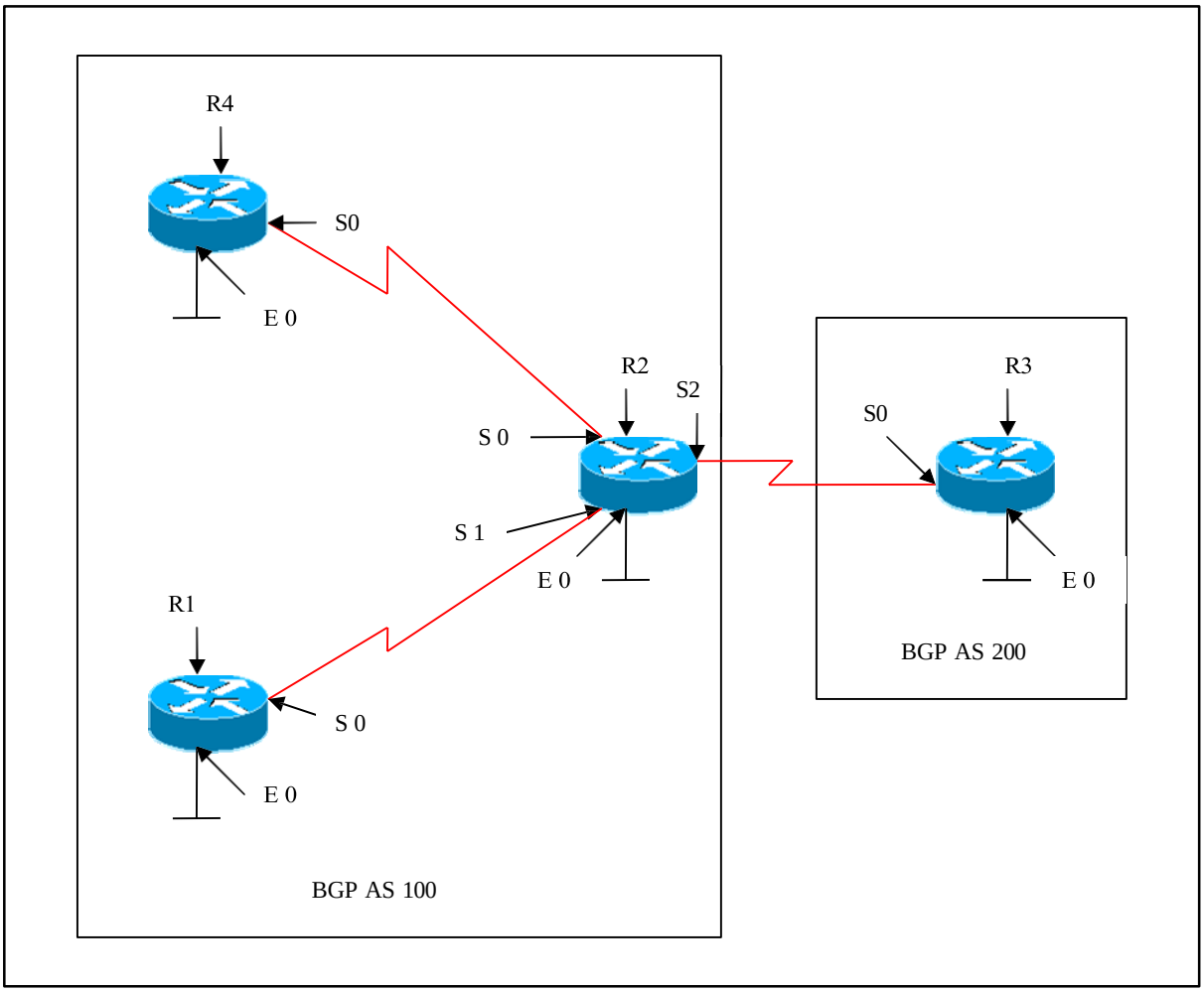
Verification:

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0
B 2.0.0.0/8 [200/0] via 1.1.1.2, 00:00:33
B 20.0.0.0/8 [200/0] via 1.1.1.2, 00:00:33
C 10.0.0.0/8 is directly connected, Ethernet0
B 30.0.0.0/8 [200/75] via 2.2.2.2, 00:00:00

The output displays network 30.0.0.0 with a metric value changed to 75.

Lab 12 – Community Attribute



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	3.3.3.1	255.0.0.0
S 1	1.1.1.2	255.0.0.0
S 2	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

R4

Interface	IP Address	Subnet Mask
S 0	3.3.3.2	255.0.0.0
E 0	40.1.1.1	255.0.0.0

Lab Objective:

Task 1:

Configure BGP on all the routers. Configure R1, R2 and R4 in AS 100. Configure R3 in AS 200. Network 10.0.0.0 should not be sent ouside AS 100 using no-export community attribute.

R1

```
Access-list 1 permit 10.0.0.0
0.255.255.255

Route-map no-exp
Match ip add 1
Set community no-export

Router bgp 100
Neighbor 1.1.1.2 route-map no-exp out
Neighbor 1.1.1.2 send-community
```

Verification:

R3#show ip route

B 1.0.0.0/8 [20/0] via 2.2.2.1, 00:01:36
C 2.0.0.0/8 is directly connected, Serial0
B 3.0.0.0/8 [20/0] via 2.2.2.1, 00:01:36
B 20.0.0.0/8 [20/0] via 2.2.2.1, 00:01:36
B 40.0.0.0/8 [20/0] via 2.2.2.1, 00:00:13
C 30.0.0.0/8 is directly connected, Ethernet0

The output does not display network 10.0.0.0 in the routing table as it is blocked by the no-export community attribute.

R2#show ip bgp 10.0.0.0

BGP routing table entry for 10.0.0.0/8, version 13
Paths: (1 available, best #1, table Default-IP-Routing-Table, not advertised to EBGP peer)
Not advertised to any peer
Local
1.1.1.1 from 1.1.1.1 (10.1.1.1)
Origin IGP, metric 0, localpref 100, valid, internal, best
Community: no-export

The output displays the community attribute no-export set .

Task 2:

Configure BGP on all the routers. Configure R1, R2 and R4 in AS 100. Configure R3 in AS 200. Network 10.0.0.0 should not be advertised to any peers, internal or external.

R1

Access-list 1 permit 10.0.0.0
0.255.255.255

Route-map no-adv
Match ip add 1
Set community no-advertise

Router bgp 100
Neighbor 1.1.1.2 route-map no-adv out
Neighbor 1.1.1.2 send-community

Verification:

R3#show ip route

B 1.0.0.0/8 [20/0] via 2.2.2.1, 00:01:18
C 2.0.0.0/8 is directly connected, Serial0
B 3.0.0.0/8 [20/0] via 2.2.2.1, 00:01:18
B 20.0.0.0/8 [20/0] via 2.2.2.1, 00:01:18
B 40.0.0.0/8 [20/0] via 2.2.2.1, 00:00:21
C 30.0.0.0/8 is directly connected, Ethernet0

R4#show ip route

B 1.0.0.0/8 [200/0] via 3.3.3.1, 00:00:21
B 2.0.0.0/8 [200/0] via 3.3.3.1, 00:01:22
C 3.0.0.0/8 is directly connected, Serial1
B 20.0.0.0/8 [200/0] via 3.3.3.1, 00:01:22
C 40.0.0.0/8 is directly connected, Ethernet0
B 30.0.0.0/8 [200/0] via 2.2.2.2, 00:00:22

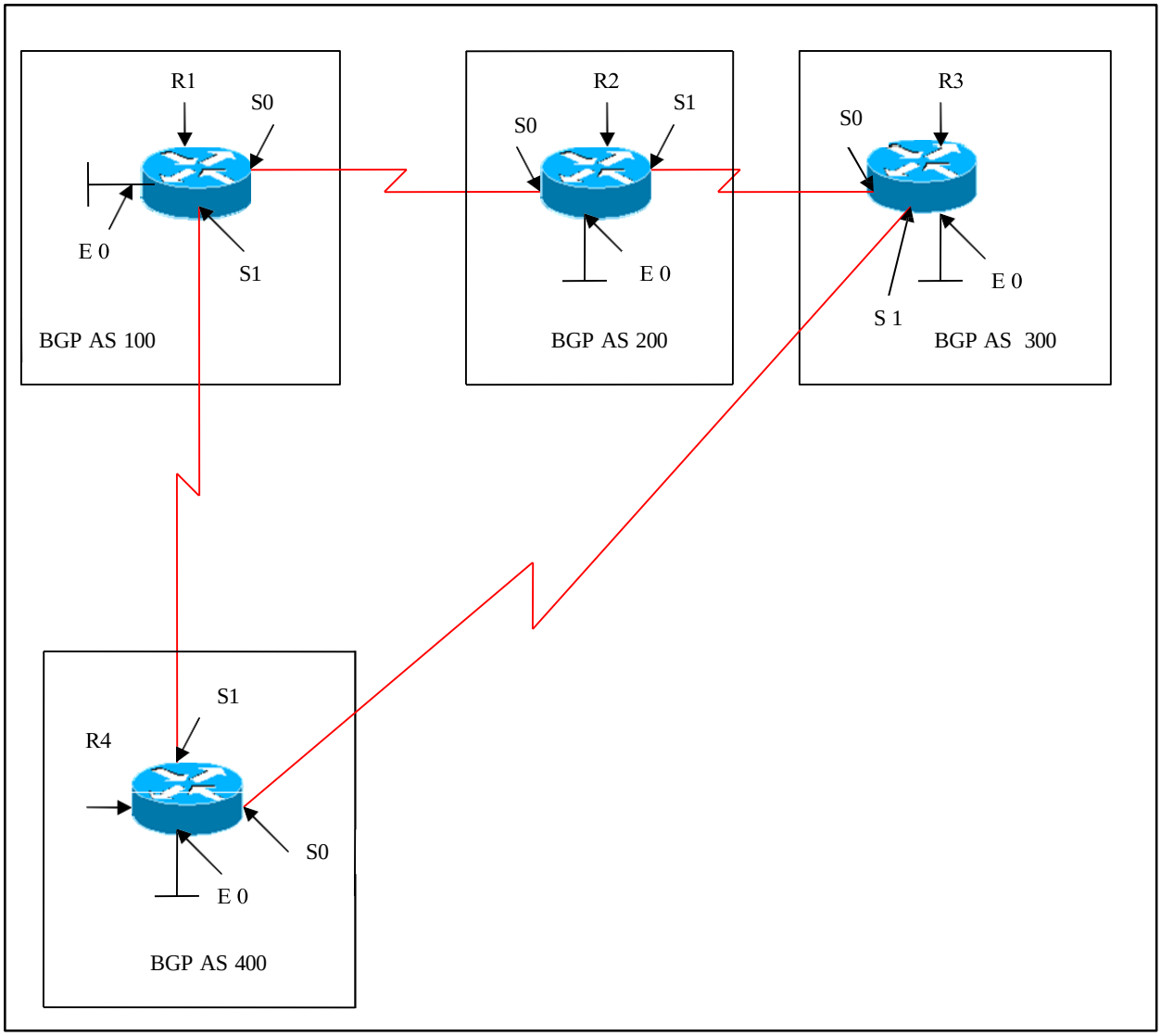
The output doesn't display network 10.0.0.0 in the routing table of both ibgp and ebgp neighbors.

R2#show ip bgp 10.0.0.0

BGP routing table entry for 10.0.0.0/8, version 18
Paths: (1 available, best #1, table Default-IP-Routing-Table, not advertised to any peer)
Not advertised to any peer
Local
1.1.1.1 from 1.1.1.1 (10.1.1.1)
Origin IGP, metric 0, localpref 100, valid, internal, best
Community: no-advertise

The output displays the community attribute no-advertise set .

Lab 13 – AS-Path Attribute



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
S 1	3.3.3.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
S 1	4.4.4.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

R4

Interface	IP Address	Subnet Mask
S 1	3.3.3.2	255.0.0.0
S 0	4.4.4.1	255.0.0.0
E 0	40.1.1.1	255.0.0.0

Lab Objective:

Task 1:

Configure BGP on all the routers.

R1	R2
Router bgp 100 Neighbor 1.1.1.2 remote-as 200 Neighbor 3.3.3.2 remote-as 400	Router bgp 200 Neighbor 2.2.2.2 remote-as 300 Neighbor 1.1.1.1 remote-as 100

Network 1.0.0.0 Network 3.0.0.0 Network 10.0.0.0 No synchronization	Network 1.0.0.0 Network 2.0.0.0 Network 20.0.0.0 No synchronization
R3 Router bgp 300 Neighbor 2.2.2.1 remote-as 200 Neighbor 4.4.4.1 remote-as 400 Network 2.0.0.0 Network 4.0.0.0 Network 30.0.0.0 No synchronization	R4 Router bgp 400 Neighbor 4.4.4.2 remote-as 300 Neighbor 3.3.3.1 remote-as 100 Network 3.0.0.0 Network 4.0.0.0 Network 40.0.0.0 No synchronization

Verification:

R4#show ip route

B 1.0.0.0/8 [20/0] via 3.3.3.1, 00:01:15
B 2.0.0.0/8 [20/0] via 4.4.4.2, 00:01:15
C 3.0.0.0/8 is directly connected, Serial1
C 4.0.0.0/8 is directly connected, Serial0
B 20.0.0.0/8 [20/0] via 3.3.3.1, 00:01:15
C 40.0.0.0/8 is directly connected, Ethernet0
B 10.0.0.0/8 [20/0] via 3.3.3.1, 00:01:15
B 30.0.0.0/8 [20/0] via 4.4.4.2, 00:01:15

R4#show ip bgp 30.0.0.0

BGP routing table entry for 30.0.0.0/8, version 8
Paths: (2 available, best #1, table Default-IP-Routing-Table)
Advertised to non peer-group peers:
3.3.3.1
300
4.4.4.2 from 4.4.4.2 (30.1.1.1)
Origin IGP, metric 0, localpref 100, valid, external, best
100 200 300
3.3.3.1 from 3.3.3.1 (3.3.3.1)
Origin IGP, localpref 100, valid, external

The output displays that network 30.0.0.0 is reached via 4.4.4.2 from R4 as it is the shortest path when compared to the other path via 3.3.3.1.

Task 2:

Manipulate the path to reach network 30.0.0.0 on R4. You can use as-path prepend command using route-map to accomplish this task.

```
R4

Access-list 1 permit 30.0.0.0
0.255.255.255

Route-map map 1 permit 10
Match ip add 1
Set as-path prepend 400 400 400 400

Route-map map1 permit 20

Router bgp 400
Neighbor 4.4.4.2 route-map map 1 in
```

Verification:

R4#show ip route

```
B    1.0.0.0/8 [20/0] via 3.3.3.1, 00:00:34
B    2.0.0.0/8 [20/0] via 4.4.4.2, 00:00:34
C    3.0.0.0/8 is directly connected, Serial1
C    4.0.0.0/8 is directly connected, Serial0
B    20.0.0.0/8 [20/0] via 3.3.3.1, 00:00:34
C    40.0.0.0/8 is directly connected, Ethernet0
B    10.0.0.0/8 [20/0] via 3.3.3.1, 00:00:34
B    30.0.0.0/8 [20/0] via 3.3.3.1, 00:00:34
```

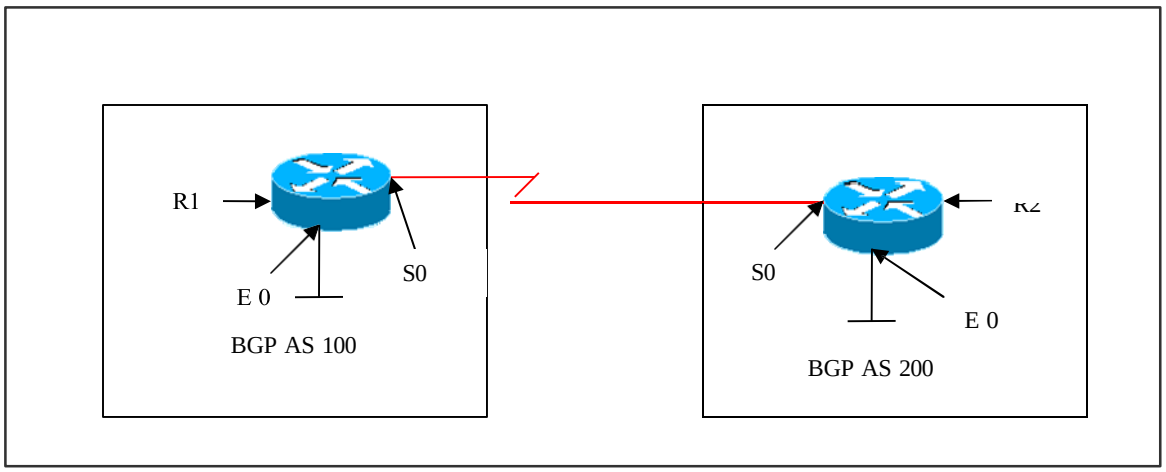
R4#show ip bgp 30.0.0.0

```
BGP routing table entry for 30.0.0.0/8, version 8
Paths: (2 available, best #2, table Default-IP-Routing-Table)
  Advertised to non peer-group peers:
  4.4.4.2
  400 400 400 400 300
```

4.4.4.2 from 4.4.4.2 (30.1.1.1)
Origin IGP, metric 0, localpref 100, valid, external
100 200 300
3.3.3.1 from 3.3.3.1 (3.3.3.1)
Origin IGP, localpref 100, valid, external, best

The output displays that network 30.0.0.0 is reached via 3.3.3.1 from R4 as it is the shortest path when compared to the other path via 4.4.4.2.

Lab 14 – BGP Neighbor MD5 Authentication



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
E 0	20.1.1.1	255.0.0.0

Lab Objective:

Task 1:

Configure BGP on all the routers. Configure R1 in AS 100 and R2 in AS 200. Configure MD5 Authentication between R1 and R2 using a password of cisco123.

R1	R2
Router bgp 100 Neighbor 1.1.1.2 remote-as 200	Router bgp 200 Neighbor 1.1.1.1 remote-as 100

Neighbor 1.1.1.2 password cisco123 Network 1.0.0.0 Network 10.0.0.0 No synchronization	Neighbor 1.1.1.1 password cisco123 Network 1.0.0.0 Network 20.0.0.0 No synchronization

Verification:

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0
B 20.0.0.0/8 [20/0] via 1.1.1.2, 00:00:04
C 10.0.0.0/8 is directly connected, Ethernet0

R1#show ip bgp summary

Neighbor	V	AS	MsgRcvd	MsgSent	TblVer	InQ	OutQ	Up/Down	State/PfxRcd
1.1.1.2	4	200	13	11	4	0	0	00:01:43	2

Authentication in R2 and no authentication in R1:

R2#debug ip bgp events

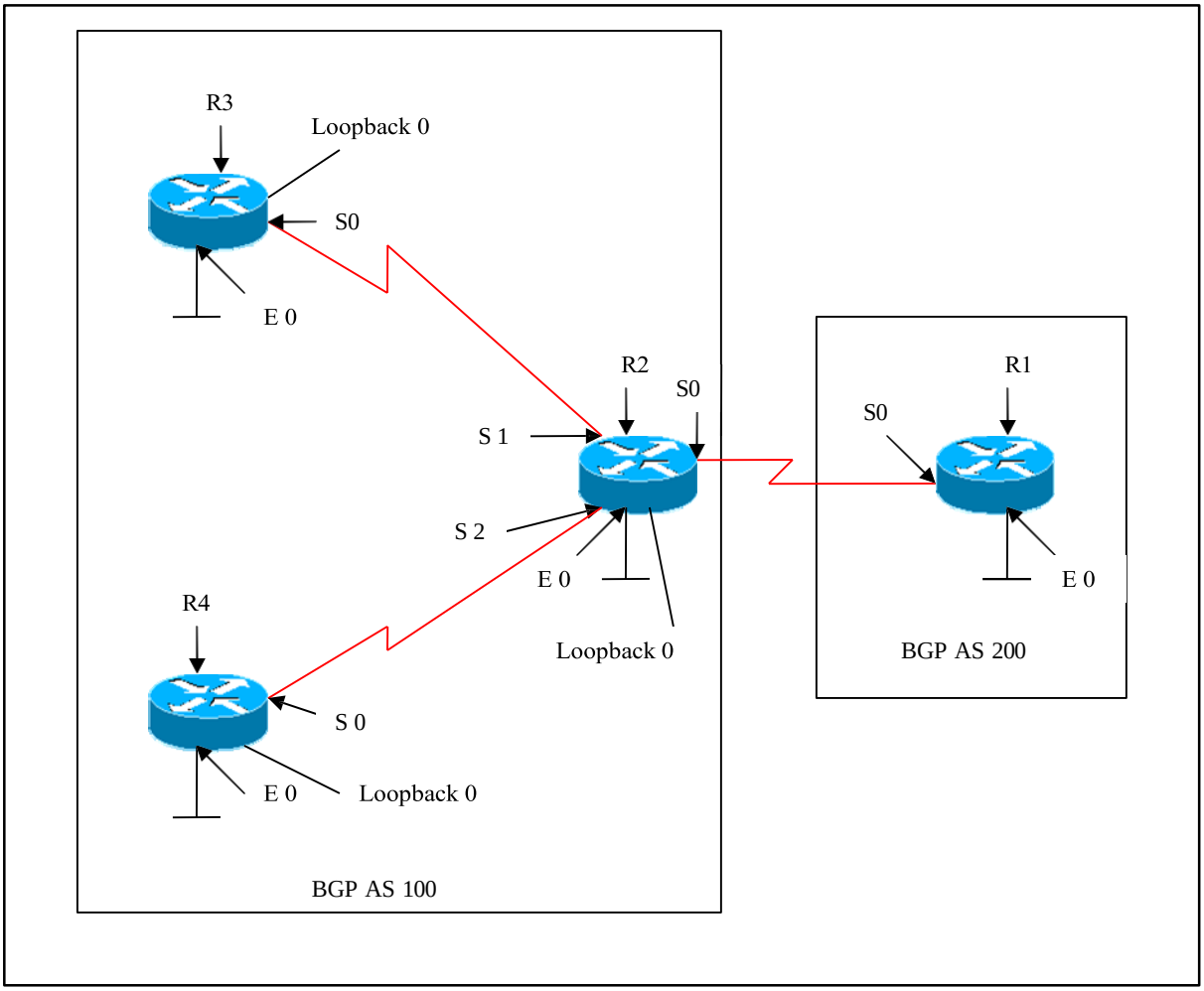
04:58:02: %TCP-6-BADAUTH: No MD5 digest from 1.1.1.1:179 to 1.1.1.2:11087
04:58:04: %TCP-6-BADAUTH: No MD5 digest from 1.1.1.1:179 to 1.1.1.2:11087
04:58:04: %TCP-6-BADAUTH: No MD5 digest from 1.1.1.1:179 to 1.1.1.2:11087

Authentication mismatch:

R2#debug ip bgp events

05:01:09: %TCP-6-BADAUTH: Invalid MD5 digest from 1.1.1.1:11040 to 1.1.1.2:179
05:01:12: %TCP-6-BADAUTH: Invalid MD5 digest from 1.1.1.1:11040 to 1.1.1.2:179
05:01:16: %TCP-6-BADAUTH: Invalid MD5 digest from 1.1.1.1:11040 to 1.1.1.2:179

Lab 15 – Configuring Peer-groups



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	3.3.3.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	3.3.3.2	255.0.0.0
S 1	1.1.1.1	255.0.0.0
S 2	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0
Loopback 0	7.7.7.7	255.255.255.255

R3

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0
Loopback 0	8.8.8.8	255.255.255.255

R4

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
E 0	40.1.1.1	255.0.0.0
Loopback 0	6.6.6.6	255.255.255.255

Lab Objective:

Task 1:

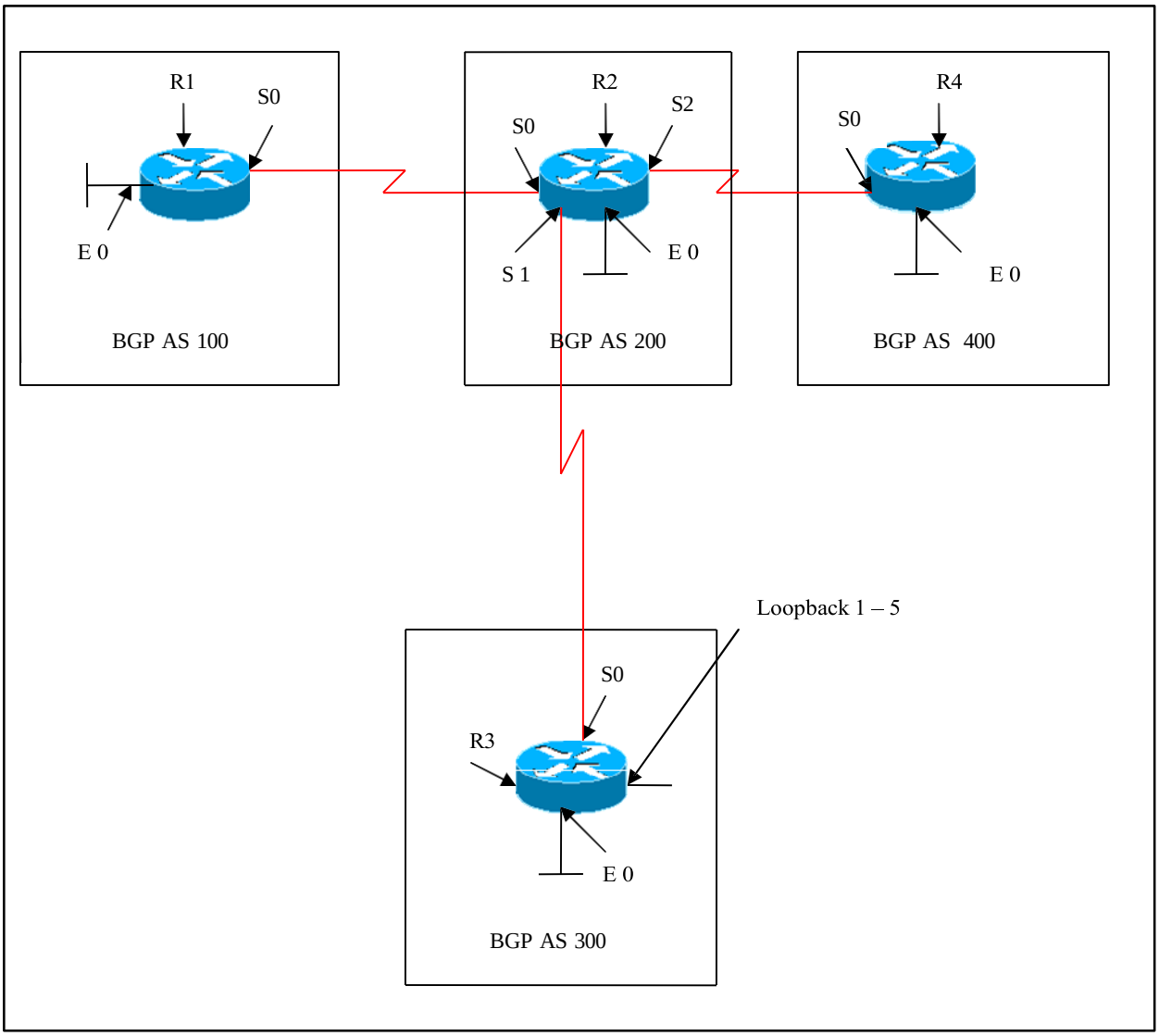
Configure BGP on all the routers. Configure R1 in AS 200 and configure R2, R3 and R4 in AS 100. Configure the loopbacks as per the scenario and advertise in BGP. Also configure route-map blocking network 10.0.0.0 from being advertised to iBGP peers. You can use peer-group to accomplish these tasks.

R1	R2
ip route 7.7.7.7 255.255.255.255 3.3.3.2 Router bgp 200 Neighbor 7.7.7.7 remote-as 100 Neighbor 7.7.7.7 ebgp-multihop Network 3.0.0.0 Network 10.0.0.0 No synchronization	Router bgp 100 Neighbor internal peer-group Neighbor internal remote-AS 100 Neighbor internal update-source loopback 0 Neighbor internal route-map map1 out Neighbor 8.8.8.8 peer-group internal Neighbor 6.6.6.6 peer-group internal

R3	R4
Router bgp 100 Neighbor internal peer-group Neighbor internal remote-AS 100 Neighbor internal update-source loopback 0 Neighbor 7.7.7.7 peer-group internal Neighbor 6.6.6.6 peer-group internal	Router bgp 100 Neighbor internal peer-group Neighbor internal remote-AS 100 Neighbor internal update-source loopback 0 Neighbor 7.7.7.7 peer-group internal Neighbor 8.8.8.8 peer-group internal

Configuring BGP using peer-group simplifies configuration reducing the number of statements in the configuration.

Lab 16 – Route Aggregation



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	3.3.3.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	3.3.3.2	255.0.0.0
S 1	1.1.1.1	255.0.0.0
S 2	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0
Loopback 1	172.1.0.1	255.255.0.0
Loopback 2	172.2.0.1	255.255.0.0
Loopback 3	172.3.0.1	255.255.0.0
Loopback 4	172.4.0.1	255.255.0.0
Loopback 5	172.5.0.1	255.255.0.0

R4

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
E 0	40.1.1.1	255.0.0.0

Lab Objective:

Task 1 :

Configure BGP on all the routers. Create loopbacks on R3 as per the above scenario and advertise them under BGP.

Loopback 1 – 172.1.0.1/16
Loopback 2 – 172.2.0.1/16
Loopback 3 – 172.3.0.1/16
Loopback 4 – 172.4.0.1/16
Loopback 5 – 172.5.0.1/16

R3

```
interface Loopback1
 ip address 172.1.0.1 255.255.0.0
```

```
interface Loopback2
 ip address 172.2.0.1 255.255.0.0

interface Loopback3
 ip address 172.3.0.1 255.255.0.0

interface Loopback4
 ip address 172.4.0.1 255.255.0.0

interface Loopback4
 ip address 172.5.0.1 255.255.0.0

Router BGP 300
 Network 172.1.0.0
 Network 172.2.0.0
 Network 172.3.0.0
 Network 172.4.0.0
 Network 172.5.0.0
```

Task 2

Configure Route Aggregation on R3 such that these routes are summarized as a single route.

```
R3

Router bgp 300
 Aggregate-address 172.0.0.0 255.248.0.0
```

Verification :

```
R1#show ip route
B    1.0.0.0/8 [20/0] via 3.3.3.2, 00:15:39
B    2.0.0.0/8 [20/0] via 3.3.3.2, 00:16:38
C    3.0.0.0/8 is directly connected, Serial0
B    20.0.0.0/8 [20/0] via 3.3.3.2, 00:15:39
B    172.1.0.0/16 [20/0] via 3.3.3.2, 00:08:03
B    172.2.0.0/16 [20/0] via 3.3.3.2, 00:08:03
B    172.3.0.0/16 [20/0] via 3.3.3.2, 00:08:03
B    172.4.0.0/16 [20/0] via 3.3.3.2, 00:08:03
B    172.5.0.0/16 [20/0] via 3.3.3.2, 00:07:03
B    40.0.0.0/8 [20/0] via 3.3.3.2, 00:16:38
C    10.0.0.0/8 is directly connected, Ethernet0
B    30.0.0.0/8 [20/0] via 3.3.3.2, 00:08:51
B    172.0.0.0/13 [20/0] via 3.3.3.2, 00:00:34
```

The routing table displays the prefix route (172.0.0.0/13) and also all the specific-routes.

Task 3

Configure Route Aggregation on R3 such that these routes are summarized as a single route. Only the Summary route should be send to R3's neighbors

```
R3

Router bgp 300
 Aggregate-address 172.0.0.0 255.248.0.0 summary-only
```

Verification:

R1#show ip route

```
B    1.0.0.0/8 [20/0] via 3.3.3.2, 00:20:36
B    2.0.0.0/8 [20/0] via 3.3.3.2, 00:21:35
C    3.0.0.0/8 is directly connected, Serial0
B    20.0.0.0/8 [20/0] via 3.3.3.2, 00:20:36
B    40.0.0.0/8 [20/0] via 3.3.3.2, 00:21:35
C    10.0.0.0/8 is directly connected, Ethernet0
B    30.0.0.0/8 [20/0] via 3.3.3.2, 00:13:48
B    172.0.0.0/13 [20/0] via 3.3.3.2, 00:00:20
```

The output displays only the prefix route (172.0.0.0/13) and suppresses all the specific routes.

Task 4

Configure Route Aggregation on R3 such that these routes are summarized as a single route. Only the Summary route and the 172.1.0.0, 172.2.0.0 and 172.3.0.0 route should be send to R3's neighbor, blocking 172.4.0.0 and 172.5.0.0 routes.

```
R3

Access-list 1 permit 172.4.0.0 0.0.255.255
Access-list 1 permit 172.5.0.0 0.0.255.255
Access-list 1 deny 0.0.0.0 255.255.255.255

Route-map map 1 permit 10
Match ip address 1

Router bgp 200
Aggregate-address 172.0.0.0 255.248.0.0 suppress-map map1
```

By definition of suppress-map, the match criteria set to permit will be suppressed and the rest will be forwarded.

Verification:

R1#show ip route

```
B    1.0.0.0/8 [20/0] via 3.3.3.2, 00:00:32
B    2.0.0.0/8 [20/0] via 3.3.3.2, 00:00:32
C    3.0.0.0/8 is directly connected, Serial0
B    20.0.0.0/8 [20/0] via 3.3.3.2, 00:00:32
B    172.1.0.0/16 [20/0] via 3.3.3.2, 00:00:33
B    172.2.0.0/16 [20/0] via 3.3.3.2, 00:00:33
B    172.3.0.0/16 [20/0] via 3.3.3.2, 00:00:33
B    40.0.0.0/8 [20/0] via 3.3.3.2, 00:00:32
C    10.0.0.0/8 is directly connected, Ethernet0
B    30.0.0.0/8 [20/0] via 3.3.3.2, 00:00:33
B    172.0.0.0/13 [20/0] via 3.3.3.2, 00:00:32
```

The output displays only 172.1.0.0/16, 172.2.0.0/16 & 172.3.0.0/16, thus blocking 172.4.0.0 and 172.5.0.0 routes.

R2#show ip bgp

Network	Next Hop	Metric	LocPrf	Weight	Path
* 1.0.0.0	1.1.1.2	0		0	300 i
*>	0.0.0.0	0		32768	i
* 2.0.0.0	2.2.2.2	0		0	400 i
*>	0.0.0.0	0		32768	i
* 3.0.0.0	3.3.3.1	0		0	100 i
*>	0.0.0.0	0		32768	i
*> 10.0.0.0	3.3.3.1	0		0	100 i
*> 20.0.0.0	0.0.0.0	0		32768	i
*> 30.0.0.0	1.1.1.2	0		0	300 i
*> 40.0.0.0	2.2.2.2	0		0	400 i
*> 172.0.0.0/13	0.0.0.0			32768	i
*> 172.1.0.0	1.1.1.2	0		0	300 i
*> 172.2.0.0	1.1.1.2	0		0	300 i
*> 172.3.0.0	1.1.1.2	0		0	300 i
s> 172.4.0.0	1.1.1.2	0		0	300 i
s> 172.5.0.0	1.1.1.2	0		0	300 i

The output displays network 172.4.0.0 and 172.5.0.0 as suppressed routes.

Task 5

Configure Route Aggregation on R3 such that these routes are summarized as a single route. Configure route-map and set the attribute origin to the route-map and implement in BGP process such that the aggregate address appears as incomplete route.

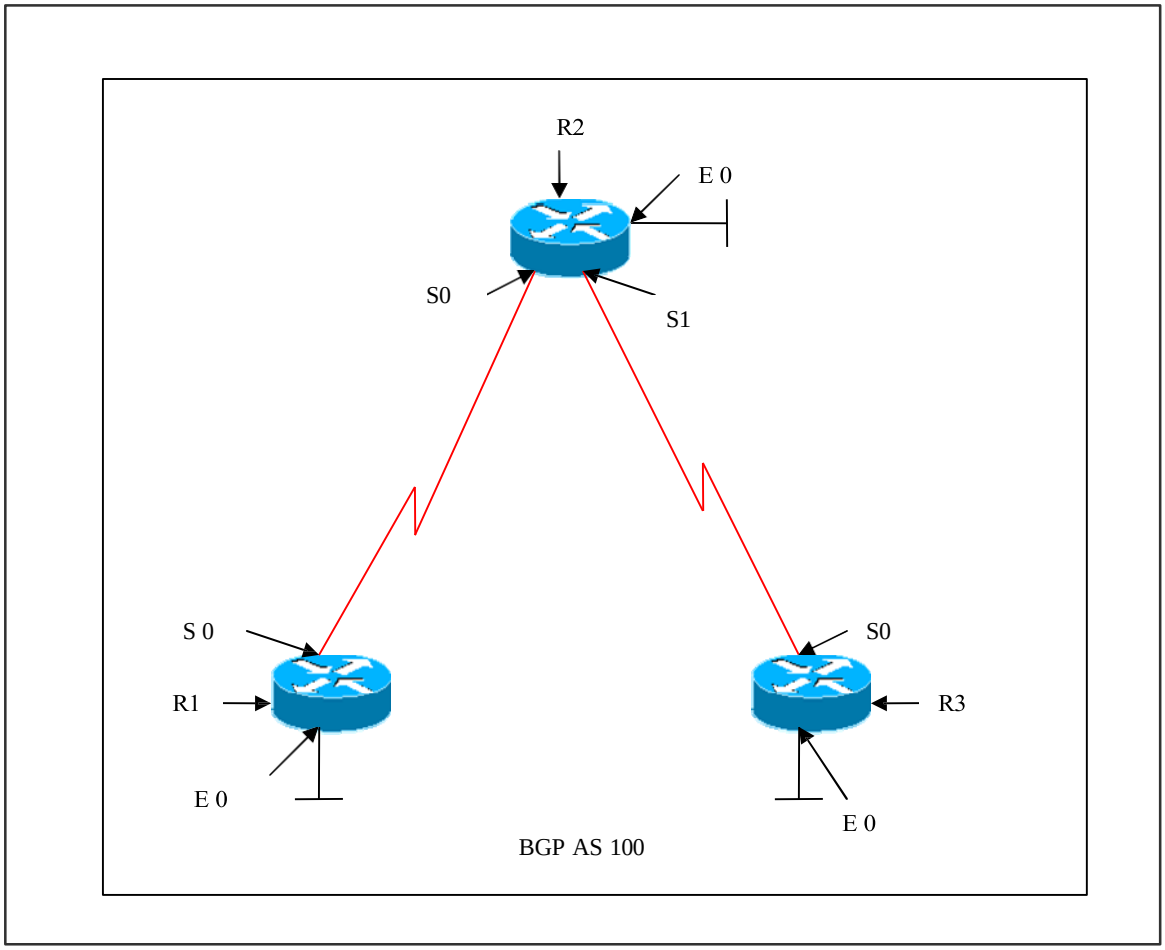
```
R3

Route-map map1
Set origin incomplete

Router bgp 300
 Aggregate-address 172.0.0.0 255.248.0.0 attribute-map map1
```

Verification:

```
R1#show ip bgp 172.0.0.0
BGP routing table entry for 172.0.0.0/13, version 33
Paths: (1 available, best #1)
  200, (aggregated by 200 20.1.1.1)
    3.3.3.2 from 3.3.3.2 (20.1.1.1)
      Origin incomplete, localpref 100, valid, external, atomic-aggregate, best
```

The output displays network 172.0.0.0 as incomplete route.

Lab 17 – Configuring Route Reflectors



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

Lab Objective:

Task 1:

Configure neighbor relationships between R1 and R2 and another one between R2 and R3. Do not configure a neighbor relationship between R1 and R3. Make sure routes from R1 can get propagated to R3.

R1 Router bgp 100 Neighbor 1.1.1.2 remote-as 100 Network 1.0.0.0 Network 10.0.0.0 No synchronization	R3 Router bgp 100 Neighbor 2.2.2.1 remote-as 100 Network 2.0.0.0 Network 30.0.0.0 No synchronization
R2 Router bgp 100 Neighbor 2.2.2.2 remote-as 100 Neighbor 2.2.2.2 route-reflector-client Neighbor 1.1.1.1 remote-as 100 Neighbor 1.1.1.1 route-reflector-client Network 1.0.0.0 Network 2.0.0.0 Network 20.0.0.0 No synchronization	

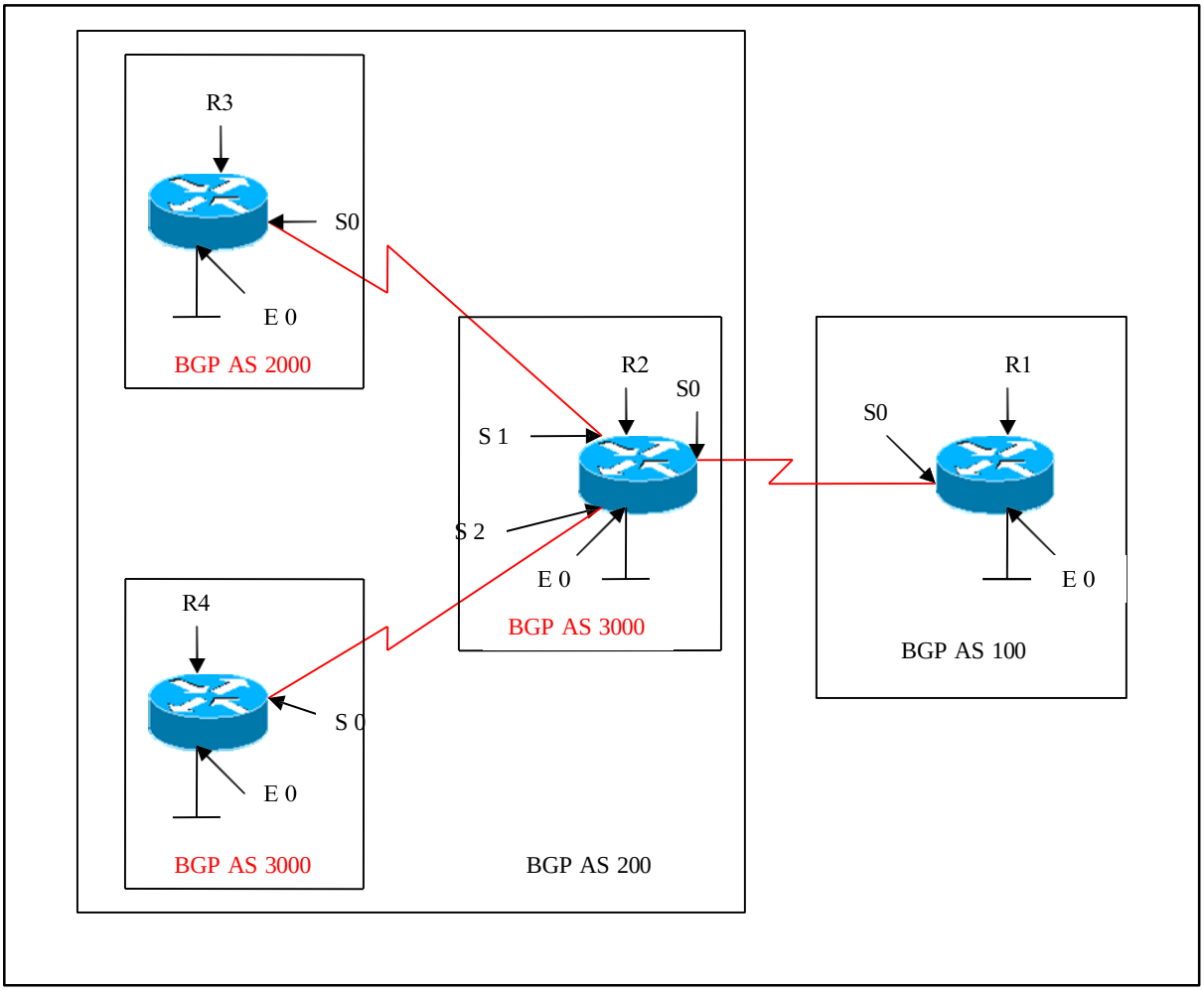
Verification:

R1#show ip route

C 1.0.0.0/8 is directly connected, Serial0
B 2.0.0.0/8 [200/0] via 1.1.1.2, 00:00:42
B 20.0.0.0/8 [200/0] via 1.1.1.2, 00:00:42
C 10.0.0.0/8 is directly connected, Ethernet0
B 30.0.0.0/8 [200/0] via 2.2.2.2, 00:00:36

If RR was not configured on R2, then the routing table will not display network 30.0.0.0, because of iBGP rule, which states that a BGP speaker will not advertise a route that the BGP speaker learned via another iBGP speaker to a third party iBGP speaker.

Lab 18 – Confederations



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 0	1.1.1.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0	1.1.1.2	255.0.0.0
S 1	2.2.2.1	255.0.0.0
S 2	3.3.3.1	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
E 0	30.1.1.1	255.0.0.0

R4

Interface	IP Address	Subnet Mask
S 0	3.3.3.2	255.0.0.0
E 0	40.1.1.1	255.0.0.0

Lab Objective:

Task 1 :

Configure AS 1000, AS 2000 and AS 3000 are Sub Autonomous Systems of a Larger AS 200 using Confederations. Configure a Neighbor relationship between AS 100 and AS 200 and another Neighbor relationship between AS 1000, AS 2000 and AS 3000.

R1	R2
Router bgp 100 Neighbor 1.1.1.2 remote-as 200 Neighbor 7.7.7.7 ebgp-multihop Network 1.0.0.0 Network 10.0.0.0 No synchronization	Router bgp 1000 Bgp confederation identifier 200 Bgp confederation peers 2000 3000 Neighbor 2.2.2.2 remote-as 2000 Neighbor 3.3.3.2 remote-as 3000 Neighbor 1.1.1.1 remote-as 100 Network 1.0.0.0 Network 2.0.0.0 Network 3.0.0.0 Network 20.0.0.0 No synchronization

R3	R4
Router bgp 2000 Bgp confederation identifier 200 Bgp confederation peers 1000 3000 Neighbor 2.2.2.1 remote-as 1000 Network 2.0.0.0 Network 30.0.0.0 No synchronization	Router bgp 3000 Bgp confederation identifier 200 Bgp confederation peers 1000 2000 Neighbor 3.3.3.1 remote-as 1000 Network 3.0.0.0 Network 40.0.0.0 No synchronization

Verification:

R3#show ip bgp
B 1.0.0.0/8 [200/0] via 2.2.2.1, 00:05:48
C 2.0.0.0/8 is directly connected, Serial0
B 3.0.0.0/8 [200/0] via 2.2.2.1, 00:05:48
B 20.0.0.0/8 [200/0] via 2.2.2.1, 00:05:48
B 40.0.0.0/8 [200/0] via 3.3.3.2, 00:05:03
B 10.0.0.0/8 [200/0] via 1.1.1.1, 00:05:03
C 30.0.0.0/8 is directly connected, Ethernet0

R3#show ip bgp

Network	Next Hop	Metric	LocPrf	Weight	Path
*> 1.0.0.0	2.2.2.1	0	100	0	(1000) i
* 2.0.0.0	2.2.2.1	0	100	0	(1000) i
*>	0.0.0.0	0		32768	i
*> 3.0.0.0	2.2.2.1	0	100	0	(1000) i
*> 10.0.0.0	1.1.1.1	0	100	0	(1000) 100 i
*> 20.0.0.0	2.2.2.1	0	100	0	(1000) i
*> 30.0.0.0	0.0.0.0	0		32768	i
*> 40.0.0.0	3.3.3.2	0	100	0	(1000 3000) i

R1#show ip bgp

Network	Next Hop	Metric	LocPrf	Weight	Path
* 1.0.0.0	1.1.1.2	0		0	200 i
*>	0.0.0.0	0		32768	i
*> 2.0.0.0	1.1.1.2	0		0	200 i
*> 3.0.0.0	1.1.1.2	0		0	200 i
*> 10.0.0.0	0.0.0.0	0		32768	i
*> 20.0.0.0	1.1.1.2	0		0	200 i
*> 30.0.0.0	1.1.1.2			0	200 i
*> 40.0.0.0	1.1.1.2			0	200 i

The output displays AS-Path 200 whereas on R3 the AS-Path is 1000 2000.

PAPER 2

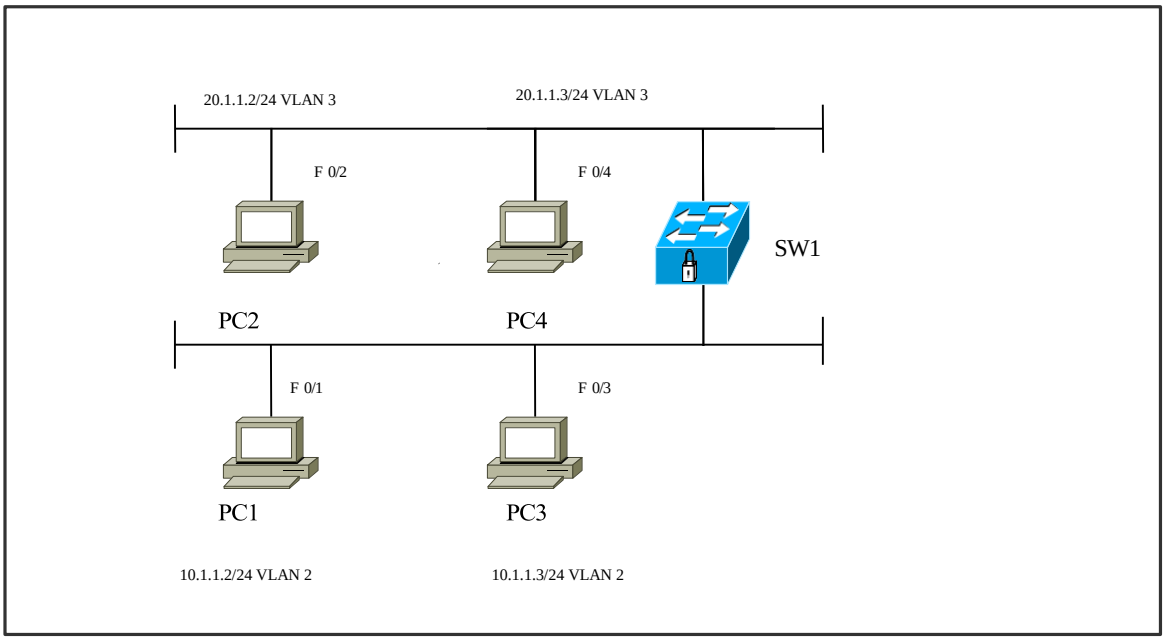
Switching

BULDING CISCO MULTILAYER SWITCHED NETWORK

BCMSN (642–812)

SWITCHING LAB INDEX

Lab 1 – Implementing VLANs



SW1

Ports	Assigned VLANs	PC
FA 0/1	VLAN 2	PC 1 (10.1.1.2)
FA 0/2	VLAN 3	PC 2 (20.1.1.2)
FA 0/3	VLAN 2	PC 3 (10.1.1.3)
FA 0/4	VLAN 3	PC 4 (20.1.1.3)

Task 1

Create VLAN 2 and VLAN 3 and assign name SALES and FINANCE to each VLAN. Configure ports fa 0/2 –fa 0/4 as access-ports and assign VLAN 2 to ports fa 0/1 and fa0/3. Assign VLAN 3 to ports fa 0/2 and fa 0/4. Configure VLANs using the database mode.

SW1

Vlan database
Vlan 2
vlan 2 name sales

Vlan 3
Vlan 3 name finance

Int fa0/1
Switchport mode access
Switchport access vlan2

Int fa0/2
Switchport mode access
Switchport access vlan3

Int fa0/3
Switchport mode access
Switchport access vlan2

Int fa0/4
Switchport mode access
Switchport access vlan3

Verification:

SW1#show interfaces fastEthernet 0/1 switchport

Name: Fa0/1
Switchport: Enabled
Administrative Mode: static access
Operational Mode: static access
Administrative Trunking Encapsulation: negotiate
Operational Trunking Encapsulation: native
Negotiation of Trunking: Off
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)

The output displays mode as access.

SW1#show vlan brief

```
VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                                Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                                Fa0/17, Fa0/18, Fa0/19, Fa0/20
                                                Fa0/21, Fa0/22, Fa0/23, Fa0/24
                                                Gi0/1, Gi0/2
2    sales                            active    Fa0/1, Fa0/3
3    finance                          active    Fa0/2, Fa0/4
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
```

The output displays VLAN 2, name SALES assigned to ports fa 0/1 and fa 0/3. Also VLAN 3, name FINANCE assigned to ports fa 0/2 and fa 0/4.

Verifying connectivity between PC 1 and PC 3 (i.e PC's in the same vlan):

From PC 1:

```
C:\>ping 10.1.1.3

Pinging 10.1.1.3 with 32 bytes of data:

Reply from 10.1.1.3: bytes=32 time=1ms TTL=255
Reply from 10.1.1.3: bytes=32 time=1ms TTL=255
Reply from 10.1.1.3: bytes=32 time=1ms TTL=255
Reply from 10.1.1.3: bytes=32 time=1ms TTL=255

Ping statistics for 10.1.1.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss)
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum =  1ms, Average =  1ms
```

Ping is successful.

Verifying connectivity between PC 1 and PC 2 (i.e PC's in different vlan):

From PC 1:

```
C:\>ping 20.1.1.2

Pinging 20.1.1.2 with 32 bytes of data:

Destination host unreachable.
Destination host unreachable.
Destination host unreachable.
Destination host unreachable.

Ping statistics for 20.1.1.2:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum =  0ms, Average =  0ms
```

Ping not successful.

Therefore we need a router connected to the switch to do inter-vlan communication. Also the link should be configured as trunk.

Task 2

Create VLAN 2 and VLAN 3 and assign name SALES and FINANCE to each VLAN. Configure ports fa 0/2 –fa 0/4 as access-ports and assign VLAN 2 to ports fa 0/1 and fa0/3. Assign VLAN 3 to ports fa 0/2 and fa 0/4. Configure VLANs using the global configuration mode.

SW1

Vlan 2
name sales

Vlan 3
name finance

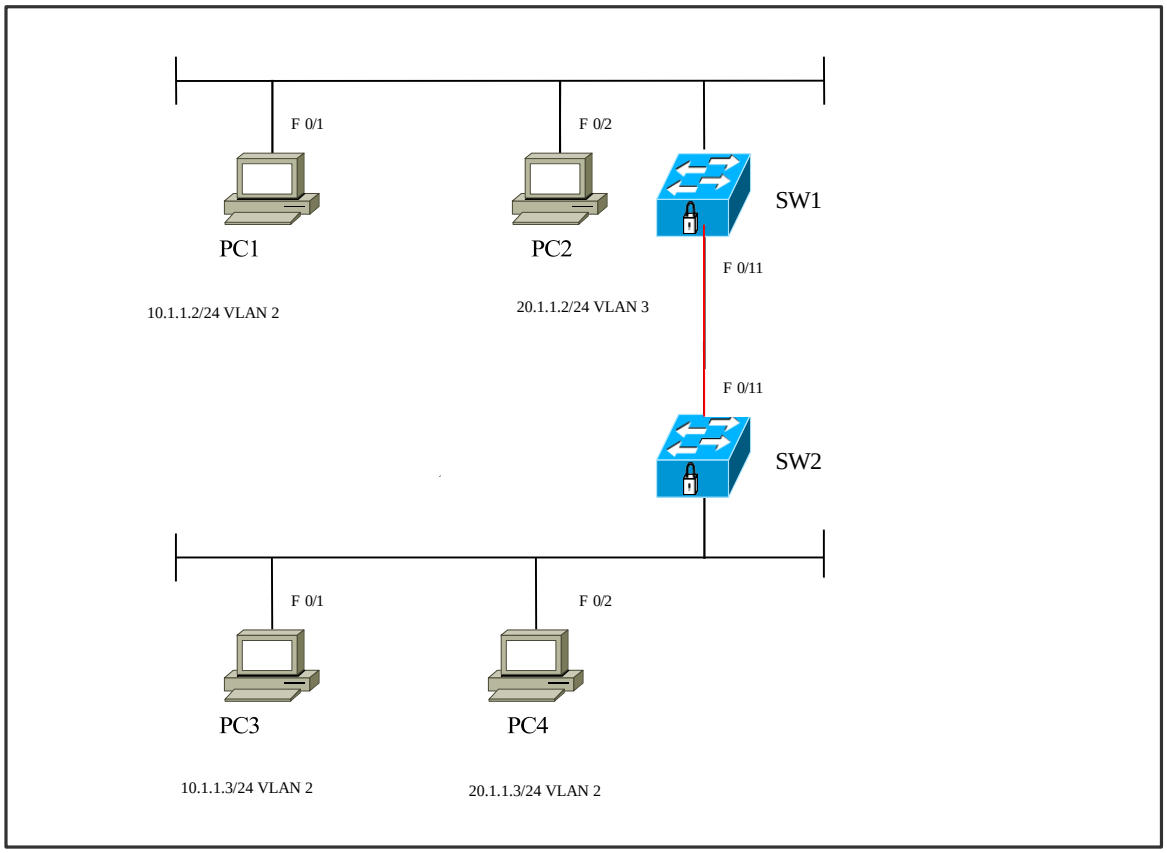
Int fa0/1
Switchport mode access
Switchport access vlan2

Int fa0/2
Switchport mode access
Switchport access vlan3

Int fa0/3
Switchport mode access
Switchport access vlan2

Int fa0/4
Switchport mode access
Switchport access vlan3

Lab 2 – Configure Trunking



SW1

Ports	Assigned VLANs	PC
FA 0/1	VLAN 2	PC 1 (10.1.1.2)
FA 0/2	VLAN 3	PC 2 (20.1.1.2)
FA 0/11 Configured as trunk		

SW2

Ports	Assigned VLANs	PC
FA 0/1	VLAN 2	PC 3 (10.1.1.3)
FA 0/2	VLAN 3	PC 4 (20.1.1.3)
FA 0/11 Configured as trunk		

Task 1

Create VLANs according to the scenarioand assign to their respective access-ports.
Configure ISL trunk between SW1 (fa0/11) and SW 2 (fa0/11)

```
SW1

Vlan 2
name sales

Vlan 3
name finance

Int fa0/1
Switchport mode access
Switchport access vlan2

Int fa0/2
Switchport mode access
Switchport access vlan3

Int fa0/11
shutdown
Switchport trunk encapsulation isl
Switchport mode trunk
No shutdown
```

SW2

Vlan 2
name sales

Vlan 3
name finance

Int fa0/1
Switchport mode access
Switchport access vlan2

Int fa0/2
Switchport mode access
Switchport access vlan3

Int fa0/11
shutdown
Switchport trunk encapsulation isl
Switchport mode trunk
No shutdown

Verification :

SW1#show interfaces trunk

Port	Mode	Encapsulation	Status	Native vlan
Fa0/11	on	isl	trunking	1

Port	Vlans allowed on trunk
Fa0/11	1-4094

Port	Vlans allowed and active in management domain
Fa0/11	1-3

Port	Vlans in spanning tree forwarding state and not pruned
Fa0/11	1-3

SW1#show interfaces fastEthernet 0/11 switchport

Name: Fa0/11
Switchport: Enabled
Administrative Mode: trunk
Operational Mode: trunk

Administrative Trunking Encapsulation: isl
Operational Trunking Encapsulation: isl
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)

Verifying connectivity between PC 1 and PC 3(i.e PC's in the same vlan)

From PC 1

```
C:\Documents and Settings\Administrator>ping 10.1.1.3

Pinging 10.1.1.3 with 32 bytes of data:

Reply from 10.1.1.3: bytes=32 time=2ms TTL=255
Reply from 10.1.1.3: bytes=32 time=1ms TTL=255
Reply from 10.1.1.3: bytes=32 time=1ms TTL=255
Reply from 10.1.1.3: bytes=32 time=1ms TTL=255

Ping statistics for 10.1.1.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum =  2ms, Average =  1ms
```

Ping successful.

Verifying connectivity between PC 1 and PC 4 (i.e PC's in different vlan):

From PC 1:

```
C:\Documents and Settings\Administrator>ping 20.1.1.3

Pinging 20.1.1.3 with 32 bytes of data:

Destination host unreachable.
Destination host unreachable.
Destination host unreachable.
Destination host unreachable.

Ping statistics for 20.1.1.3:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum =  0ms, Average =  0ms
```

Task 2

Create VLANs according to the scenarioand assign to their respective access-ports.
Configure 802.1q (dot1q) trunk between SW1 (fa0/11) and SW 2 (fa0/11)

SW1

Int fa0/11
shutdown
Switchport trunk encapsulation dot1q
Switchport mode trunk
No shutdown

SW2

Int fa0/11
shutdown
Switchport trunk encapsulation dot1q
Switchport mode trunk
No shutdown

Verification :

SW1#show interfaces trunk

Port	Mode	Encapsulation	Status	Native vlan
Fa0/11	on	802.1q	trunking	1

Port	Vlans allowed on trunk
Fa0/11	1-4094

Port	Vlans allowed and active in management domain
Fa0/11	1-3

Port	Vlans in spanning tree forwarding state and not pruned
Fa0/11	1-3

SW1#show interfaces fa0/11 switchport

Name: Fa0/11
Switchport: Enabled
Administrative Mode: trunk
Operational Mode: trunk
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)

The output displays mode as trunk and encapsulation used is dot1q, and the default native vlan is vlan1 which is used to carry the untagged frames across.

Verifying connectivity between PC 1 and PC 3 (i.e PC's in the same vlan)

From PC 1

```
C:\Documents and Settings\Administrator>ping 10.1.1.3

Pinging 10.1.1.3 with 32 bytes of data:

Reply from 10.1.1.3: bytes=32 time=2ms TTL=255
Reply from 10.1.1.3: bytes=32 time=1ms TTL=255
Reply from 10.1.1.3: bytes=32 time=1ms TTL=255
Reply from 10.1.1.3: bytes=32 time=1ms TTL=255

Ping statistics for 10.1.1.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum =  2ms, Average =  1ms
```

Ping successful.
Verifying connectivity between PC 1 and PC 4 (i.e PC's in different vlan):

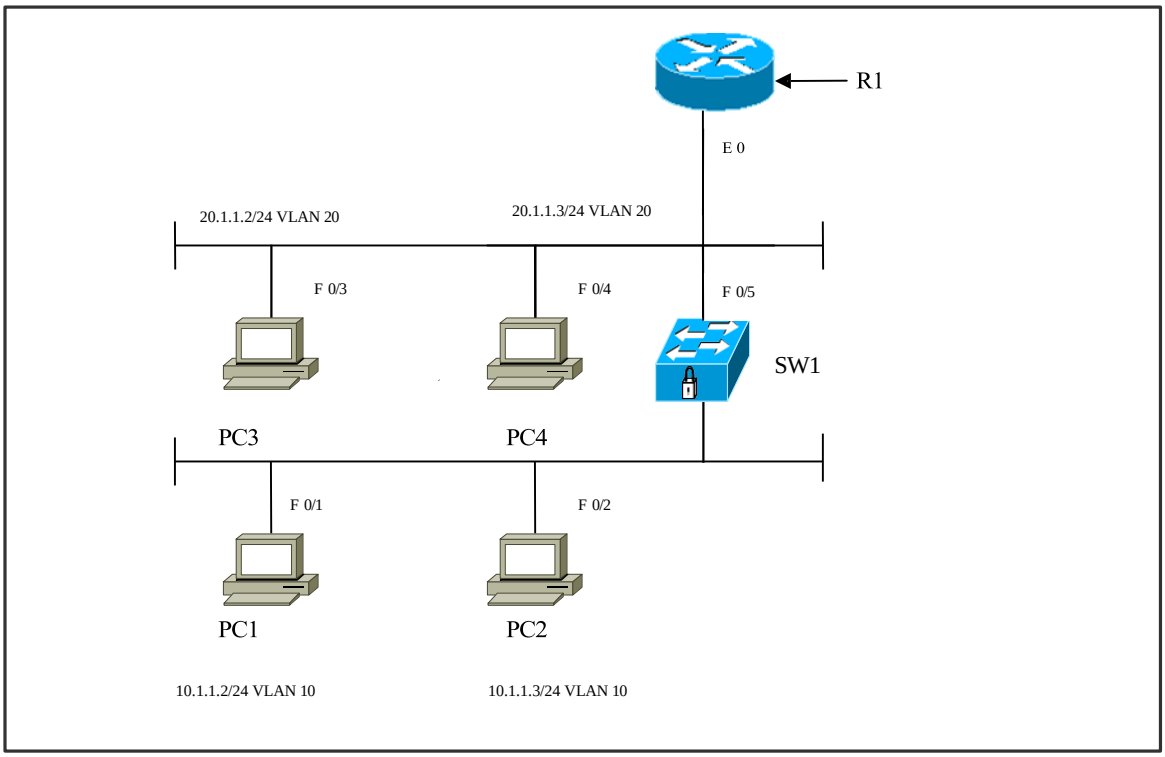
From PC 1:

```
C:\Documents and Settings\Administrator>ping 20.1.1.3

Pinging 20.1.1.3 with 32 bytes of data:

Destination host unreachable.
Destination host unreachable.
Destination host unreachable.
Destination host unreachable.

Ping statistics for 20.1.1.3:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum =  0ms, Average =  0ms
```

Ping not successful.

Therefore we need to configure inter-vlan routing.

Lab 3 – Implementing Inter-VLAN Routing



SW1

Ports	Assigned VLANs	PC
FA 0/1	VLAN 10	PC 1 (10.1.1.2)
FA 0/2	VLAN 10	PC 2 (10.1.1.3)
FA 0/3	VLAN 20	PC 3 (20.1.1.2)
FA 0/4	VLAn 20	PC 4 (20.1.1.3)
FA 0/5 Configured as trunk		

R1

Sub-Interfaces	Ip Address	Subnet - Mask
E 0/0.10	10.1.1.1	255.0.0.0
E 0/0.20	20.1.1.1	255.0.0.0
E 0 Configured as trunk		

Task 1

Create VLAN 10 and assign to ports fa 0/1 and fa 0/2. Create VLAN 20 and assign to ports fa 0/3 and fa 0/4. Configure port fa 0/5 as dot1q trunk. Use sub-interfaces on interface e 0 on R1 to accomplish this task.

R1

Int e 0
No ip address

Int e 0/0.10
Encapsulation dotlq 10
Ip address 10.1.1.1 255.0.0.0

Int e 0/0.20
Encapsulation dotlq 20
Ip address 20.1.1.1 255.0.0.0

SW1

```
Vlan 10
Name sales
Vlan 20
Name finance

Int fa 0/1
Switchport mode access
Switchport access vlan 10

Int fa 0/2
Switchport mode access
Switchport access vlan 10

Int fa 0/3
Switchport mode access
Switchport access vlan 20

Int fa 0/4
Switchport mode access
Switchport access vlan 20

Int fa 0/5
Shutdown
Switchport trunk encapsulation dotlq
Switchport mode trunk
Switchport nonegotiate
No shutdown
```

Verification :

Verify if PC's in VLAN 10 can communicate with PC's in VLAN 20.

From PC 1 (10.1.1.2) :

```
C:\DOCUME~1\ADMINI~1>ping 20.1.1.2

Pinging 20.1.1.2 with 32 bytes of data:

Reply from 20.1.1.2: bytes=32 time=2ms TTL=254
Reply from 20.1.1.2: bytes=32 time=2ms TTL=254
Reply from 20.1.1.2: bytes=32 time=2ms TTL=254
Reply from 20.1.1.2: bytes=32 time=2ms TTL=254

Ping statistics for 20.1.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum =  2ms, Average =  2ms
```

Ping successful which means inter-vlan communication is working properly.

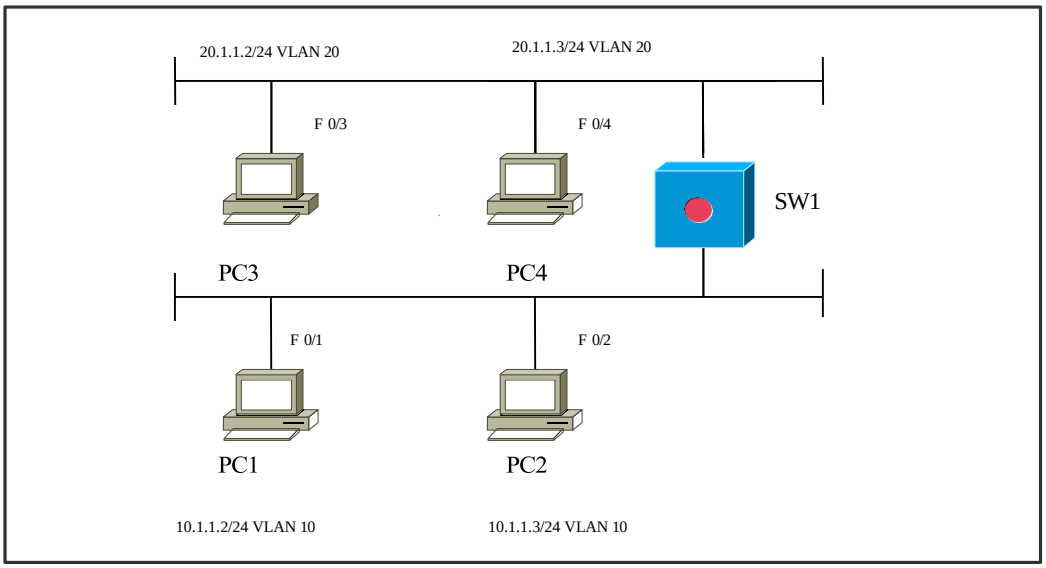
SW1#show int fa0/5 switchport

Name: Fa0/5
Switchport: Enabled
Administrative Mode: trunk
Operational Mode: trunk
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)

The output displays trunk dot1q encapsulation enabled.

Task 2

Implementing inter-vlan communication on a multilayer switch. Create VLAN 10 and assign to ports fa 0/1 and fa 0/2. Create VLAN 20 and assign to ports fa 0/3 and fa 0/4. Configure SVI and assign Ip address.



SW1

Ip routing

Interface vlan 10
Ip address 10.1.1.1 255.0.0.0
No shutdown

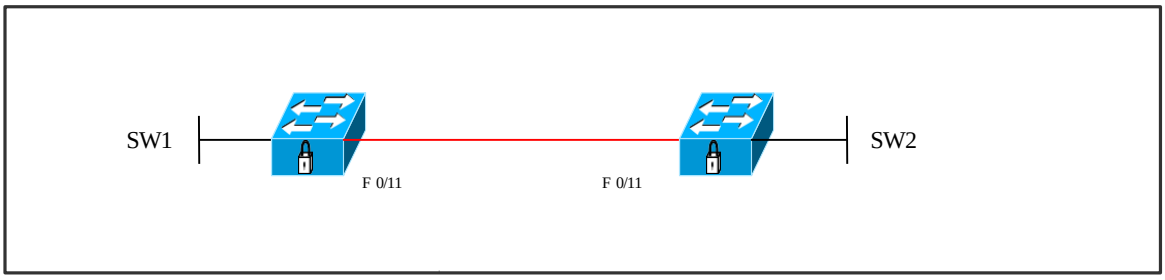
Interface vlan 20
Ip address 20.1.1.1 255.0.0.0
No shutdown

Verification :
From PC 1 (10.1.1.2) :

```
C:\>ping 20.1.1.2

Pinging 20.1.1.2 with 32 bytes of data:

Reply from 20.1.1.2: bytes=32 time=2ms TTL=254
Reply from 20.1.1.2: bytes=32 time=2ms TTL=254
Reply from 20.1.1.2: bytes=32 time=2ms TTL=254
Reply from 20.1.1.2: bytes=32 time=2ms TTL=254

Ping statistics for 20.1.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum =  2ms, Average =  2ms
```

Ping 100% successful which means inter-vlan communication is working properly.

Lab 4 – Propagating VLAN Configuration with



Task 1

Configure Switch1 as the VTP Server and the other Switch (SW2) as VTP Client. Use NETMETRICS as the Domain name. Authenticate the relationship using CISCO123 as the password.

Switch1	Switch2
VTP domain NETMETRICS VTP mode server VTP password CISCO123	VTP domain NETMETRICS VTP mode client VTP password CISCO123

Task 2

Create VLANs 2,3,4, and 5 on SW1 (VTP SERVER) and name them as aaa, bbb, ccc, ddd.

Switch1
Vlan 2 Name aaa Vlan 3 Name bbb Vlan 4 Name ccc Vlan 5 Name ddd

Verification:

SW1#show vtp status

```
VTP Version                     2
Configuration Revision          15
Maximum VLANs supported locally : 1005
Number of existing VLANs        9
VTP Operating Mode              : Server
VTP Domain Name                 : netmetrics
```

The output displays vtp revision number, configuration revision number, vtp operation mode and vtp domain name.

SW2#show vtp status

```
VTP Version                     2
Configuration Revision          15
Maximum VLANs supported locally : 1005
Number of existing VLANs        9
VTP Operating Mode              :  Client
VTP Domain Name                 : netmetrics
```

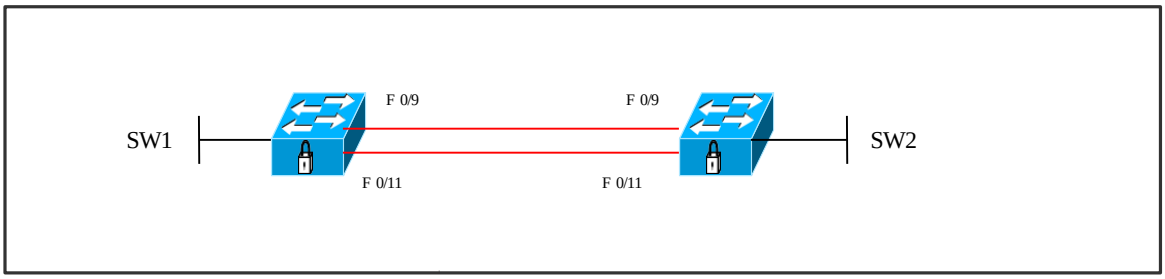
The output displays vtp revision number, configuration revision number, vtp operation mode and vtp domain name.

SW2#show vlan brief

```
VLAN Name                              Status    Ports
---- ----------------------------------- --------- -------------------------------
1    default                           active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                 Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                 Fa0/9, Fa0/10, Fa0/12, Fa0/13
                                                 Fa0/14, Fa0/15, Fa0/16, Fa0/17
                                                 Fa0/18, Fa0/19, Fa0/20, Fa0/21
                                                 Fa0/22, Fa0/23, Fa0/24, Gi0/1
                                                 Gi0/2
2    aaa                               active
3    bbb                               active
4    ccc                               active
5    ddd                               active
```

The output displays VLANs 2, 3, 4, 5 propagated from vtp server.

Lab 5 – Implementing Spanning Tree Protocol



Task 1

Configure Switch1 as the VTP Server and the other Switch (SW2) as VTP Client. Configure SW1 to be the STP root for VLAN 1. Change the forward delay time such that the port transitions from listening to learning state in just 6 seconds instead of the default of 15 seconds. Configure ports fa 0/9 and fa 0/11 as dot1q trunks on both the switches.

Switch1	Switch2
VTP domain NETMETRICS VTP mode server VTP password CISCO123 Interface range fa0/9, fa0/11 Switchport trunk encapsulation Switchport mode trunk Spanning-tree vlan 1 root primary Spanning-tree vlan 1 forward-time 6	VTP domain NETMETRICS VTP mode client VTP password CISCO123 Interface range fa0/9, fa0/11 Switchport trunk encapsulation Switchport mode trunk

Verification:
SW1#show spanning-tree vlan 1

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID Priority 24577
        Address 0014.a82f.a680
        This bridge is the root
        Hello Time 2 sec Max Age 20 sec Forward Delay 6 sec

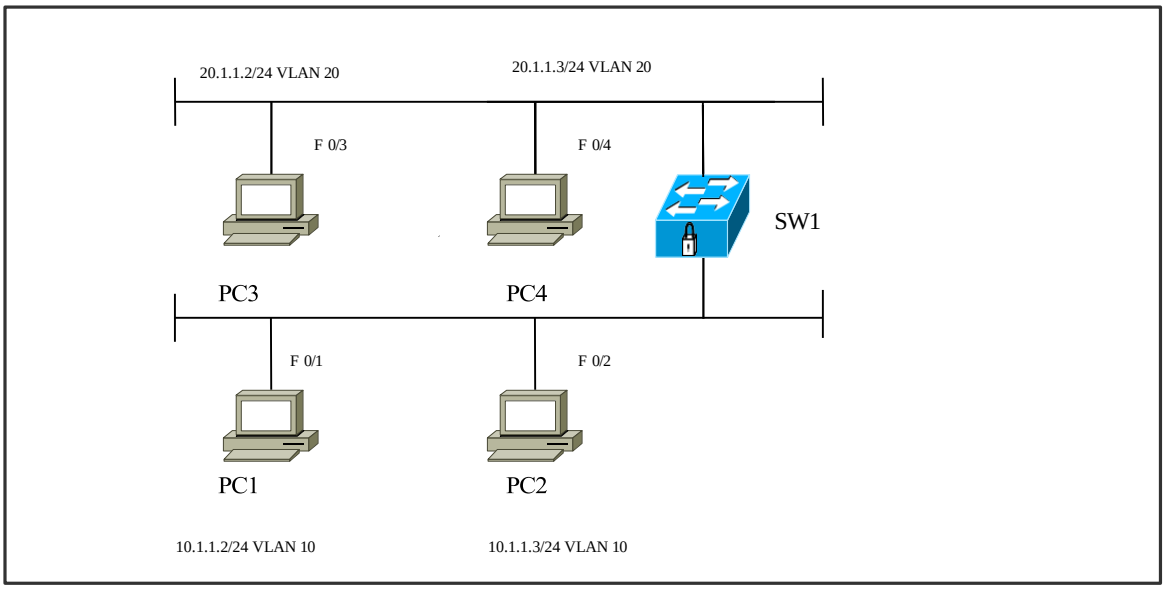
```
  Bridge ID  Priority    24577  (priority 24576 sys-id-ext 1)
             Address     0014.a82f.a680
             Hello Time  2 sec  Max Age 20 sec  Forward Delay  6 sec
             Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ----- --- --------- -------- --------------------------------
Fa0/1            Desg FWD 19        128.1    P2p
Fa0/9            Desg FWD 19        128.9    P2p
Fa0/11           Desg FWD 19        128.11   P2p
```

The output displays that SW1 is the root bridge and forward delay time is 6 seconds.

SW1#debug spanning-tree events

05:23:22: STP: VLAN0004 Fa0/9 -> listening
05:23:22: set portid: VLAN0005 Fa0/9: new port id 8009
05:23:22: STP: VLAN0005 Fa0/9 -> listening
05:23:23: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to up
05:23:28: STP: VLAN0001 Fa0/9 -> learning
05:23:34: STP: VLAN0001 Fa0/9 -> forwarding
05:23:37: STP: VLAN0002 Fa0/9 -> learning
05:23:37: STP: VLAN0005 Fa0/9 -> learning
05:23:52: STP: VLAN0002 Fa0/9 -> forwarding

The output displays the transition of ports from listening to learning in just 6 seconds instead of the default of 15 seconds.



Task 2

Configure ports fa0/1 - fa0/3 on SW1 to operate in portfast mode.

Switch1
Int range fa0/1 - fa0/3 Spanning-tree portfast

Verification:

```
SW1#show spanning-tree interface fa0/1 detail
 Port 1 (FastEthernet0/1) of VLAN0001 is forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.1.
   Designated root has priority 24577, address 0014.a82f.a680
   Designated bridge has priority 24577, address 0014.a82f.a680
   Designated port id is 128.1, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 1
   The port is in the portfast mode
   Link type is point-to-point by default
   BPDU: sent 3140, received 0
```

The output displays that port fa0/1 is in portfast mode and also we see that BPDU's are sent

Verify the transition by shutting down interface fa 0/1 and again bringing the interface up.

SW1#debug spanning-tree events

05:36:16: set portid: VLAN0001 Fa0/1: new port id 8001
05:36:16: STP: VLAN0001 Fa0/1 ->jump to forwarding from blocking

The output displays port fa 0/1 jumps to forwarding state from blocking immediately because of portfast enabled on that port.

Task 3

(Scenario Based on Task 1)

Configure SW1 to quickly switch its root port in the event of an uplink failure. Trunking should be configured between the switches.

Switch1
spanning-tree uplinkfast

Verification:

SW1#show spanning-tree vlan 1

```
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    32769
              Address     000f.34f4.f080
              Cost        3019
              Port        11 (FastEthernet0/11)
              Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    49153  (priority 49152 sys-id-ext 1)
              Address     0014.a82f.a680
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time 300
  Uplinkfast enabled

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Fa0/9            Altn BLK 3019      128.9    P2p
Fa0/11           Root FWD 3019      128.11   P2p
```

The output displays cost of ports increased by 3000 & priority of the bridge has increased to 49152.

Verify the transition from blocking to forwarding :

- Shutdown the port fa0/9 which is in the forwarding state.

SW1#debug spanning-tree uplinkfast

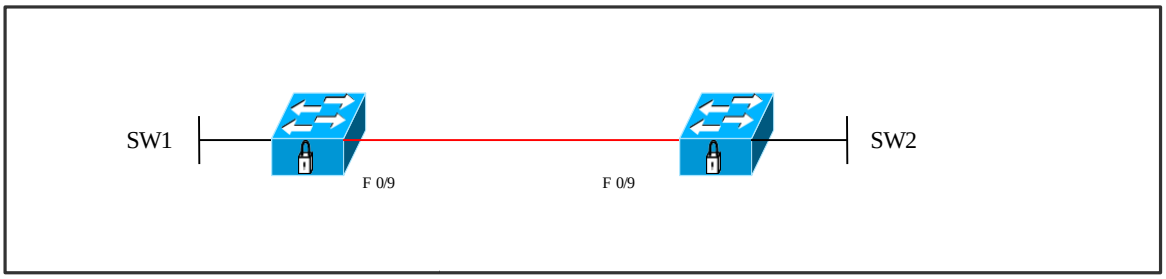
00:47:18: STP FAST: UPLINKFAST: make_forwarding on VLAN0001 FastEthernet0/11 root port id new: 128.11 prev: 128.9

00:47:18: %SPANTREE_FAST-7-PORT_FWD_UPLINK: VLAN0001 FastEthernet0/11 moved to Forwarding (UplinkFast).

00:47:18: STP: UFAST: removing prev root port Fa0/9 VLAN0001 port-id 8009

The output displays the transition of port fa0/11 from blocking to forwarding in one second.

Task 4



Configure portfast on port fa 0/9 between SW1 and SW2. (By default all ports on the switch are in dynamic desirable mode, they autonegotiate to become trunk. Portfast should not be enabled on trunk as there is a possibility of loops, we need to shutdown the port fa 0/9 and enable portfast on both the switches on port fa 0/9). Enable BPDU guard on port fa 0/9 of SW1 to stop BPDU's on that port.

Switch1	Switch2
Int fa 0/9 Shutdown Spanning-tree portfast Spanning-tree bpdu guard enable	Int fa 0/9 Shutdown Spanning-tree portfast

Now bring the port fa 0/9 on both switches to up. As soon as the BPDU's are being sent on the port . The port enabled with BPDU guard will immediately come into err-disable state .

Verification:

Console messages on SW1 when the bpdu's are received on the bpduguard enabled port fa0/9

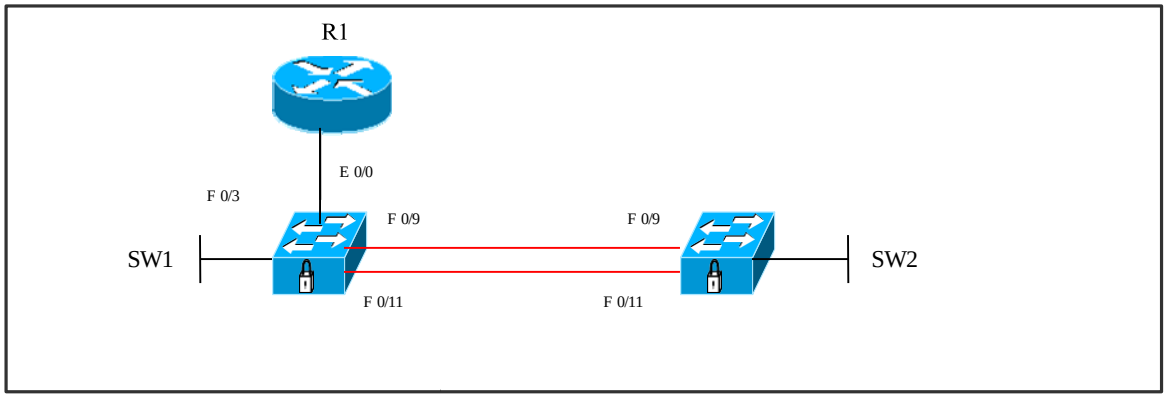
01:04:30: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to up
01:04:31: %SPANTREE-2-BLOCK_BPDUGUARD: Received BPDU on port FastEthernet0/9 with BPDU Guard enabled. Disabling port.
01:04:31: %PM-4-ERR_DISABLE: bpduguard error detected on Fa0/9, putting Fa0/9 in err-disable state
01:04:32: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/9, changed state to downstate.

SW1#show interfaces fa0/9

FastEthernet0/9 is down, line protocol is down (err-disabled)
  Hardware is Fast Ethernet, address is 0014.a82f.a689 (bia 0014.a82f.a689)
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)

The output displays the port as (err-disabled) state. But the BPDU's are sent out of this port, it doesn't affect that feature.

Task 5



Configure R1 to send BPDUs to SW 1. Enable BPDU guard on port fa0/3 on sw1 to block the access port fa 0/3 on SW 1, if any BPDUs received.

R1	Switch1
Int e0/0 No ip address Bridge-group 1 Bridge 1 protocol ieee Bridge 1 priority 4096	Int fa0/3 Spanning-tree bpduguard enable

Verification:

SW1#show interfaces fa0/3

FastEthernet0/3 is down, line protocol is down (err-disabled)
  Hardware is Fast Ethernet, address is 0014.a82f.a683 (bia 0014.a82f.a683)
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)

The output displays the port as (err-disabled) state. But the BPDU's are sent out of this port, it doesn't affect that feature.
SW1#debug spanning-tree events

01:33:12: STP: VLAN0001 Fa0/3 -> listening

01:33:13: %SPANTREE-2-BLOCK_BPDUGUARD: Received BPDU on port FastEthernet0/3 with BPDU Guard enabled. Disabling port.

01:33:13: %PM-4-ERR_DISABLE: bpduguard error detected on Fa0/3, putting Fa0/3 inerr-disable state

The output displays that as soon as BPDU received on port fa0/3, it is disabled because of the BPDU guard enabled on that port.

Task 6

(Scenario Based on Task 5)

Configure portfast on port fa0/3 on sw1. Enable BPDU filter on port fa0/3 on sw1. Configure R1 to send BPDUs to port fa0/3 on sw1.

R1	Switch1
Int e0/0 No shutdown No ip address Bridge-group 1 Bridge 1 protocol ieee Bridge 1 priority 4096	Int fa0/3 Switchport mode access Spanning-tree portfast Spanning-tree bpduguard enable

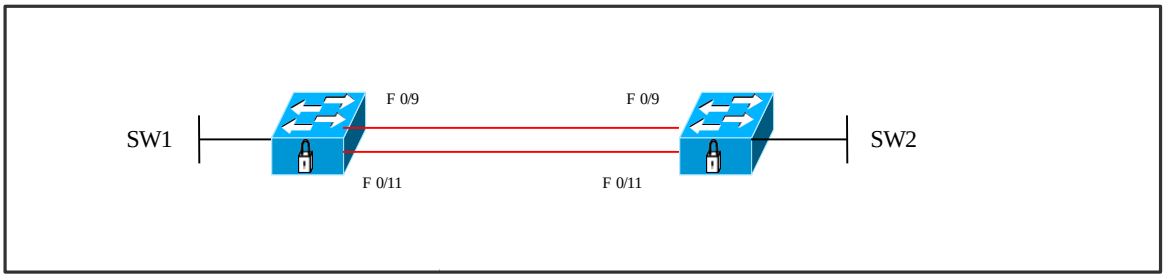
Verification:

SW1#show spanning-tree interface fa0/3 detail

Port 3 (FastEthernet0/3) of VLAN0001 is forwarding
Port path cost 100, Port priority 128, Port Identifier 128.3.
Designated root has priority 32769, address 000f.34f4.f080
Designated bridge has priority 32769, address 0014.a82f.a680
Designated port id is 128.3, designated path cost 19
Timers: message age 0, forward delay 0, hold 0
Number of transitions to forwarding state: 1
Link type is shared by default
Bpdu filter is enabled
BPDU: sent 0, received 0

The output displays BPDU filter enabled and no BPDU's sent or received

Task 7



Configure SW1 to be the root for VLAN 1. Configure root guard feature on SW1 port fa0/9, fa0/11.

Switch1
Spanning-tree vlan 1 root primary Int range fa0/9, fa0/11 No shutdown

```
Spanning-tree guard root
```

Verification:

SW1#show spanning-tree interface fa0/9 detail

```
 Port 9 (FastEthernet0/9) of VLAN0001 is forwarding
   Port path cost 19, Port priority 128, Port Identifier 128.9.
   Designated root has priority 4097, address 0014.a82f.a680
   Designated bridge has priority 4097, address 0014.a82f.a680
   Designated port id is 128.9, designated path cost 0
   Timers: message age 0, forward delay 0, hold 0
   Number of transitions to forwarding state: 2
   Link type is point-to-point by default
   Root guard is enabled on the port
   BPDU: sent 3671, received 2431
```

The output displays root guard enabled on port.
Now change the priority in SW2:

```
Switch2

Spanning-tree vlan 1 priority 4096
```

As root guard is enabled on SW1, the ports on SW1 change to root inconsistent ports, thus blocking the port when superior BPDUs are received on SW1.

SW1#show spanning-tree interface fa0/9 detail

```
 Port 9 (FastEthernet0/9) of VLAN0001 is broken  (Root Inconsistent)
   Port path cost 19, Port priority 128, Port Identifier 128.9.
   Designated root has priority 32769, address 0014.a82f.a680
   Designated bridge has priority 32769, address 0014.a82f.a680
   Designated port id is 128.9, designated path cost 0
   Timers: message age 1, forward delay 0, hold 0
   Number of transitions to forwarding state: 2
   Link type is point-to-point by default
   Root guard is enabled on the port
   BPDU: sent 3991, received 2445
```

SW1#debug spanning-tree events

03:29:15: %SPANTREE-2-ROOTGUARD_BLOCK: Root guard blocking port FastEthernet0/9 on VLAN0001.
03:29:15: STP: VLAN0001 Fa0/9 -> blocking

The output displays that root guard blocking port fa0/9

SW1#show spanning-tree vlan 1

```
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    32769
             Address     0014.a82f.a680
             This bridge is the root
             Hello Time   2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)
             Address     0014.a82f.a680
             Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
             Aging Time 300
Interface        Role Sts     Cost      Prio.Nbr      Type
---------                     --------------------------------
Fa0/9            Desg BKN*   19        128.9         P2p *ROOT_Inc
Fa0/11           Desg BKN*   19        128.11        P2p *ROOT_Inc
```

The output displays that the ports fa0/9 & fa0/11 are in “BKN” state as root-inconsistent type.

SW1#show spanning-tree inconsistentports

```
Name                 Interface            Inconsistency
-------------------------------------------------------------
VLAN0001             FastEthernet0/9      Root Inconsistent
VLAN0001             FastEthernet0/11     Root Inconsistent
```

The output displays both fa 0/9 and fa 0/11 as inconsistent ports.

Task 8

(Scenario Based on Task 7)

Configure SW1 to the root bridge for vlan1. Configure loop guard on SW2, i.e., on the switch that is not the root bridge. Configure ports fa0/9 & fa0/11 between SW1 and SW2 as trunk ports.

Switch1	Switch2
Int range fa0/9 , fa0/11 Switchport trunk encapsulation dot1q Switchport mode trunk Spanning-tree vlan 1 root primary	Int range fa0/9 , fa0/11 Switchport trunk encapsulation dot1q Switchport mode trunk Spanning-tree guard loop

Verification:

SW2#show spanning-tree interface fastEthernet 0/9 detail

Port 9 (FastEthernet0/9) of VLAN0001 is forwarding
Port path cost 19, Port priority 128, Port Identifier 128.9.
Designated root has priority 24577, address 0014.a82f.a680
Designated bridge has priority 24577, address 0014.a82f.a680
Designated port id is 128.9, designated path cost 0
Timers: message age 1, forward delay 0, hold 0
Number of transitions to forwarding state: 1
Link type is point-to-point by default
Loop guard is enabled on the port
BPDU: sent 6419, received 2212

The output displays that loop guard is enabled on the port.

Now filter BPDU's on port fa 0/9 on SW1 :

Switch1
Int fa0/9 Spanning-tree bpdufilter enable

BPDU's will be stopped on SW1 and the port changes to loop inconsistent.

SW2#show spanning-tree interface fa0/9 detail

Port 9 (FastEthernet0/9) of VLAN0001 is broken (Loop Inconsistent)
Port path cost 19, Port priority 128, Port Identifier 128.9.
Designated root has priority 24577, address 0014.a82f.a680
Designated bridge has priority 32769, address 000f.34f4.f080
Designated port id is 128.9, designated path cost 19
Timers: message age 0, forward delay 0, hold 0
Number of transitions to forwarding state: 1

Link type is point-to-point by default
Loop guard is enabled on the port
BPDU: sent 6420, received 2257

The loop inconsistent state indicates that the port is not receiving any BPDU's or not sending any BPDU's through the port.

SW2#show spanning-tree inconsistentports

Name	Interface	Inconsistency
VLAN0001	FastEthernet0/9	Loop Inconsistent

Number of inconsistent ports (segments) in the system : 1

Lab 6 – Load Balancing in STP

Task 1
(Scenario Based on Lab 5 – Task 7)

Configure VTP to propagate VLAN information. Create 2 VLANs (VLAN 2, VLAN 3) on SW1 (VTP server). Configure SW1 to be the root for VLAN 2 and configure SW2 to be the root for VLAN 3.

Switch1	Switch2
spanning-tree vlan 2 root primary	spanning-tree vlan 3 root primary

Verification :

SW1#show spanning-tree vlan 2

VLAN0002
Spanning tree enabled protocol ieee
Root ID Priority 24578
----------Output Omitted----------

Bridge ID Priority 24578 (priority 24576 sys-id-ext 2)
----------Output Omitted----------

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/9	Desg	FWD	19	128.9	P2p
Fa0/11	Desg	FWD	19	128.11	P2p

The output displays that SW1 is root for VLAN 2 i.e both ports fa 0/9 and fa 0/11 are in forwarding state.

SW1#show spanning-tree vlan 3

VLAN0003
Spanning tree enabled protocol ieee
Root ID Priority 24578
----------Output Omitted---------

Bridge ID Priority 32771 (priority 32768 sys-id-ext 3)

----------Output Omitted----------

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/9	Root	FWD	19	128.9	P2p
Fa0/11	Altn	BLK	19	128.11	P2p

The output displays that SW1 is not root for VLAN 3 and port fa 0/9 is in forwarding and fa 0/11 is in blocked state as it is not the root bridge. Thus load balancing is achieved.

Task 2
(Scenario Based on Task 1)

Configure dotlq trunk between SW1 and SW2 on ports fa0/9 and fa0/11. Configure VTP on both the switches to propagate VLAN information. Create VLANs 1 to 6 on SW1 (server). Allow VLANs 2, 4, 6 on port fao/9 on SW1 & SW2. Allow VLANs 1, 3, 5 on port fao/11 on SW1 & SW2.

Switch1	Switch2
Int fa0/9 Switchport trunk encapsulation dotlq Switchport mode trunk Switchport trunk allowed vlan 2, 4, 6 Int fa0/11 Switchport trunk encapsulation dotlq Switchport mode trunk Switchport trunk allowed vlan 1, 3, 5	Int fa0/9 Switchport trunk encapsulation dotlq Switchport mode trunk Switchport trunk allowed vlan 2, 4, 6 Int fa0/11 Switchport trunk encapsulation dotlq Switchport mode trunk Switchport trunk allowed vlan 1, 3, 5

Verification:

SW1#show int trunk

Port	Mode	Encapsulation	Status	Native vlan
Fa0/9	on	802.1q	trunking	1
Fa0/11	on	802.1q	trunking	1

Port	Vlans allowed on trunk
Fa0/9	2,4,6
Fa0/11	1,3,5

Port Vlans allowed and active in management domain

Fa0/9 2,4,6
Fa0/11 1,3,5

Port Vlans in spanning tree forwarding state and not pruned
Fa0/9 2,4,6
Fa0/11 1,3,5

The output displays that on port fa0/9 only vlans 2, 4, 6 and on port fa0/11 only vlans 1,3,5 are allowed

SW1#show spanning-tree vlan 2

VLAN0002
Spanning tree enabled protocol ieee
Root ID Priority 32770
Address 000f.34f4.f080
Cost 19
Port 9 (FastEthernet0/9)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32770 (priority 32768 sys-id-ext 2)
Address 0014.a82f.a680
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec
Aging Time 300

Interface Role Sts Cost Prio.Nbr Type
---------- ---- --- ---------- ---------- ----------
Fa0/9 Root FWD 19 128.9 P2p

The output displays that port fa0/9 is in forwarding state as vlans 2 is configured to allow on port fa0/9.

SW1#show spanning-tree vlan 3

VLAN0003
Spanning tree enabled protocol ieee
Root ID Priority 32771
Address 000f.34f4.f080
Cost 19
Port 11 (FastEthernet0/11)
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Bridge ID Priority 32771 (priority 32768 sys-id-ext 3)
Address 0014.a82f.a680
Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

Aging Time 300

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/11	Root	FWD	19	128.11	P2p

The output displays that port fa0/11 is in forwarding state as vlan 3 is configured to allow on port fa0/11. Thus load balancing is achieved.

Lab 7 – Implementing MSTP

(Scenario Based on Lab 6 – Task 1)
Task 1

Configure dotlq trunks on ports fa0/9 and fa0/11. Configure VTP to propagate VLAN information. Configure instance 1 MSTP and map VLANs 1, 2, 3. Configure instance 2 MSTP and map VLANs 4, 5, 6. Make SW1 the STP root for instances 1, 2.

Switch1	Switch
Int range fa0/9, fa0/11 Switchport trunk encapsulation dotlq Switchport mode trunk Vtp domain netmet Vtp mode server Vtp password cisco123 Vlan 2 Name aaa Vlan 3 Name bbb Vlan 4 Name ccc Vlan5 Name ddd Vlan 6 Name 666 Spanning-tree mode mst Spanning-tree mst configuration Instance 1 vlan 1 – 3 Instance 2 vlan 4 – 6 Spanning-tree mst 1 – 2 root primary	Int range fa0/9, fa0/11 Switchport trunk encapsulation dotlq Switchport mode trunk Vtp domain netmet Vtp mode client Vtp password cisco123 Spanning-tree mode mst Spanning-tree mst configuration Instance 1 vlan 1 – 3 Instance 2 vlan 4 – 6

Verification:

SW1#show spanning-tree mst 1

MST01 vlans mapped: 1-3
Bridge address 0014.a82f.a680 priority 24577 (24576 sysid 1)
Root this switch for MST01

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/9	Desg	FWD	200000	128.9	P2p
Fa0/11	Desg	FWD	200000	128.11	P2p

The output displays the VLANs mapped to this MST instance 1.

SW1#show spanning-tree mst 2

MST02 vlans mapped: 4-6
Bridge address 0014.a82f.a680 priority 24578 (24576 sysid 2)
Root this switch for MST02

Interface	Role	Sts	Cost	Prio.Nbr	Type
Fa0/9	Desg	FWD	200000	128.9	P2p
Fa0/11	Desg	FWD	200000	128.11	P2p

The output displays the VLANs mapped to this MST instance 2.

Task 2
(Scenario Based On Task 1)

Configure MSTP on SW1 & SW2. Make SW1 the STP root for instance 1. Make SW2 the STP root for instance 2. Configure MST instance 1 and map VLANs 1 - 3. Configure MST instance 2 and map VLANs 4 - 6.

Switch1	Switch2
Spanning-tree mode mst Spanning-tree mst configuration Instance 1 vlan 1 – 3 Instance 2 vlan 4 – 6 Spanning-tree mst 1 root primary	Spanning-tree mode mst Spanning-tree mst configuration Instance 1 vlan 1 – 3 Instance 2 vlan 4 – 6 Spanning-tree mst 2 root primary

Verification:

```
SW1#show spanning-tree mst 1

###### MST01        vlans mapped:   1-3
Bridge      address 0014.a82f.a680  priority  24577 (24576 sysid 1)
Root        this switch for MST01

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ----- ---- ---------- ---------- --------------------------------
Fa0/9            Desg FWD 200000    128.9    P2p
Fa0/11           Desg FWD 200000    128.11   P2p

SW1#show spanning-tree mst 2

###### MST02        vlans mapped:   4-6
Bridge      address 0014.a82f.a680  priority  32770 (32768 sysid 2)
Root        address 000f.34f4.f080  priority  24578 (24576 sysid 2)
          port    Fa0/9           cost      200000               rem hops 19

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ----- ---- ---------- ---------- --------------------------------
Fa0/9            Root FWD 200000    128.9    P2p
Fa0/11           Altn BLK 200000    128.11   P2p
```

The output displays that sw1 acts as the root bridge for vlans 1-3 only.

This can be verified from the output that ports fa0/9 and fa0/11 are in forwarding state only for vlans 1-3 whereas one port forwarding and other blocking for vlans 4-6 on the same switch.

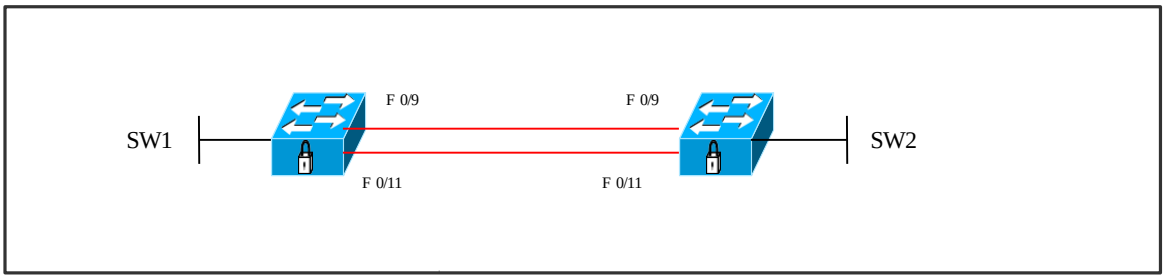
```
SW2#show spanning-tree mst 1

###### MST01        vlans mapped:   1-3
Bridge      address 000f.34f4.f080  priority  32769 (32768 sysid 1)
Root        address 0014.a82f.a680  priority  24577 (24576 sysid 1)
          port    Fa0/9           cost      200000               rem hops 19

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ----- ---- ---------- ---------- --------------------------------
Fa0/9            Root FWD 200000    128.9    P2p
Fa0/11           Altn BLK 200000    128.11   P2p
```

```
SW2#show spanning-tree mst 2

###### MST02        vlans mapped:   4-6
Bridge      address 000f.34f4.f080  priority  24578 (24576 sysid 2)
Root        this switch for MST02

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ----- ---- ---------- ---------- ----------------------------------------
Fa0/9            Desg FWD 200000    128.9    P2p
Fa0/11           Desg FWD 200000    128.11   P2p
```

The output displays that sw2 acts as the root bridge for vlans 4-6 only.

This can be verified from the output that ports fa0/9 and fa0/11 are in forwarding state only for vlans 4-6 whereas one port forwarding and other blocking for vlans 1-3 on the same switch.

Lab 8 – Configuring Link Aggregation with EtherChannel



Task 1

Configure L 2 trunk between SW1 & SW2 using default encapsulation on ports fa0/9, fa0/11.
Configure ether channel between SW1 and SW2 on interfaces fa0/9, fa0/11, without using negotiation protocols.
Configure interfaces fa0/9, fa0/11 on SW1 & SW2 in channel group 1 with a mode of "on".

Switch1	Switch2
Interface port-channel 1 Int range fa0/9, fa0/11 Channel-group 1 mode on	Interface port-channel 1 Int range fa0/9, fa0/11 Channel-group 1 mode on

Verification :

SW2#show etherchannel summary

Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2
u - unsuitable for bundling
U - in use f - failed to allocate aggregator
d - default port

Number of channel-groups in use: 1
Number of aggregators: 1

```
Group    Port-channel    Protocol    Ports
-------+---------------+------------+-----------------------------------------------------
   1          Po1(SU)              -          Fa0/9(P)    Fa0/11(P)
```

The output displays port channel created for ports fa0/9, fa0/11 and is denoted as po 1 (su) where, s : layer 2, u : in use, P : in port channel

SW2#show interfaces port-channel 1 switchport

```
Name: Po1
Switchport: Enabled
Administrative Mode: dynamic desirable
Operational Mode: trunk
Administrative Trunking Encapsulation: negotiate
Operational Trunking Encapsulation: isl
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
```

By default all interfaces are in dynamic desirable mode which automatically negotiates to become trunk if not specified.
The output displays default ISL trunking for this port-channel.

SW2#show int trunk

```
Port        Mode         Encapsulation  Status        Native vlan
Po1         desirable        n-isl          trunking        1

Port      Vlans allowed on trunk
Po1         1-4094

Port        Vlans allowed and active in management domain
Po1         1

Port        Vlans in spanning tree forwarding state and not pruned
Po1         1
```

The output displays the port-channel interface as trunk instead of individual ports.

SW2#show spanning-tree vlan 1

```
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID    Priority    32769
```

```
          This bridge is the root
  Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)

Interface  Role     Sts      Cost      Prio.Nbr    Type
------------------- ----- ---- ----------- ---------- ----------------------------------------
Po1          Desg    FWD     12        128.65        P2p
```

The output displays the forwarding port as portchannel 1 instead of separate port because of ether channel configured on ports fa0/9, fa0/11, they appear as one bundle.

Task 2

(Scenario Based On Task 1)

Configure L 2 trunk between SW1 & SW2 using dot1q or isl encapsulation on ports fa 0/7 , fa 0/9, fa 0/11.

Configure ether channel between SW1 and SW2 on interfaces fa 0/7, fa0/9, fa0/11. Both switches SW1 and SW2 should initiate negotiation via PAgP.

Switch1	Switch2
Interface port-channel 1 Int range fa0/7 , fa0/9 , fa0/11 Channel-group 1 mode desirable	Interface port-channel 1 Int range fa0/7 , fa0/9 , fa0/11 Channel-group 1 mode desirable

Verification :

SW1#show etherchannel summary

```
Flags:  D - down        P - in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        u - unsuitable for bundling
        U - in use      f - failed to allocate aggregator
        d - default port

Number of channel-groups in use: 1
Number of aggregators:           1

Group      Port-channel      Protocol       Ports
-------+----------------+-------------+-----------------------------------------------------------

     1            Po1(SU)          PAgP        Fa0/7(P)    Fa0/9(P)    Fa0/11(P)
```

The output displays protocol as “PAgP” and Po1 (SU) (port-channel 1) created for ports fa0/7, fa0/9, fa0/11, where s : layer 2, U : in use.

SW1#show interfaces port-channel 1 switchport

Name: Po1
Switchport: Enabled
Administrative Mode: dynamic desirable
Operational Mode: trunk
Administrative Trunking Encapsulation: negotiate
Operational Trunking Encapsulation: isl
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)

The output displays that this interface port-channel 1 has automatically negotiated to become trunk.

SW1#show int trunk

Port	Mode	Encapsulation	Status	Native vlan
Po1	desirable	n-isl	trunking	1

Port	Vlans allowed on trunk
Po1	1-4094

Port	Vlans allowed and active in management domain
Po1	1

Port	Vlans in spanning tree forwarding state and not pruned
Po1	1

The output displays port-channel 1 as trunk instead of individual ports.

SW1#show spanning-tree vlan 1

VLAN0001
  Spanning tree enabled protocol ieee
  Root ID Priority 32769
           Address 000f.34f4.f080
           Cost 9
           Port 65 (Port-channel1)
           Hello Time 2 sec Max Age 20 sec Forward Delay 15 sec

```
 Bridge ID  Priority    32769  (priority 32768 sys-id-ext 1)
            Address     0014.a82f.a680
            Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
            Aging Time 300

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Po1              Root FWD 9         128.65   P2p
```

The output displays the forwarding port as portchannel 1 instead of separate ports.

Task 3

(Scenario Based On Task 1)

Configure L 2 trunk between SW1 & SW2 using dot1q or isl encapsulation on ports fa 0/7 , fa 0/9, fa 0/11.

Configure ether channel between SW1 and SW2 on interfaces fa 0/7, fa0/9, fa0/11. Both switches SW1 and SW2 should initiate negotiation via LAcP.

Switch1	Switch2
Interface port-channel 1 Int range fa0/7 , fa0/9 , fa0/11 Channel-group 1 mode active	Interface port-channel 1 Int range fa0/7 , fa0/9 , fa0/11 Channel-group 1 mode active

Verification :

SW1#show etherchannel summary

```
Flags:  D - down        P - in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        u - unsuitable for bundling
        U - in use      f - failed to allocate aggregator
        d - default port

Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
-------+-------------+-----------+-----------------------------------------------
```

1 Po1(SU) LACP Fa0/7(P) Fa0/9(P) Fa0/11(P)

The output displays protocol as “LACP” and po1 (SU) (port-channel 1) created for ports fa0/7, fa0/9, fa0/11.

Task 4

(Scenario Based On Task 1)

Configure interface port-channel 1 to ports fa0/7, fa0/9, fa0/11.
Configure VLAN 100 and assign to ports fa0/7, fa0/9, fa0/11.
Configure ether-channel between SW1 & SW2 i.e. create channel-group 1 with the mode “on” (without using negotiating protocols).

Switch1	Switch2
Interface range fa0/7, fa0/9, fa0/11 Switchport mode access Switchport access vlan 100 Channel-group 1 mode on	Interface range fa0/7, fa0/9, fa0/11 Switchport mode access Switchport access vlan 100 Channel-group 1 mode on

Verification :

SW1#show vlan brief

```
VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5, Fa0/6, Fa0/8, Fa0/10
                                                Fa0/12, Fa0/13, Fa0/14, Fa0/15
                                                Fa0/16, Fa0/17, Fa0/18, Fa0/19
                                                Fa0/20, Fa0/21, Fa0/22, Fa0/23
                                                Fa0/24, Gi0/1, Gi0/2
100  VLAN0100                         active    Po1
```

The output displays portchannel 1 in VLAN 100 instead of individual ports.

SW1#show etherchannel summary

```
Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
```

1 Po1(SU) - Fa0/7(P) Fa0/9(P) Fa0/11(P)

The output displays no protocol and po1 (SU) created for ports fa0/7, fa0/9, fa0/11, where :
P = Port-channel, s = layer 2, U = in use.

Task 5

(Scenario Based On Task 1)

To configure Layer 3 ether-channel, create the port channel logical interface, assign ip address and then put the ethernet interfaces into the port-channel.

Switch1	Switch2
Interface port-channel 1 Ip add 100.0.0.1 255.0.0.0 Interface range fa0/7, fa0/9, fa0/11 No switchport No ip address Channel-group 1 mode on	Interface port-channel 1 Ip add 100.0.0.2 255.0.0.0 Interface range fa0/7, fa0/9, fa0/11 No switchport No ip address Channel-group 1 mode on

Verification :

Test the connectivity of port-channel
Ping from SW1 to SW2
100 % successful

SW1#ping 100.0.0.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 100.0.0.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms

SW1#show Etherchannel summary

Flags: D - down P - in port-channel
I - stand-alone s - suspended
H - Hot-standby (LACP only)
R - Layer3 S - Layer2

Number of channel-groups in use: 1

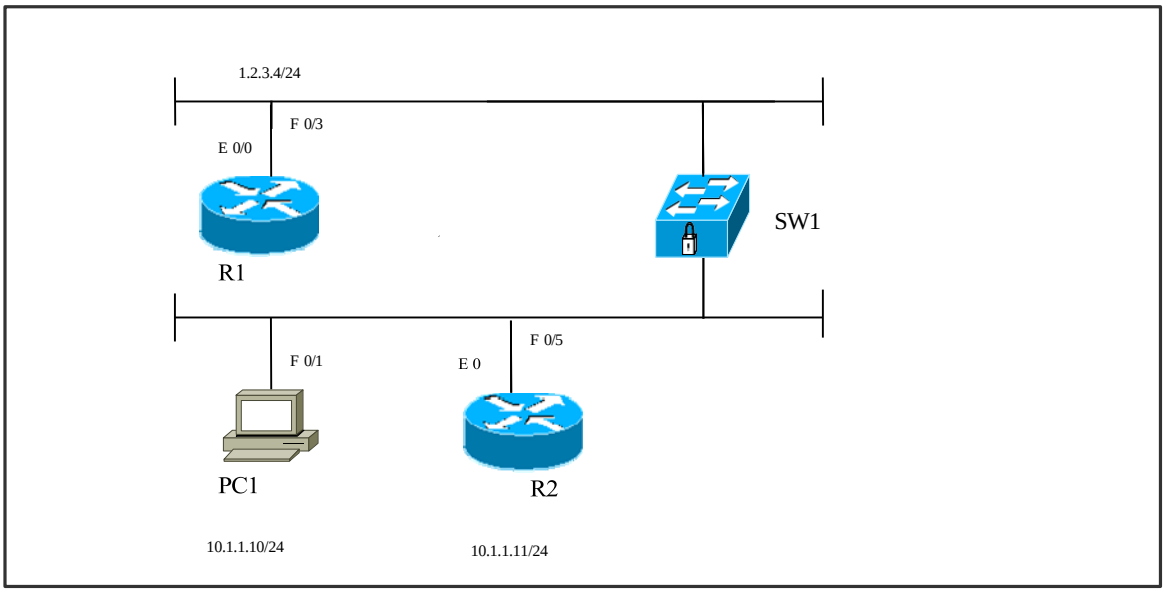
Number of aggregators: 1

Group Port-channel Protocol Ports
-------+----------------------+-------------+---

1 Po1(RU) - Fa0/7(P) Fa0/9(P) Fa0/11(P)

The output displays port channel 1 created and denoted as po1 (RU) where : R = layer 3, U = in use, p = port-channel

Lab 9 – SPAN: Switched Port Analyzer



Task 1

Create VLAN 10 and assign to ports fa0/1 & fa0/5 on SW1.
Configure SW1 to redirect all traffic from VLAN 10 to port fa0/3.
Enable R1 for debug process.

Switch1	Router1
Vlan 10 Int range fa0/1, fa0/5 Switchport mode access Switchport access vlan 10 Monitor session 1 source vlan 10 rx Monitor session 1 destination interface fa0/3 Int fa0/3 Switchport mode access	Int e0/0 Ip add 1.2.3.4 255.0.0.0 No shutdown

Verification :

R1#debug ip packet

Now ping from PC1:

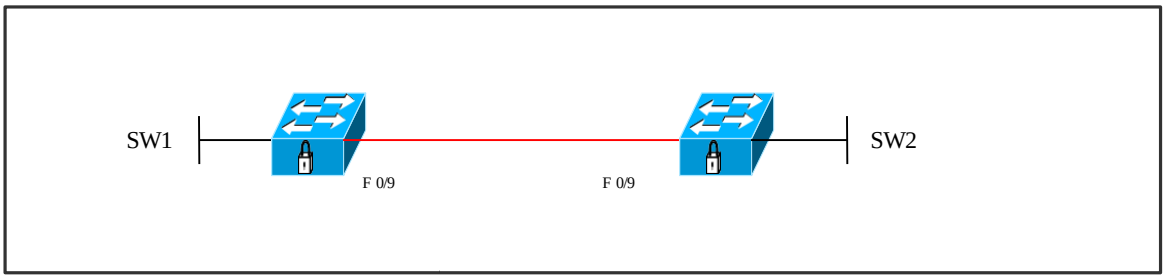
PC 1 > Ping 255.255.255.255.

IP packet debugging is on

*Mar 1 05:32:11.626: IP: s=10.1.1.11 (Ethernet0/0), d=255.255.255.255, len 100, rcvd 2
*Mar 1 05:32:11.626: IP: s=1.2.3.4 (local), d=10.1.1.11, len 100, unroutable

The output displays source ip 10.1.1.11 and destination ip as 255.255.255.255.
The second message displays, source ip 1.2.3.4 and destination ip as 10.1.1.11.
Thus, R1 receives packets sent from R2 even through they are not in the same VLAN.

Task 2



Configure dot1q encapsulation on port fa 0/9 of SW1 to become trunk.
Configure SPAN monitoring on port fa 0/9 of SW2 and also configure dot1q encapsulation of port fa 0/9 of SW2.

Switch1	Switch2
Int fa0/9 Switchport trunk encapsulation dot1q Switchport mode trunk	Int fa0/9 Switchport trunk encapsulation dot1q Switchport mode trunk Monitor session 1 source vlan1 rx Monitor session 1 destination interface fa0/9

Verification :

SW1#show interfaces trunk

Port	Mode	Encapsulation	Status	Native vlan
Fa0/9	on	802.1q	trunking	1

Port	Vlans allowed on trunk
Fa0/9	1-4094

Port	Vlans allowed and active in management domain
Fa0/9	1,10

Port	Vlans in spanning tree forwarding state and not pruned
Fa0/9	1,10

The output displays port fa0/9 as dot1q trunk

SW2#show interfaces trunk
---------Nil-------

The output doesn't display anything as there is no trunk established on port fa0/9 of SW2.

SW2#show int fa0/9

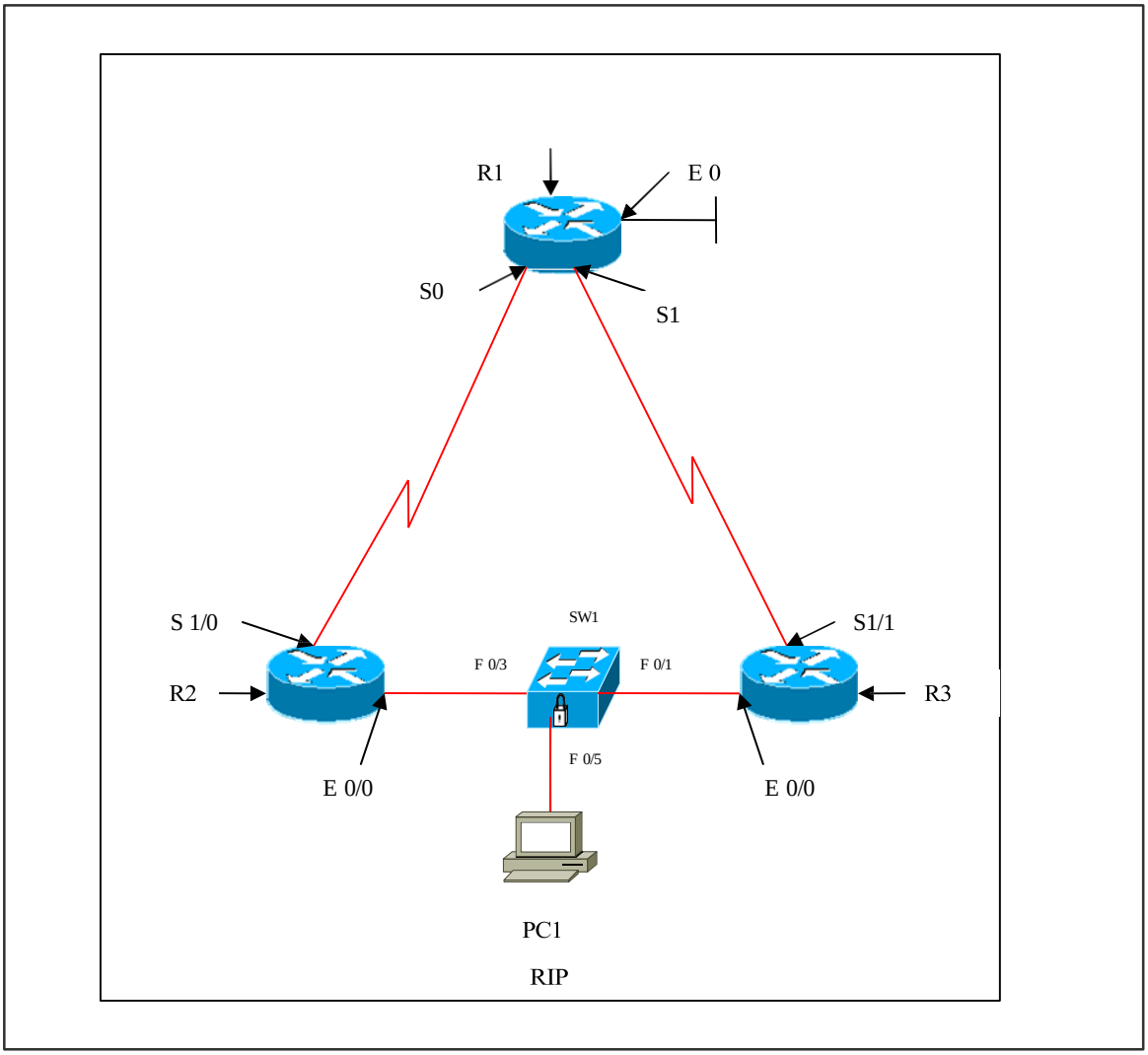
FastEthernet0/9 is up, line protocol is down (monitoring)
  Hardware is Fast Ethernet, address is 000f.34f4.f089 (bia 000f.34f4.f089)
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)

The output displays line protocol down (monitoring).

To troubleshoot this issue we have to remove the SPAN monitoring for port fa 0/9 on SW2.

NOTE : SPAN monitoring should not be configured on trunk ports.

Lab 10 – Configuring HSRP



Interface IP Address Configuration :

R1

Interface	IP Address	Subnet Mask
S 0	3.3.3.2	255.0.0.0
S 1	2.2.2.2	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 1/0	3.3.3.1	255.0.0.0
E 0/0	10.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 1/1	2.2.2.1	255.0.0.0
E 0/0	10.1.1.2	255.0.0.0

SW1

Ports	VLAN Assigned	Connected To
FA 0/1	VLAN 1	R3 (10.1.1.2)
FA 0/3	VLAN 1	R2 (10.1.1.1)
FA 0/5	VLAN 1	PC 1 (10.1.1.3)

Task 1

Configure routing protocol (RIP) on R1, R2, and R3.
Configure ports fa0/3, fa0/1 & fa0/5 as access ports on SW1
Configure HSRP group 1 on R2 & R3, using the virtual ip address 10.1.1.10.

R2	R3
Int e0/0 Standby 1 ip 10.1.1.10 Standby 1 preempt Standby 1 priority 200	Int e0/0 Standby 1 ip 10.1.1.10 Standby 1 priority 100

Verification :

```
R3#show standby brief
                     P indicates configured to preempt.
                     |
Interface   Grp Prio P State   Active          Standby         Virtual IP
Et0/0         1  100  P Standby  10.1.1.1        local           10.1.1.10
```

The output displays that this is the standby router and the active router is (10.1.1.1), the virtual ip is (10.1.1.10) and this router configured to preempt.

R2#show ip arp

Protocol	Address	Age (min)	Hardware Addr	Type	Interface
Internet	10.1.1.10	-	0000.0c07.ac01	ARPA	Ethernet0/0
Internet	10.1.1.2	23	0001.4289.a241	ARPA	Ethernet0/0
Internet	10.1.1.3	19	0008.0216.0d31	ARPA	Ethernet0/0
Internet	10.1.1.1	-	0008.a3d1.b540	ARPA	Ethernet0/0

The output displays ip add 10.1.1.10 (virtual ip) with the MAC address 0000.0c07.ac01, which is well-known HSRP MAC addres 01 : hsrp group identifier ,0000.0c : vendor code, 07.ac : HSRP .

Verify the route chosen to reach network 20.1.1.1

From PC1 : tracert 20.1.1.1

From PC1:

```
C:\Documents and Settings\Administrator>tracert 20.1.1.1

Tracing route to 20.1.1.1 over a maximum of 30 hops

  1     2 ms     3 ms     3 ms  10.1.1.1
  2    28 ms    28 ms    28 ms  20.1.1.1
```

Traceroute command displays that the packet reaches 10.1.1.1 (active router) and reaches 20.1.1.1.

Shut down the interface E0/0 on router 2 and traceroute .

From PC1 : tracert 20.1.1.1

From PC1:

```
C:\Documents and Settings\Administrator>tracert 20.1.1.1

Tracing route to 20.1.1.1 over a maximum of 30 hops

  1     1 ms     1 ms     1 ms  10.1.1.2
  2    27 ms    27 ms    28 ms  20.1.1.1
```

Traceroute command displays that the packet reaches 10.1.1.2 (standby router becomes active) and then reaches 20.1.1.1.

Task 2

Configure tracking on R2, so that in case of failure of S 1/0, the priority is decreased automatically, so that the standby router takes the active role.

R2

Int e0/0
Standby 1 track s1/0 150

Verification :
R2#show standby brief
P indicates configured to preempt.
|

Interface	Grp	Prio	P	State	Active addr	Standby addr	Group addr
Et0/0	1	200	P	Active	local	10.1.1.2	10.1.1.10

The output displays that this is the standby router and the active router is (10.1.1.1), the virtual ip is (10.1.1.10) and this router configured to preempt.

From PC1:

```
C:\Documents and Settings\Administrator>tracert 20.1.1.1

Tracing route to 20.1.1.1 over a maximum of 30 hops

  1     2 ms     3 ms     3 ms  10.1.1.1
  2    28 ms    28 ms    28 ms  20.1.1.1
```

Traceroute command displays that the packet reaches 10.1.1.1 (active router) and reaches 20.1.1.1.

Shut down the interface s1/0 on router 2 and traceroute .

R2#show standby brief
P indicates configured to preempt.
|

Interface	Grp	Prio	P	State	Active addr	Standby addr	Group addr
Et0/0	1	50	P	Standby	10.1.1.2	local	10.1.1.10

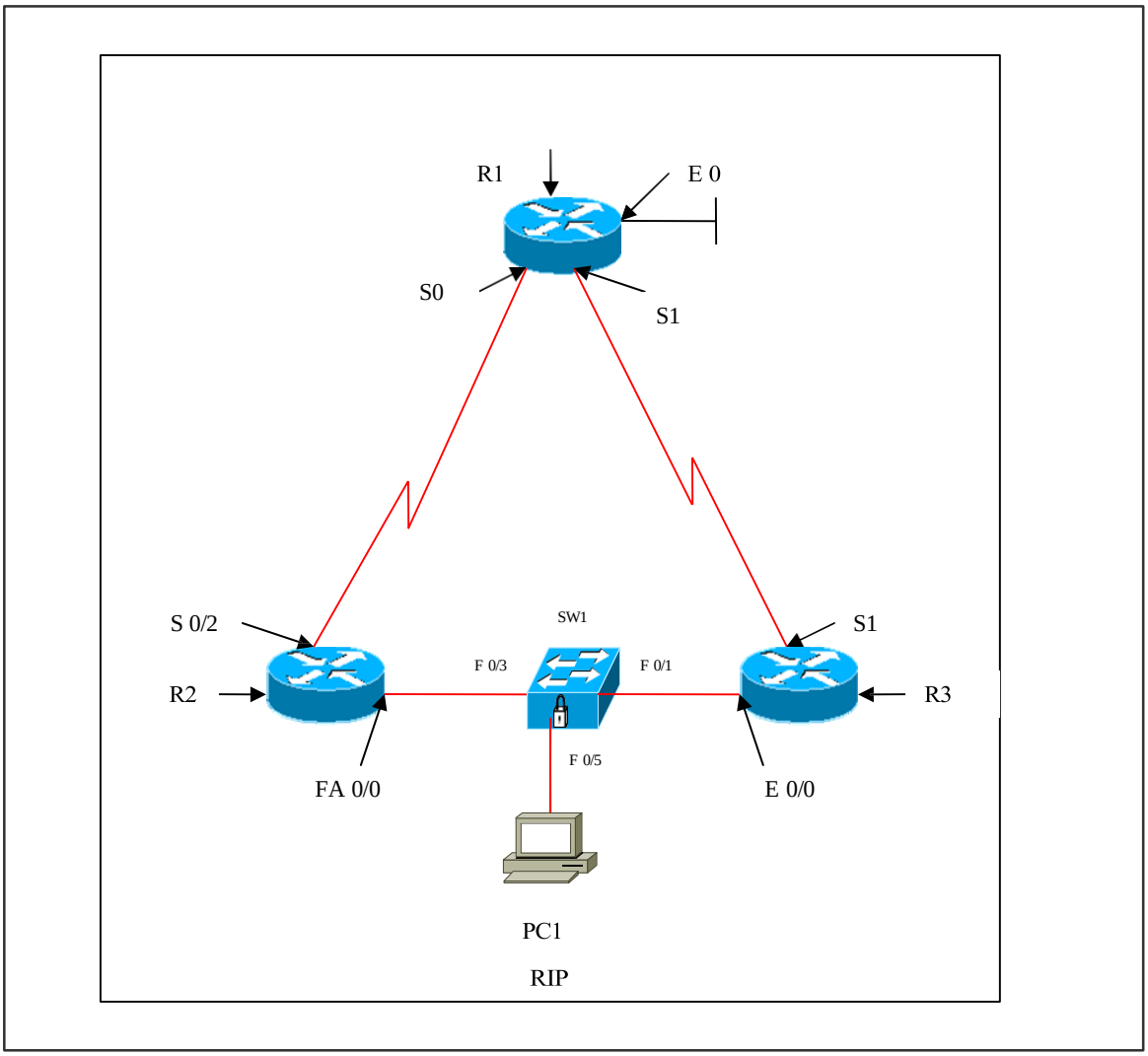
The priority is decreased to 50 from 200 automatically, and the router becomes standby for the HSRP group.

From PC1:

```
C:\Documents and Settings\Administrator>tracert 20.1.1.1

Tracing route to 20.1.1.1 over a maximum of 30 hops

  1     1 ms     1 ms     1 ms  10.1.1.2
  2    27 ms    27 ms    28 ms  20.1.1.1
```

The traceroute command displays that the packets are sent via 10.1.1.2 (standby becomes active) because of higher priority value.

Lab 11 – Configuring VRRP



Interface IP Address Configuration :

R1

Interface	IP Address	Subnet Mask
S 0	3.3.3.2	255.0.0.0
S 1	2.2.2.2	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0/2	3.3.3.1	255.0.0.0
E 0/0	10.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 1	2.2.2.1	255.0.0.0
E 0/0	10.1.1.2	255.0.0.0

SW1

Ports	VLAN Assigned	Connected To
FA 0/1	VLAN 1	R3 (10.1.1.2)
FA 0/3	VLAN 1	R2 (10.1.1.1)
FA 0/5	VLAN 1	PC 1 (10.1.1.3)

Task 1

Configure routing protocol (RIP) on R1, R2, and R3.
Configure ports fa0/3, fa0/1 & fa0/5 as access ports on SW1
Configure VRRP group 1 on R2 & R3, using the virtual ip address 10.1.1.10.

R2	R3
Int fa 0/0 Vrrp 1 ip 10.1.1.10 Vrrp 1 priority 200 Vrrp 1 timers advertise 4 Vrrp 1 preempt	Int e 0/0 Vrrp 1 ip 10.1.1.10 Vrrp 1 priority 100 Vrrp 1 timers learn Vrrp 1 preempt

Verification :

R2#show vrrp brief

Interface	Grp	Pri	Time	Own	Pre	State	Master addr	Group addr
FastEthernet0/0	1	200	12218		Y	Master	10.1.1.1	10.1.1.10

The output displays that this router is master and virtual ip address is 10.1.1.10

R3#show vrrp brief

Interface	Grp	Pri	Time	Own	Pre	State	Master addr	Group addr
Ethernet0/0	1	100	12609		Y	Backup	10.1.1.1	10.1.1.10

The output displays that this router is backup router

From PC1:

```
C:\Documents and Settings\Administrator>tracert 20.1.1.1

Iracing route to 20.1.1.1 over a maximum of 30 hops

  1     1 ms     1 ms     1 ms  10.1.1.1
  2    27 ms    27 ms    27 ms  20.1.1.1

Irace complete.
```

When packets sent to network 20.1.1.1 from PC1 (10.1.1.3), the packet first reaches 10.1.1.1 (master) and finally reaches the destination.

Shut down the interface Fa0/0 on router 2 and traceroute .

R3#debug vrrp packets

*Mar 1 05:01:40.790: %VRRP-6-STATECHANGE: Et0/0 Grp 1 state Backup -> Master
*Mar 1 05:01:40.790: VRRP: Grp 1 sending Advertisement checksum 6FF1

The output displays the transition of backup to master on R3.

R3#show vrrp brief

Interface	Grp	Pri	Time	Own	Pre	State	Master addr	Group addr
Ethernet0/0	1	100	3609		Y	Master	10.1.1.2	10.1.1.10

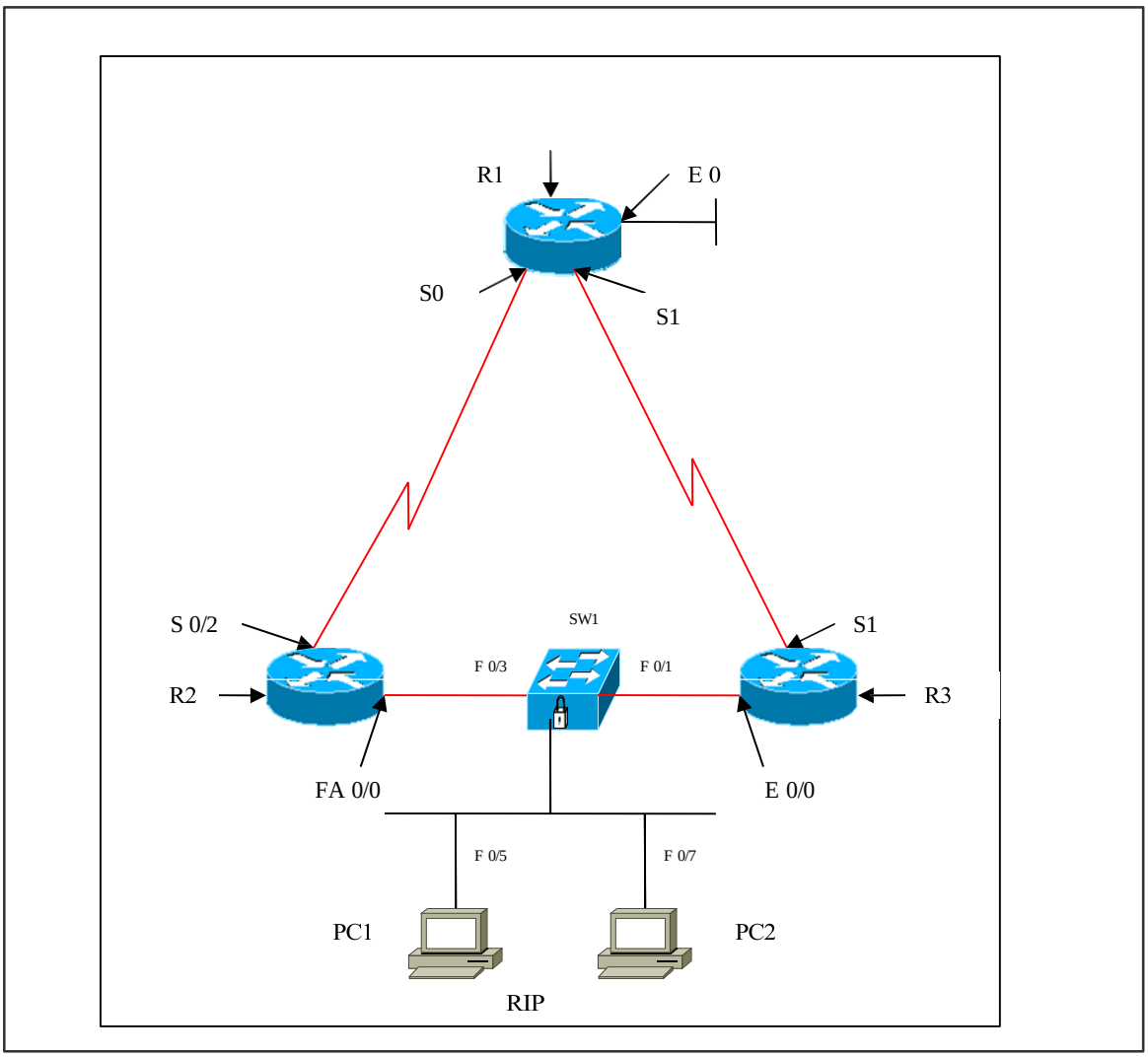
The output displays that R3 is master now.

From PC1:

```
C:\Documents and Settings\Administrator>tracert 20.1.1.1

Iracing route to 20.1.1.1 over a maximum of 30 hops

  1     1 ms     1 ms     1 ms  10.1.1.2
  2    28 ms    28 ms    28 ms  20.1.1.1
```

When traceroute from PC1 to 20.1.1.1, the output displays that packet is reaching 20.1 1.1 via 10.1.1.2.

Lab 12 – Configuring GLBP



Interface IP Address Configuration :

R1

Interface	IP Address	Subnet Mask
S 0	3.3.3.2	255.0.0.0
S 1	2.2.2.2	255.0.0.0
E 0	20.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0/2	3.3.3.1	255.0.0.0
FA 0/0	10.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 1	2.2.2.1	255.0.0.0
E 0/0	10.1.1.2	255.0.0.0

SW1

Ports	VLAN Assigned	Connected To
FA 0/1	VLAN 1	R3 (10.1.1.2)
FA 0/3	VLAN 1	R2 (10.1.1.1)
FA 0/5	VLAN 1	PC 1 (10.1.1.3)
FA 0/7	VLAN 1	PC 2 (10.1.1.4)

Task 1

Configure routing protocol (RIP) on R1, R2, and R3.
Configure ports fa0/3, fa0/1, fa0/5 and fa0/7 as access ports on SW1
Configure GLBP.

R2	R3
Int fa 0/0 Glbp 1 ip 10.1.1.10 Glbp 1 priority 200 Glbp 1 timers msec 250 msec 750 Glbp 1 preempt	Int e 0/0 Glbp 1 ip 10.1.1.10 Glbp 1 priority 100 Glbp 1 timers msec 250 msec 750

Verification:

R2#show glbp brief

```
Interface   Grp  Fwd Pri  State    Address          Active router   Standby route
Fa0/0         1    -   200 Active   10.1.1.10                local          10.1.1.2

Fa0/0         1    1     7  Active   0007.b400.0101          local          -
Fa0/0         1    2     7  Listen   0007.b400.0102          10.1.1.2       -
```

When the PC's send traffic to 20.0.0.0 network, the traffic is send via the active router which is R2. If R2 is busy in sending the traffic then R3 takes the active state and R2 is in the listening state. Thus load balancing is achieved.

```
R2#show glbp

FastEthernet0/0 - Group 1
  State is Active
    2 state changes, last state change 00:11:30
  Virtual IP address is 10.1.1.10
  Hello time 250 msec, hold time 750 msec
    Next hello sent in 0.000 secs
  Redirect time 600 sec, forwarder time-out 14400 sec
  Preemption enabled, min delay 0 sec
  Active is local
  Standby is 10.1.1.2, priority 100 (expires in 0.530 sec)
  Priority 200 (configured)
  Weighting 100 (default 100), thresholds: lower 1, upper 100
  Load balancing: round-robin
  Group members:
    0001.4289.a241 (10.1.1.2)
    0006.534b.7090 (10.1.1.1) local
  There are 2 forwarders (1 active)
  Forwarder 1
    State is Active
      1 state change, last state change 00:11:20
    MAC address is 0007.b400.0101 (default)
    Owner ID is 0006.534b.7090
    Redirection enabled
    Preemption enabled, min delay 30 sec
    Active is local, weighting 100

Forwarder 2
    State is Listen
    MAC address is 0007.b400.0102 (learnt)
    Owner ID is 0001.4289.a241
    Redirection enabled, 599.800 sec remaining (maximum 600 sec)
    Time to live: 14399.800 sec (maximum 14400 sec)
    Preemption enabled, min delay 30 sec
    Active is 10.1.1.2 (primary), weighting 100 (expires in 0.546 sec)
```

The output displays that the active router takes its default MAC address, whereas the second forwarder learns the MAC address from the default gateway (active forwarding router) (i.e. R2). Load balancing is achieved in round-robin algorithm.

How to verify:

Traceroute from PC1 to 20.0.0.0 network, the packet is send via R2.
Traceroute from PC2 to 20.0.0.0 network, the packet is send via R2.
If R2 is busy then the packet is send via R3, which is verified from the above output (traceroute 20.1.1.1 from PC2)

From PC1:

```
C:\Documents and Settings\Administrator>tracert 20.1.1.1

Tracing route to 20.1.1.1 over a maximum of 30 hops

  1   <10 ms   <10 ms   <10 ms  10.1.1.1
  2    27 ms    27 ms    27 ms  20.1.1.1
```

The first packet reaches 20.1.1.1 via 10.1.1.1

From PC2:

```
C:\Documents and Settings\Administrator>tracert 20.1.1.1

Iracing route to 20.1.1.1 over a maximum of 30 hops

  1     1 ms     1 ms     1 ms  10.1.1.2
  2    28 ms    27 ms    27 ms  20.1.1.1
```

The first packet reaches 20.1.1.1 via 10.1.1.2

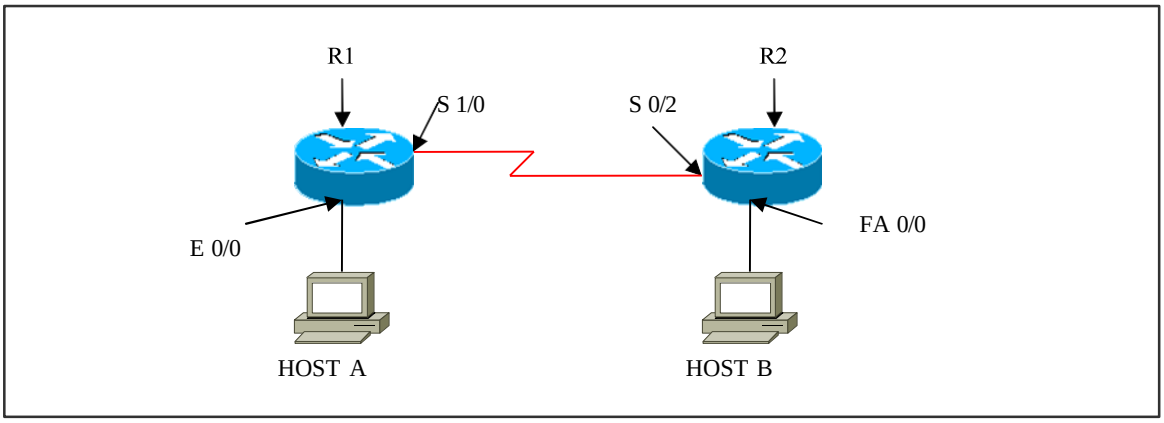
PAPER 3

IMPLEMENTING SECURE CONVERGED WIDE AREA NETWORKS

ISCW (642–825)

ISCW LAB INDEX

Lab 1 – Configure Site-to-Site IPSEC VPN



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 1/0	2.2.2.1	255.0.0.0
E 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0/2	2.2.2.2	255.0.0.0
Fa 0/0	20.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure the ISAKMP policy required to establish on IKE tunnel.
Define the IPSec transform-set.
Create crypto ACL to define which traffic should be sent through the IPSec tunnel.
Create crypto map that maps the previously configured parameters and defines IPSec peer device.
Apply the crypto map to the outgoing interface of the VPN device.

R1	R2
Crypto isakmp enable Crypto isakmp policy 20 Encryption 3des Hash md5 Authentication pre-share Group1 Crypto isakmp key cisco123 address 2.2.2.2 Crypto ipsec transform-set set1 esp-des Access-list 101 permit ip 10.0.0.0 0.255.255.255 20.0.0.0 0.255.255.255 Crypto map map1 10 ipsec-isakmp Set peer 2.2.2.2 Set transform-set set1 Match address 101 Int s1/0 Crypto map map1 Ip route 20.0.0.0 255.0.0.0 2.2.2.2	Crypto isakmp enable Crypto isakmp policy 15 Encryption 3des Hash md5 Authentication pre-share Group1 Crypto isakmp key cisco123 address 2.2.2.1 Crypto ipsec transform-set set1 esp-des Access-list 101 permit ip 20.0.0.0 0.255.255.255 10.0.0.0 0.255.255.255 Crypto map map1 10 ipsec-isakmp Set peer 2.2.2.1 Set transform-set set1 Match address 101 Int s0/2 Crypto map map1 Ip route 10.0.0.0 255.0.0.0 2.2.2.2

Verification:

R1#show crypto isakmp sa

dst	src	state	conn-id	slot
2.2.2.2	2.2.2.1	QM_IDLE	1	0

The output displays the IKE tunnel established between src and dst. With the state displayed as QM-IDLE and a connection-id, if nothing of the above is displayed then the IKE phase I has not established.

```
R1#show crypto isakmp policy

Protection suite of priority 10
        encryption algorithm:   Three key triple DES
        hash algorithm:         Message Digest 5
        authentication method:  Pre-Shared Key
        Diffie-Hellman group:   #1 (768 bit)
        lifetime:               86400 seconds, no volume limit
```

The output displays all the policies defined and also the default policy set.

```
R1#show crypto isakmp key
Keyring              Hostname/Address            Preshared Key
default                    2.2.2.2                    cisco123
```

The output displays the pre-shared key defined manually.

```
R1#show crypto map

Crypto Map "map1" 10 ipsec-isakmp
        Peer = 2.2.2.2
        Extended IP access list 101
        access-list 101 permit ip 10.0.0.0 0.255.255.255 20.0.0.0 0.255.255.255
        Current peer: 2.2.2.2
        Security association lifetime: 4608000 kilobytes/3600 seconds
        PFS (Y/N): N
        Transform sets={
                set1,
        }
        Interfaces using crypto map map1:
                Serial1/0
```

The output displays the crypto map configured and also SA lifetime is displayed.

```
R1#show crypto ipsec sa

interface: Serial1/0
    Crypto map tag: map1, local addr. 2.2.2.1

   protected vrf:
   local  ident (addr/mask/prot/port): (10.0.0.0/255.0.0.0/0/0)
   remote ident (addr/mask/prot/port): (20.0.0.0/255.0.0.0/0/0)
   current_peer: 2.2.2.2:500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 103, #pkts encrypt: 103, #pkts digest 0
```

```
    #pkts decaps: 103, #pkts decrypt: 103, #pkts verify 0
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 1, #recv errors 0
     local crypto endpt.: 2.2.2.1, remote crypto endpt.: 2.2.2.2
     path mtu 1500, media mtu 1500
     current outbound spi: 163B5574
inbound esp sas:
      spi: 0xECF19512(3975255314)
        transform: esp-des ,
        in use settings ={Tunnel, }
        slot: 0, conn id: 2000, flow_id: 1, crypto map: map1
        sa timing: remaining key lifetime (k/sec): (4412874/2809)
        IV size: 8 bytes
        replay detection support: N
outbound esp sas:
      spi: 0x163B5574(372987252)
        transform: esp-des ,
        in use settings ={Tunnel, }
        slot: 0, conn id: 2001, flow_id: 2, crypto map: map1
        sa timing: remaining key lifetime (k/sec): (4412874/2809)
        IV size: 8 bytes
        replay detection support: N
```

The output displays the packets encrypted or decrypted.
Before verifying this command ping to the destination, i.e., once the interesting traffic is sent the SA is formed and then secured.

```
R1#show crypto ipsec transform-set

 Transform set set1: { esp-des  }
 will negotiate = { Tunnel,  },
```

The output displays the transform-set.

Lab 2 – Configure IPSEC Site-to-Site VPN Using SDM

Configure IPSec side-to-side VPN using SDM (Security Device Manager).

- SDM is an easy-to-use internet browser-based device management tool that is embedded within Cisco IOS 800 – 3800 series router at no cost.
- SDM simplifies router and security configuration through the use of intelligent wizards to enable customers and partners to quickly and easily deploy, configure, and monitor Cisco router.

Navigations

From the desktop, start the cisco SDM launcher software.
Click configure icon from the main window.
Click VPN icon to open VPN page.
Choose side-to-side VPN wizard from the list.
Click launch the selected task button.
Window will open to choose wizard mode.
Choose step-by-step setup.
Choose the outside interface towards IPSec peer.
Specify the IP address of the peer.
Choose the authentication method and specify the key.
Click next button to proceed.

Set IKE policies by clicking add button and specify the parameters:
IKE proposal priority – 2
Encryption algorithm – 3des.
HMAC – sha
IKE authentication method
Diffie-Hellman group – 1
IKE lifetime

Click next button to proceed..
Set transform-set by clicking add button and specify the parameters:
Transform set name – set 1
Encryption algorithm – esp-des
HMAC
Mode of operation – tunnel
Optional compression

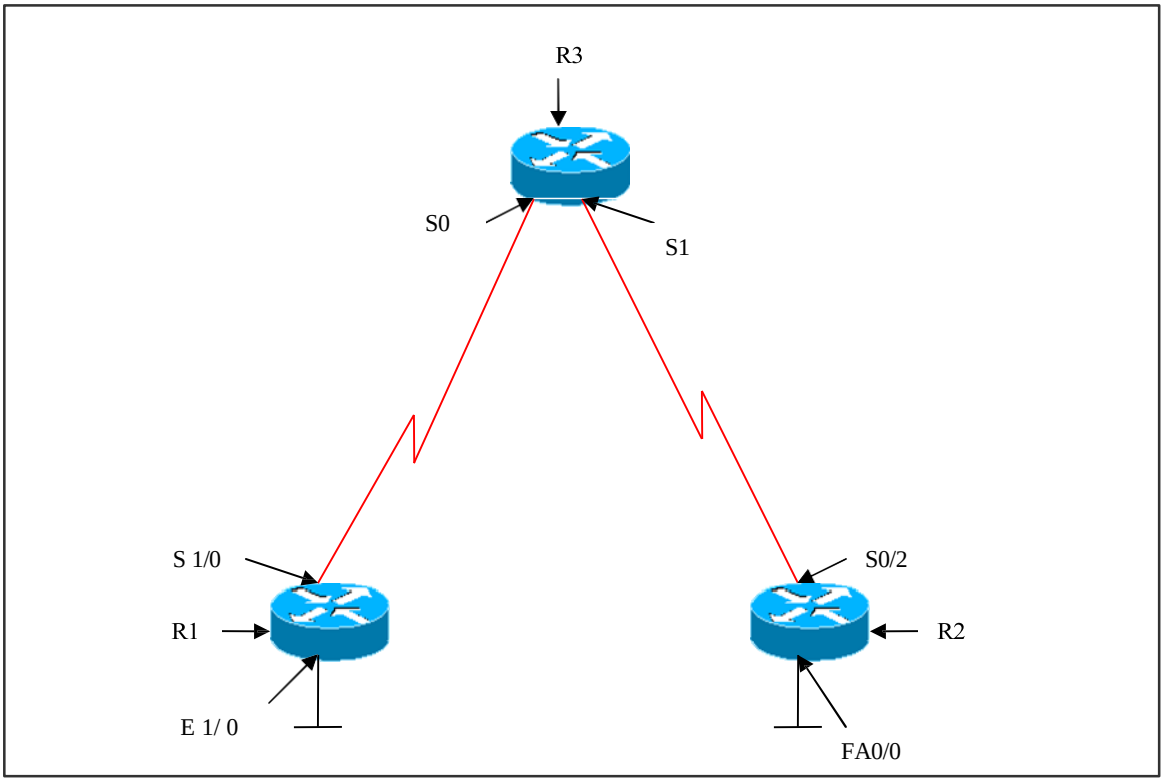
Click next to proceed

- Click create / select an access-list for IPSec traffic radio button.
- Click create a new rule (ACL) and select option.
- Give the access rule a name and click add button.
  -At the end of step-by-step setup the wizard presents a summary of the configured parameters.
  -Click finish button to complete the configuration.

Verify

- Click “test tunnel” button to run a test to determine the configuration correctness of the tunnel.
- Click “monitor icon” – the screen will display all IPSec tunnels, parameters and status.
- Same with “VPN status” icon & “IPSec tunnels”.

Lab 3 – Configure Split Tunneling



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 1/0	2.2.2.1	255.0.0.0
E 1/0	10.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
S 1	3.3.3.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0/2	3.3.3.2	255.0.0.0

Fa 0/0	20.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure routing (EIGRP 10) on R1, R2, and R3.
Configure IPSec VPN only on R1 and R2.
No IPSec VPN configuration on R3.

R1	R2
Crypto isakmp enable	Crypto isakmp enable
Crypto isakmp policy 10 Encryption 3des Hash md5 Authentication pre-share Group1	Crypto isakmp policy 15 Encryption 3des Hash md5 Authentication pre-share Group1
Crypto isakmp key cisco123 address 3.3.3.2	Crypto isakmp key cisco123 address 2.2.2.1
Crypto ipsec transform-set set1 esp-des	Crypto ipsec transform-set set1 esp-des
Access-list 101 permit ip 10.0.0.0 0.255.255.255 20.0.0.0 0.255.255.255	Access-list 101 permit ip 20.0.0.0 0.255.255.255 10.0.0.0 0.255.255.255
Crypto map map1 10 ipsec-isakmp Set peer 3.3.3.2 Set transform-set set1 Match address 101	Crypto map map1 10 ipsec-isakmp Set peer 2.2.2.1 Set transform-set set1 Match address 101
Int s1/0 Crypto map map1	Int s0/2 Crypto map map1

Verification:
R1#show crypto isakmp sa

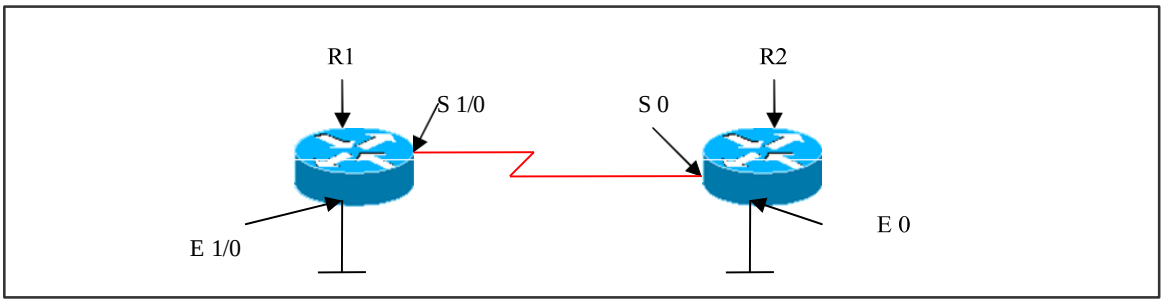
dst	src	state	conn-id	slot
3.3.3.2	2.2.2.1	QM_IDLE	1	0

The output displays current IKE SA's. QM_IDLE status indicates an active IKE SA.

```
R1#show crypto ipsec sa

interface: Serial1/0
 Crypto map tag: map1, local addr. 2.2.2.1

   protected vrf:
   local  ident (addr/mask/prot/port): (10.0.0.0/255.0.0.0/0/0)
   remote ident (addr/mask/prot/port): (20.0.0.0/255.0.0.0/0/0)
   current_peer: 3.3.3.2:500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 99, #pkts encrypt: 99, #pkts digest 0
    #pkts decaps: 99, #pkts decrypt: 99, #pkts verify 0
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 1, #recv errors 0
----output omitted----
```

The output displays current settings used by current SA's. Non-zero encryption and decryption statistics can indicate a working set of IPSec SA's.

Lab 4 – Configure GRE Tunnel (Point-to-point)



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 1/0	2.2.2.1	255.0.0.0
E 1/0	10.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
Fa 0/0	20.1.1.1	255.0.0.0

Lab Objective:

Task 1

Configure static route for reachability to the destination ip address for both R1 and R2.
Configure tunneling by creating interface tunnel 0 on both R1 & R2.
Assign virtual IP address to this interface tunnel 0 on both R1 & R2.

R1	R2
Ip route 20.0.0.0 255.0.0.0 2.2.2.2 Int tunnel 0 Ip address 30.1.1.1 255.0.0.0 Tunnel source s1/0 Tunnel destination 2.2.2.2 Tunnel mode gre ip	Ip route 10.0.0.0 255.0.0.0 2.2.2.1 Int tunnel 0 Ip address 30.1.1.2 255.0.0.0 Tunnel source s0 Tunnel destination 2.2.2.1 Tunnel mode gre ip

Verification:

R1#show ip int brief

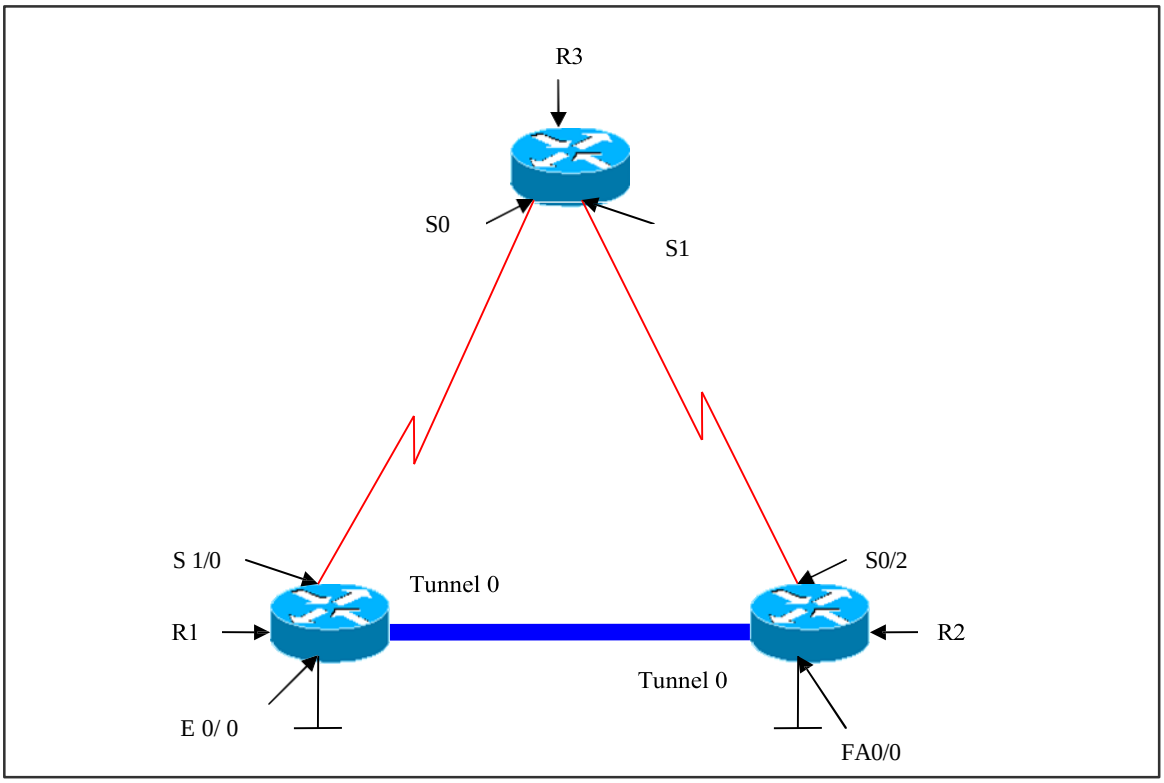
Interface	IP-Address	OK? Method Status	Protocol
Ethernet0/0	10.1.1.1	YES manual up	up
Serial1/0	2.2.2.1	YES manual up	up
Tunnel0	30.1.1.1	YES manual up	up

The output displays int tunnel 0 status is up and protocol status is also up, which indicates that GRE tunnel configuration is successful.

R1#ping 30.1.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 30.1.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 36/39/44 ms

Lab 5 – GRE Tunneling Using Three Routers With no Routing in the Middle Router



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 1/0	2.2.2.1	255.0.0.0
E 0/0	10.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
S 1	3.3.3.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0/2	3.3.3.2	255.0.0.0

Fa 0/0	20.1.1.1	255.0.0.0

Lab Objective:

Task

Create interface tunnel 0 on R1 & R2.
Verify connectivity.
Configure OSPF routing protocol on R1 & R2 only.
Verify if routes are visible in the routing table of R1 & R2.

R1	R2
Ip route 3.0.0.0 255.0.0.0 2.2.2.2 Int tunnel 0 Ip address 30.1.1.1 255.0.0.0 Tunnel source s1/0 Tunnel destination 3.3.3.2 Tunnel mode gre ip	Ip route 2.0.0.0 255.0.0.0 3.3.3.1 Int tunnel 0 Ip address 30.1.1.2 255.0.0.0 Tunnel source s0/2 Tunnel destination 2.2.2.1 Tunnel mode gre ip

Verification:

R1#show ip int brief

Interface	IP-Address	OK?	Method	Status	Protocol
Ethernet0/0	10.1.1.1	YES	manual	up	up
Serial1/0	2.2.2.1	YES	manual	up	up
Tunnel0	30.1.1.1	YES	manual	up	up

The output displays tunnel 0 is up

Task

Configure OSPF routing protocol on R1 & R2 only.
Verify if routes are visible in the routing table of R1 & R2.

R1	R2
Router ospf 1 Network 10.0.0.0 0.255.255.255 area 0 Network 30.0.0.0 0.255.255.255 area 0	Router ospf 1 Network 20.0.0.0 0.255.255.255 area 0 Network 30.0.0.0 0.255.255.255 area 0

Verification:

R1#show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
30.1.1.2	0	FULL/ -	00:00:37	30.1.1.2	Tunnel0

The output displays tunnel ip address (30.1.1.2) as the neighbor-id

R1#show ip route

C 2.0.0.0/8 is directly connected, Serial1/0
S 3.0.0.0/8 [1/0] via 2.2.2.2
O 20.0.0.0/8 [110/11112] via 30.1.1.2, 00:15:35, Tunnel0
C 10.0.0.0/8 is directly connected, Ethernet0/0
C 30.0.0.0/8 is directly connected, Tunnel0

The output displays 'O' (OSPF) route for network 20.0.0.0 carrying via the tunnel IP address (30.1.1.2)
This indicates that routes are traveling via the gre tunnel.
Though, there is another router in between R1 & R2, the tunnel appears as a point-to-point link.
R1#traceroute 20.1.1.1

Type escape sequence to abort.
Tracing the route to 20.1.1.1

1 30.1.1.2 40 msec 40 msec *

The output displays the trace as 1 hop because of the gre tunnel.

Lab 6 – Configuring GRE Over IPSEC

(Scenario Based On Lab 5)

Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
S 1/0	2.2.2.1	255.0.0.0
E 0/0	10.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
S 0	2.2.2.2	255.0.0.0
S 1	3.3.3.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
S 0/2	3.3.3.2	255.0.0.0
Fa 0/0	20.1.1.1	255.0.0.0

Lab Objective:

Task

Create interface tunnel 0 on R1 and R2
Verify connectivity
Configure OSPF on R1 & R2 only.
Verify if the routes are traveling via the tunnel.

R1	R2
Ip route 3.0.0.0 255.0.0.0 2.2.2.2 Int tunnel 0 Ip address 30.1.1.1 255.0.0.0 Tunnel source s1/0 Tunnel destination 3.3.3.2 Tunnel mode gre ip	Ip route 2.0.0.0 255.0.0.0 3.3.3.1 Int tunnel 0 Ip address 30.1.1.2 255.0.0.0 Tunnel source s0/2 Tunnel destination 2.2.2.1 Tunnel mode gre ip

Router ospf 1 Network 10.0.0.0 0.255.255.255 area 0 Network 30.0.0.0 0.255.255.255 area 0	Router ospf 1 Network 20.0.0.0 0.255.255.255 area 0 Network 30.0.0.0 0.255.255.255 area 0

Task

Configure IPSec from R1 to R2 on the GRE tunnel.

R1	R2
Crypto isakmp enable	Crypto isakmp enable
Crypto isakmp policy 10 Encryption 3des Hash md5 Authentication pre-share Group1	Crypto isakmp policy 20 Encryption 3des Hash md5 Authentication pre-share Group1
Crypto isakmp key cisco123 address 3.3.3.2	Crypto isakmp key cisco123 address 2.2.2.1
Crypto ipsec transform-set set1 esp-des	Crypto ipsec transform-set set1 esp-des
Access-list 101 permit ip 10.0.0.0 0.255.255.255 20.0.0.0 0.255.255.255	Access-list 101 permit ip 20.0.0.0 0.255.255.255 10.0.0.0 0.255.255.255
Crypto map map1 10 ipsec-isakmp Set peer 3.3.3.2 Set transform-set set1 Match address 101	Crypto map map1 10 ipsec-isakmp Set peer 2.2.2.1 Set transform-set set1 Match address 101
Int s1/0 Crypto map map1	Int s0/2 Crypto map map1
Int tunnel 0 Crypto map map1	Int tunnel 0 Crypto map map1

Verification:

R1#show crypto isakmp sa

dst	src	state	conn-id	slot
3.3.3.2	2.2.2.1	QM_IDLE	1	0

The output displays the current IKE session and QM_IDLE indicates that the IKE is active.

R1#show crypto ipsec sa

```
interface: Serial1/0
    Crypto map tag: map1, local addr. 2.2.2.1
   protected vrf:
   local  ident (addr/mask/prot/port): (10.0.0.0/255.0.0.0/0/0)
   remote ident (addr/mask/prot/port): (20.0.0.0/255.0.0.0/0/0)
   current_peer: 3.3.3.2:500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 99, #pkts encrypt: 99, #pkts digest 0
    #pkts decaps: 99, #pkts decrypt: 99, #pkts verify 0
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 1, #recv errors 0
----output omitted----

interface: Tunnel0
    Crypto map tag: map1, local addr. 2.2.2.1
    protected vrf:
   local  ident (addr/mask/prot/port): (10.0.0.0/255.0.0.0/0/0)
   remote ident (addr/mask/prot/port): (20.0.0.0/255.0.0.0/0/0)
   current_peer: 3.3.3.2:500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 99, #pkts encrypt: 99, #pkts digest 0
    #pkts decaps: 99, #pkts decrypt: 99, #pkts verify 0
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 1, #recv errors 0
----output omitted----
```

The output displays current settings used by current SA's. Non-zero encryption and decryption statistics can indicate a working set of IPSec SA's.

Lab 7 – Configuring GRE Over IPSEC Site-to-Site Tunnel Using SDM

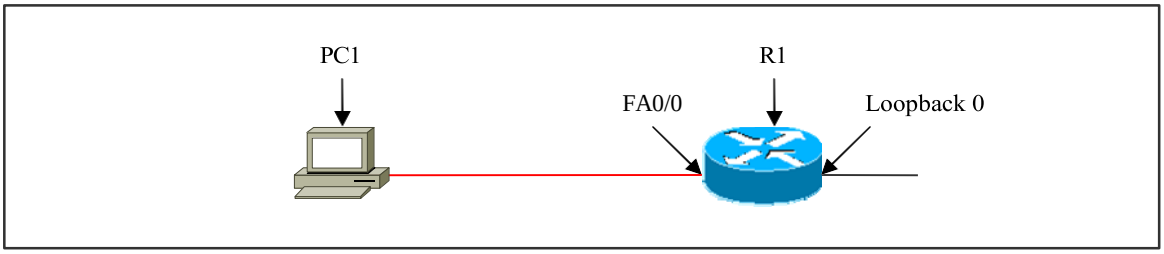
Configure GRE over IPSec side-to-side tunnel using SDM

- Click configure icon to enter configuration page.
- Click VPN icon.
- Choose site-to-site VPN wizard
- Click create site-to-site VPN tab.
- Click create secure GRE tunnel (GRE over IPSec) radio button.
- Click launch the selected task.

GRE tunnel information

- Specify GRE tunnel source IP address and destination IP address.
- Define the IP address & subnet mask that are applied to virtual point-to-point link.
- Click next
- Optionally w can create second GRE tunnel and click next.
- IPSec – specific parameters :
  -Click preshared keys authentication method radio button.
  -Specify preshared key and click next
- IKE proposals
  -Click add button and create custom IKE policy & click next.
- Transform-set
  -Click add button and specify parameters and click next.
- Select the routing protocol
  -Select OSPF routing protocol radio button.
  -Define router OSPF process ID & area number for tunnel.
  -Define one or more local subnets to be advertised to OSPF neighbors.
- At the end, the wizard will present a summary of the configured parameters and click finish to complete the configuration.
- Verification
  -Click test tunnel button and also click monitor icon to display the status of the tunnel.

Lab 8 – Configure Cisco VPN Client (Remote Access VPN)



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
Loopback 0	100.100.100.100	255.255.255.0
Fa 0/0	20.1.1.1	255.0.0.0
PC 1	20.1.1.20	255.0.0.0

Lab Objective:

Task

Configure R1 with the VPN server configuration.
Install Cisco VPN client software on the PC.
Create a loopback 0 (100.100.100.100) and try sending traffic to this address from the PC and verify if the VPN tunnel is established or not.

R1

```
aaa new-model
aaa authentication login list1 local
aaa authorization network list2 local

Username user1 password user1

Crypto isakmp policy 10
Encryption 3des
Hash md5
```

```
Authentication pre-share
Group 2

IP local pool p1 30.1.1.1 30.1.1.100

Crypto isakmp client cocnfiguration group group1
Key cisco123
Pool p1

crypto ipsec transform-set set1 esp-3des esp-md5-hmac


Crypto dynamic-map dmap1 10
Set transform-set set1
Reverse-route

Crypto map map1 10 ipsec-isakmp dynamic map1
Crypto map map1 client configuration address respond
Crypto map map1 client authentication list list1
Crypto map map1 isakmp authorization list list2

Int fa0/0
Crypto map map1

Int loopback 0
IP address 100.100.100.100 255.0.0.0
```

PC client S/W installation :

- Install a Cisco VPN client on the remote user PC.
- Start → programs → Cisco systems VPN client → click VPN client.
- VPN client application starts.
- Click the "new" icon in the toolbar.
- Enter a name for the new connection enter field.
- Enter description of this connection in the description field.
- Enter the hostname or IP address of the remote VPN device (server) (20.1.1.1) that we want to access.
- Under the authentication tab, select the group authentication radio button.
- In the name field, enter the name of the IPSec group (group1) to which you belong.
- In the password field, enter the password (cisco123) for IPSec group.
- Verify password in the confirm password field.
- Save the connection entery by clicking the save button.

- Before we connect to the server from the client, send traffic trough the path where tunnel is established
  -Therefore, ping from PC (20.1.1.20) to loopback 0 (100.100.100.100)
  -PC > ping 100.100.100.100 –t (the output display that reply received frm the address 100.100.100.100).
  -Verify by clicking connect on the VPN client application. The VPN client window prompts for username and password
  -In the user name field enter username (user1)
  -In the password field enter password (user1)
  -As soon as you enter the above details the connection is established.

Verification:

R1#show crypto isakmp sa

dst	src	state	conn-id	slot
20.1.1.1	20.1.1.20	QM_IDLE	2	0

The output displays quick mode state and a connection id that indicates that tunnel is established

R1#show crypto ipsec sa

```
interface: FastEthernet0/0
    Crypto map tag: map1, local addr. 20.1.1.1

   protected vrf:
   local  ident (addr/mask/prot/port): (0.0.0.0/0.0.0.0/0/0)
   remote ident (addr/mask/prot/port): (30.1.1.1/255.255.255.255/0/0)
   current_peer: 20.1.1.20:500
     PERMIT, flags={}
    #pkts encaps: 110, #pkts encrypt: 110, #pkts digest 110
    #pkts decaps: 153, #pkts decrypt: 153, #pkts verify 153
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
```

The output displays that packets passing the tunnel are encrypted and also decrypted. This indicates the tunnel created is secure, thus giving access to the remote clients to the server on the internet securely.

Lab 9 – Configure Cisco Easy VPN

(Scenario Based On Lab 8)

Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
Loopback 0	100.100.100.100	255.255.255.0
Fa 0/0	20.1.1.1	255.0.0.0

Lab Objective:

Task

Configure R1 as easy VPN server.
Do not cofigure authentication and username and password.
Create loopback address to send traffic from the client PC to verify the tunnel.

R1

```
aaa new-model
aaa authorization network list2 local

Crypto isakmp policy 10
Encryption 3des
Hash md5
Authentication pre-share
Group 2

IP local pool p1 30.1.1.1 30.1.1.100

Crypto isakmp client cocnfiguration group group1
Key cisco123
Pool p1

crypto ipsec transform-set set1 esp-3des esp-md5-hmac


Crypto dynamic-map dmap1 10
Set transform-set set1
```

Reverse-route

Crypto map map1 10 ipsec-isakmp dynamic map1
Crypto map map1 client configuration address respond
Crypto map map1 isakmp authorization list list2

Int fa0/0
Crypto map map1

Int loopback 0
IP address 100.100.100.100 255.0.0.0

PC : Easy VPN client

- Install a Cisco VPN client on the PC.
- Start → programs → Cisco systems VPN client → click VPN client.
- VPN client application starts.
- Click the "new" icon in the toolbar.
- Enter name and description for the connection entry.
- Enter the hostname or IP address of the server.
- Under the authentication tab : enter the name of the IPSec group (group1) and password for the group (cisco123).
- Save the connection entry
  -Before we connect to the server from the client PC, send traffic through the path where tunnel is established.
  -Therefore, ping from PC (20.1.1.20) to loopback 0 (100.100.100.100)
  -PC > ping 100.100.100.100 –t
    - The output displays that replies are received from the address
- Verify by clicking connect on the application. It does not ask for username or password.

Verification :

R1#show crypto isakmp sa

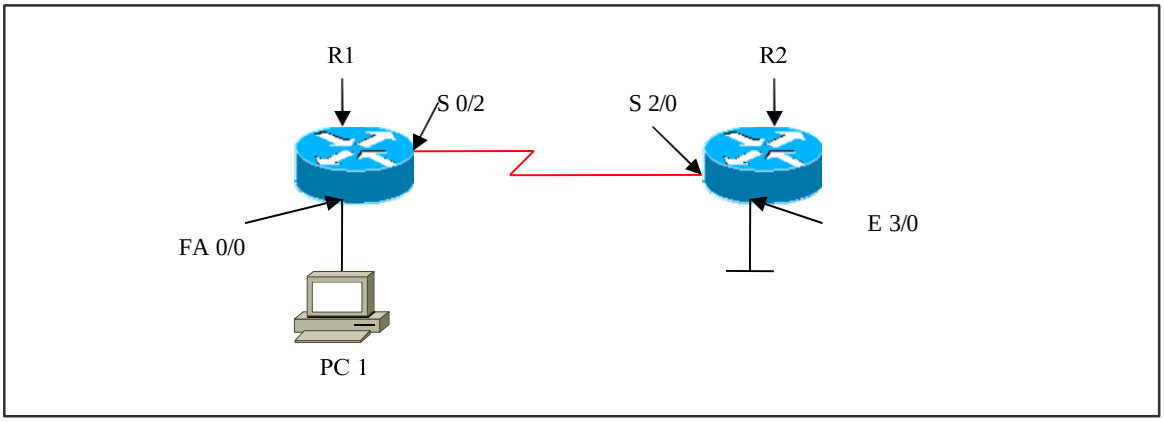
dst	src	state	conn-id	slot
20.1.1.1	20.1.1.20	QM_IDLE	2	0

The output displays quick mode state and a connection id that indicates that tunnel is established

```
R1#show crypto ipsec sa

interface: FastEthernet0/0
    Crypto map tag: map1, local addr. 20.1.1.1

   protected vrf:
   local  ident (addr/mask/prot/port): (0.0.0.0/0.0.0.0/0/0)
   remote ident (addr/mask/prot/port): (30.1.1.1/255.255.255.255/0/0)
   current_peer: 20.1.1.20:500
     PERMIT, flags={}
     #pkts encaps: 110, #pkts encrypt: 110, #pkts digest 110
     #pkts decaps: 153, #pkts decrypt: 153, #pkts verify 153
     #pkts compressed: 0, #pkts decompressed: 0
     #pkts not compressed: 0, #pkts compr. failed: 0
     #pkts not decompressed: 0, #pkts decompress failed: 0
     #send errors 0, #recv errors 0
```

The output displays that packets passing the tunnel are encrypted and also decrypted. This indicates the tunnel created is secure, thus giving access to the remote clients to the server on the internet securely.

Lab 10 – Configure Easy-VPN Server and Client as Router



Interface IP Address Configuration

R2

Interface	IP Address	Subnet Mask
S 2/0	1.1.1.2	255.0.0.0
E 3/0	20.1.1.1	255.0.0.0

R1

Interface	IP Address	Subnet Mask
S 0/2	1.1.1.1	255.0.0.0
Fa 0/0	10.1.1.1	255.0.0.0
PC 1	10.1.1.20	255.0.0.0

Lab Objective:

Task

Configure the client in network-extension mode.
Create reverse-route on the server and a static route in client to reach server.
Do not telnet until the VPN tunnel is established.

R2

```
aaa new-model
aaa authentication login xyz none
```

```
aaa authorization network lauthor local

Crypto isakmp policy 10
Encryption 3des
Hash md5
Authentication pre-share
Group 2

IP local pool p1 30.1.1.1 30.1.1.100

Crypto isakmp client cocnfiguration group group1
Key cisco123
Pool p1

crypto ipsec transform-set set1 esp-3des esp-md5-hmac


Crypto dynamic-map dmap1 10
Set transform-set set1
Reverse-route

Crypto map map1 10 ipsec-isakmp dynamic map1
Crypto map map1 client configuration address respond
Crypto map map1 isakmp authorization list lauthor

Line vty 0 4
Login authentication xyz

Int s2/0
Crypto map map1
```

```
R1

Crypto ipsec client ezvpn vpn1
Group group1 key cisco123
Peer 1.1.1.2
Connect auto
Mode network-extension

Int fa0/0
Crypto ipsec client ezvpn vpn1 inside
```

```
Int s0/2
Crypto ipsec client ezvpn vpn1 outside

Ip route 20.0.0.0 255.0.0.0 1.1.1.2
```

Verification :

R2#show crypto isakmp sa

dst	src	state	conn-id	slot
1.1.1.2	1.1.1.1	QM_IDLE	1	0

The output displays a connection-id and quick mode state denoting SA is created

R2#show crypto ipsec sa

```
interface: Serial2/0
    Crypto map tag: map1, local addr. 1.1.1.2

  protected vrf:
  local  ident (addr/mask/prot/port): (0.0.0.0/0.0.0.0/0/0)
  remote ident (addr/mask/prot/port): (10.0.0.0/255.0.0.0/0/0)
  current_peer: 1.1.1.1:500
    PERMIT, flags={}
    #pkts encaps: 50, #pkts encrypt: 50, #pkts digest 50
    #pkts decaps: 51, #pkts decrypt: 51, #pkts verify 51
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0
```

The output displays packets being encrypted and decrypted.

R1#show crypto ipsec client ezvpn

```
Easy VPN Remote Phase: 2

Tunnel name : vpn1
Inside interface list: FastEthernet0/0,
Outside interface: Serial0/2
Current State: IPSEC_ACTIVE
Last Event: SOCKET_UP
```

The output displays current state for IPSec as active that indicates the tunnel is established.

If mode client configured on the client side, the client does nat translations.

R1#show ip nat translations

Pro	Inside global	Inside local	Outside local	Outside global
icmp	30.1.1.1:512	20.1.1.20:512	10.1.1.1:512	10.1.1.1:512

The output displays the client doing nat translations. This happens only if the client is configured in 'client mode'.

R2#show ip route

Gateway of last resort is not set

C 1.0.0.0/8 is directly connected, Serial2/0
C 10.0.0.0/8 is directly connected, Ethernet3/0
30.0.0.0/32 is subnetted, 1 subnets
S 30.1.1.1 [1/0] via 1.1.1.2

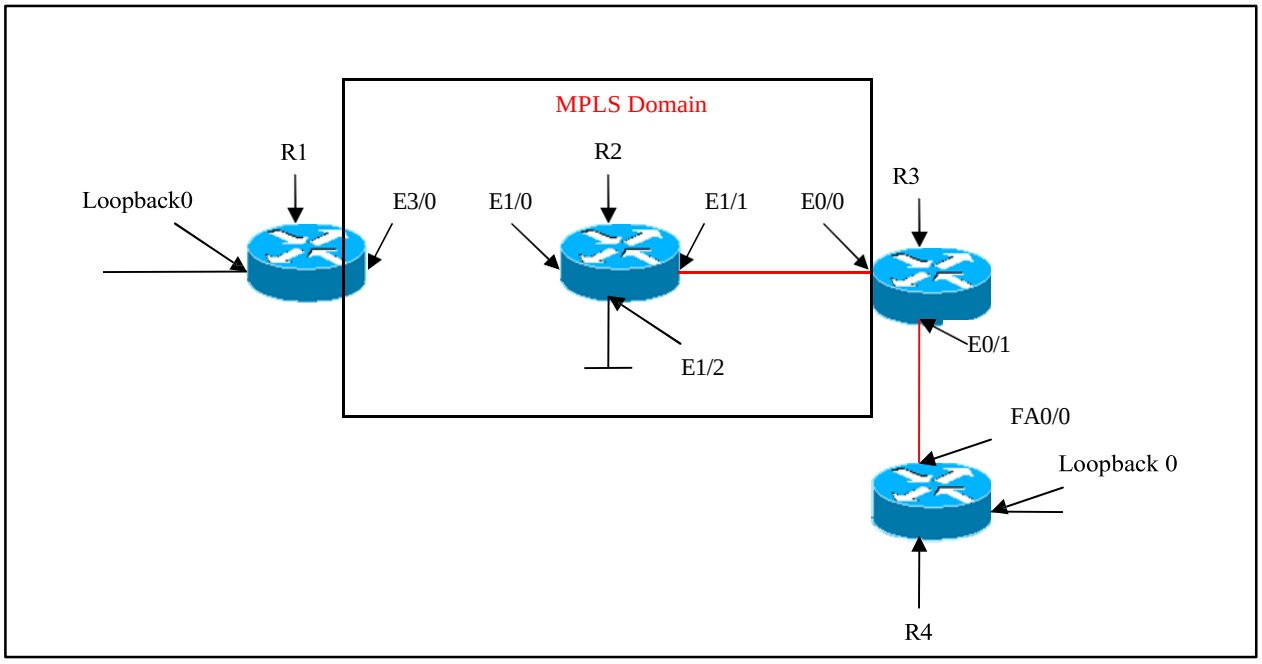
The static route for 30.0.0.0 network is automatically created because of the reverse-route configured in the server.

R2#show ip local pool

Pool	Begin	End	Free	In use
p1	30.1.1.1	30.1.1.100	100	1

The output shows the ip address in the pool.

Lab 11– Configure Frame Mode MPLS



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
E 3/0	1.1.1.1	255.0.0.0
Loopback 0	10.1.1.1	255.0.0.0

R2

Interface	IP Address	Subnet Mask
E 1/0	1.1.1.2	255.0.0.0
E 1/1	2.2.2.1	255.0.0.0
E 1/2	20.1.1.1	255.0.0.0

R3

Interface	IP Address	Subnet Mask
E 0/0	2.2.2.2	255.0.0.0
E 0/1	3.3.3.1	255.0.0.0

R4

Interface	IP Address	Subnet Mask
FA 0/0	3.3.3.2	255.0.0.0
Loopback 0	30.1.1.1	255.0.0.0

Lab Objective:

Task

Configure OSPF in Area 0 in the MPLS domain as per the scenario and EIGRP AS 200 on R1 (Loopback 0) and EIGRP AS 100 on R3 (E0/1), R4 (FA0/0, Loopback 0).
Mutually redistribute these two routing protocols.
Configure MPLS on R1 (E 3/0), R2 (E1/0, E1/1, E 1/2) and R3 (E0/0).
Enable CEF on routers configured in MPLS domain.

R1 Ip cef Interface e3/0 Mpls ip Mpls label protocol ldp Mpls mtu 1512	R3 Ip cef Interface e0/0 Mpls ip Mpls label protocol ldp Mpls mtu 1512
R2 Ip cef Interface e1/0 Mpls ip Mpls label protocol ldp Mpls mtu 1512 Interface e1/1 Mpls ip Mpls label protocol ldp Mpls mtu 1512 Interface e1/2 Mpls ip	

```
Mpls label protocol ldp
Mpls mtu 1512
```

Verification :

R1#show mpls ldp neighbor

```
    Peer LDP Ident: 20.1.1.1:0; Local LDP Ident 10.1.1.1:0
        TCP connection: 20.1.1.1.11043 - 10.1.1.1.646
        State: Oper; Msgs sent/rcvd: 99/99; Downstream
        Up time: 01:18:58
        LDP discovery sources:
          Ethernet3/0, Src IP addr: 1.1.1.2
        Addresses bound to peer LDP Ident:
          1.1.1.2         2.2.2.1         20.1.1.1
```

The output displays the neighbor for R1.

R1#show mpls forwarding-table

Local tag	Outgoing tag or VC	Prefix or Tunnel Id	Bytes tag switched	Outgoing interface	Next Hop
16	Pop tag	2.0.0.0/8	0	Et3/0	1.1.1.2
17	Pop tag	20.0.0.0/8	0	Et3/0	1.1.1.2
18	16	3.0.0.0/8	0	Et3/0	1.1.1.2
19	18	30.0.0.0/8	0	Et3/0	1.1.1.2

The output displays the local tags attached to the router, outgoing tags and the outgoing interface.

R1#show mpls ldp bindings

```
 tib entry: 1.0 0.0/8, rev 2
        local binding:  tag: imp-null
        remote binding: tsr: 20.1.1.1:0, tag: imp-null
  tib entry: 2.0 0.0/8, rev 6
        local binding:  tag: 16
        remote binding: tsr: 20.1.1.1:0, tag: imp-null
  tib entry: 3.0 0.0/8, rev 10
        local binding:  tag: 18
        remote binding: tsr: 20.1 1.1:0, tag: 16
  tib entry: 10.0 0.0/8, rev 4
        local binding:  tag: imp-null
        remote binding: tsr: 20.1 1.1:0, tag: 17
  tib entry: 20.0 0.0/8, rev 8
        local binding:  tag: 17
        remote binding: tsr: 20.1.1.1:0, tag: imp-null
```

```
 tib entry: 30.0.0.0/8, rev 12
      local binding:  tag: 19
      remote binding: tsr: 20.1.1.1:0, tag: 18
```

The output displays local bindings of the tag to the router and also the remote bindings of the same tag by its neighbor.

```
R2#sh mpls interfaces
Interface              IP         Tunnel   Operational
Ethernet1/0            Yes (ldp)  No       Yes
Ethernet1/1            Yes (ldp)  No       Yes
Ethernet1/2            Yes (ldp)  No       Yes
```

The output displays the MPLS configured interfaces on the router.

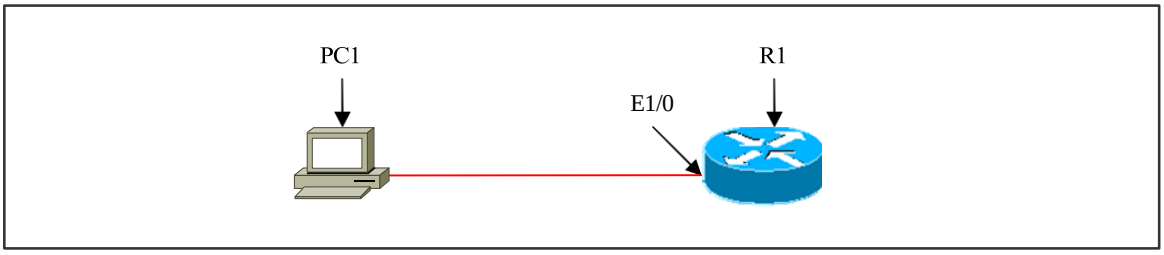
```
R2#sh mpls label range
Downstream Generic label region: Min/Max label: 16/100000
```

The output displays the range for the labels from 16, as 1 -15 are reserved.

```
R2#show ip cef
Prefix              Next Hop            Interface
0.0.0.0/0           drop                Null0 (default route handler entry)
0.0.0.0/32          receive
1.0.0.0/8           attached            Ethernet1/0
1.0.0.0/32          receive
1.1.1.1/32          1.1.1.1             Ethernet1/0
1.1.1.2/32          receive
1.255.255.255/32    receive
2.0.0.0/8           attached            Ethernet1/1
2.0.0.0/32          receive
2.2.2.1/32          receive
2.2.2.2/32          2.2.2.2             Ethernet1/1
2.255.255.255/32    receive
3.0.0.0/8           2.2.2.2             Ethernet1/1
10.0.0.0/8          1.1.1.1             Ethernet1/0
20.0.0.0/8          attached            Ethernet1/2
20.0.0.0/32         receive
20.1.1.1/32         receive
20.255.255.255/32   receive
30.0.0.0/8          2.2.2.2             Ethernet1/1
224.0.0.0/4         drop
224.0.0.0/24        receive
255.255.255.255/32  receive
```

The output displays the summary of the FIB table.

Lab 12 – Configure an SSH Server for Secure Management and Reporting



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
E 1/0	10.1.1.1	255.0.0.0

Lab Objective:

Task

Configure R1 as SSH server.
Install SSH client software on the PC.

R1

```
Username user1 password user1
Enable secret Cisco
aaa new-model
aaa authentication login lauth local
Ip domain-name netmetrics
Crypto key generate rsa 512

Line vty 0 4
Login authentication lauth
Transport input ssh

Ip ssh time-out 120
Ip ssh authentication-retries 3
```

Next step is install putty software, i.e. it is a third party tool to log into the router.

-Click run and install on the PC.
-Putty configuration window opens: → click session → the window prompts for basic options for your putty session.
-Specify the destination you want to connect to : -

- Hostname (or IP address) : 10.1.1.1
- Port : 22

-Connection type – select the radio button for SSH.
-Click open → software window prompts for username & password.
-When all details are specified, you get access to the router.

Verification :

R-1(config) #do show crypto key mypubkey rsa

% Key pair was generated at: 00:21:16 UTC JUL 7 2007
Key name: R-1.netmetrics
Usage: General Purpose Key
Key is not exportable.
Key Data:
305C300D 06092A86 4886F70D 01010105 00034B00 30480241 00B2E7D3 1328D75A
EF058A59 E6A4D4A1 44015A01 10A0B0B9 6B286D32 B889182C 5DFDAC8F 1B289436
D08768DD D9B0D192 24B94D14 5D0F077E 478AD8EB 6026D789 FB020301 0001
% Key pair was generated at: 00:21:19 UTC JUL 7 2007
Key name: R-1.netmetrics.server
Usage: Encryption Key
Key is exportable.
Key Data:
307C300D 06092A86 4886F70D 01010105 00036B00 30680261 00D11809 646CA0C6
10B53FF6 1C372194 ABBC2720 8BFCFB5F 95B7BF71 0BD4B5DF B11BFB66 E9A4BC92
1A835176 79F97BF8 4A59E21F 5A0DD904 67D9184F F513FFC5 9E279965 9EF0483D
51242BDC 2DA4F53C 00105C2C 0389F9E1 1994DB91 3EEC6BE2 AD020301 0001

The output displays the generated key.

From PC1:

```
C:\Documents and Settings>telnet 10.1.1.1
Connecting To 10.1.1.1...Could not open connection to the host, on port 23: Conn
ect failed
```

If user wants to telnet to the router, access is denied as it is configured as SSH .

```
R-1#show users

    Line       User       Host(s)          Idle          Location
*  0 con 0                 idle             00:00:00
 130 vty 0     user1      idle             00:00:21       10.1.1.2
```

The output displays the user (10.1.1.2) via SSH.

Lab 13 – Configure Syslog Logging

(Scenario Based On Lab 12)
Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
E 1/0	10.1.1.1	255.0.0.0
PC 1	10.1.1.2	255.0.0.0

PC 1

IP Address	Subnet Mask
10.1.1.2	255.0.0.0

Lab Objective:

Task

Configure R1 to send log messages to the Syslog srever.
Install Syslog server software on the PC.

R1

Logging on
Logging host 10.1.1.2
Logging trap debugging

PC 1: -

Install kiwi syslog Daemon 8.2.18 installation on PC1.
Click run → agree the license agreement → select install kiwi syslog Daemon as an application → click next → click install → select the checkbox "run kiwi syslog Daemon 8.2.18 and finally click finish.

Verification:

Logged Messages.

Date	Time	Priority	Hostname	Message
07-07-2007	15:37:58	Local7.Debug	10.1.1.1	213: ACK 53359694 WIN 64996
07-07-2007	15:37:58	Local7.Debug	10.1.1.1	212: *July 1 01:07:43.859: tcp130: I ESTAB 10.1.1.4:1041 10.1.1.1:22 seq 2008571168
07-07-2007	15:37:57	Local7.Debug	10.1.1.1	211: DATA 20 ACK 2008571168 PSH WIN 3673
07-07-2007	15:37:57	Local7.Debug	10.1.1.1	210: *July 1 01:07:43.859: tcp130: O ESTAB 10.1.1.4:22 10.1.1.1:1041 seq 53359674
07-07-2007	15:37:57	Local7.Debug	10.1.1.1	209: DATA 20 ACK 2008571168 PSH WIN 3673
07-07-2007	15:37:57	Local7.Debug	10.1.1.1	208: *July 1 01:07:43.823: tcp130: O ESTAB 10.1.1.4:22 10.1.1.1:1041 seq 53359654
07-07-2007	15:37:57	Local7.Debug	10.1.1.1	207: DATA 20 ACK 53359654 PSH WIN 65036

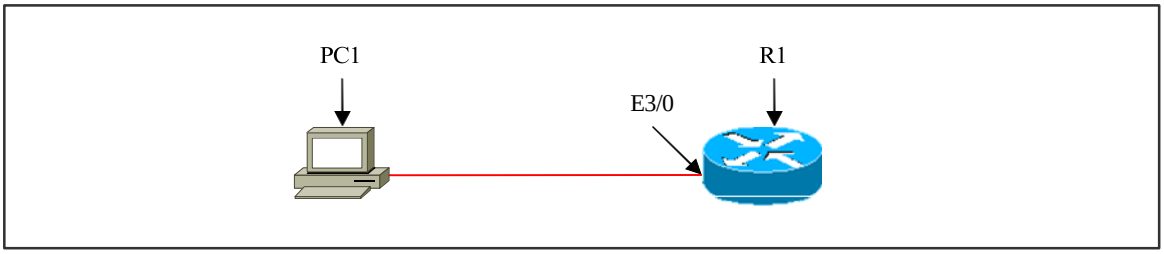
The output displays the logged messages in the Syslog server. Any configuration made via console is logged onto the syslog server. Any unauthorized access, can also be logged and viewed on the syslog server.

R-1#show logging

Syslog logging: enabled (0 messages dropped, 2 messages rate-limited, 0 flushes,
0 overruns, xml disabled)
Console logging: level debugging, 215 messages logged, xml disabled
Monitor logging: level debugging, 0 messages logged, xml disabled
Buffer logging: disabled, xml disabled
Logging Exception size (4096 bytes)
Count and timestamp logging messages: disabled
Trap logging: level debugging, 222 message lines logged
Logging to 10.1.1.2, 123 message lines logged, xml disabled

The output displays that the syslog logging is enabled , ip address of the syslog server and the number of messages logged.

Lab 14 – Configure SNMP



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
E 3/0	50.1.1.1	255.0.0.0

PC 1

IP Address	Subnet Mask
50.1.1.2	255.0.0.0

Lab Objective:

Task

Configure SNMP server.
Install network management tool (solar winds.net) on the PC.

R1

Access-list 10 permit 50.1.1.2
Access-list 10 deny any any
Snmp-server community public ro 10
Snmp-server communit private rw 10

PC 1 :

-When you install solar winds.net network management tool on the pc, an IP network browser is also installed.
-Double click IP network browser → SNMP tool opens :

-Enter hostname/ IP address: 50.1.1.1.
-Click scan device.
-The tool scans for the device with the IP address.
-You can see R1 with the IP address 50.1.1.1 and all the options and complete detailed information about the router.
-As SNMP is a network management tool, you can download the running configuration or startup-configuration:

-Click node → click tools → click view cisco config.

-Prompts for router/switch:

-Enter IP address of router (50.1.1.1)

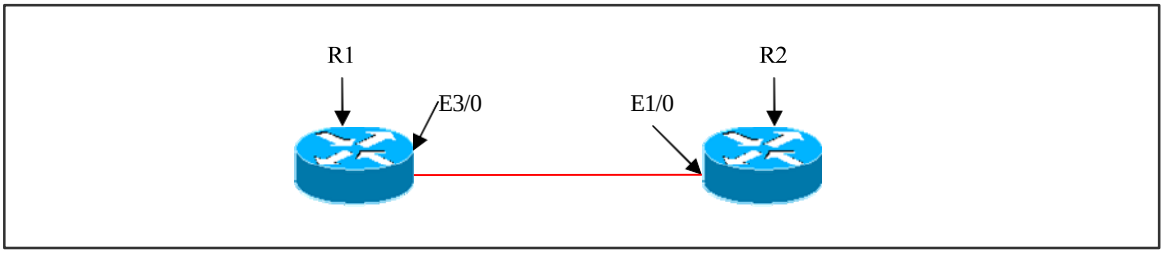
-Enter community string

-Select private as it is in read-write feature.
-Click downloads.
-Prompts for type of configuration file:

-Click either running-config or startup-config accordingly

-Click ok.
-The tool copies the file using cisco-config-MIB, from R1 to PC1 through the SNMP tool.

Lab 15 – Configuring NTP



Interface IP Address Configuration

R1 (MASTER)

Interface	IP Address	Subnet Mask
E 3/0	10.1.1.1	255.0.0.0

R2 (CLIENT)

Interface	IP Address	Subnet Mask
E 1/0	10.1.1.2	255.0.0.0

Lab Objective:

Task

Set the clock to local current time on the master router (R1).
Configure R1 as NTP master and R2 as NTP client.

R1	R2
Clock set 16:10:30 07 July 2007 Clock timezone India +5 Ntp master 5 Ntp authentication-key 1 md5 cisco123 Ntp peer 10.1.1.2 key 1 Int e3/0 Ntp broadcast	Ntp authentication - key 1 md5 cisco123 Ntp trusted – key 1 Ntp server 10.1.1.1 key 1 Int e1/0 Ntp broadcast client

Verification:

R2#show clock

19:10:28.355 UTC Sat Jul 7 2007

The output displays current time of R2 before NTP configuration.
Manually change the clock and check if the time is synchronizing :

R1#show clock

07:22:08.231 UTC Wed Sep 19 2007

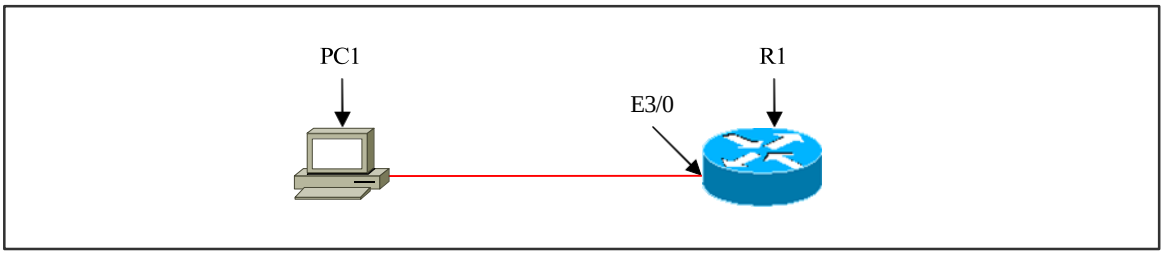
Verify that the clock has synchronized according to the server time :

R2#show clock

07:21:46.775 UTC Wed Sep 19 2007

The output displays that the client has synchronized with the server time.

Lab 16– Configuring AAA on Cisco Routers



Interface IP Address Configuration

R1

Interface	IP Address	Subnet Mask
E 3/0	10.1.1.1	255.0.0.0

PC 1

IP Address	Subnet Mask
10.1.1.10	255.0.0.0

Lab Objective:

Task

Configure the AAA server on R1.
Configure AAA login authentication.
Install Cisco secure ACS 4.0 version on PC 1 and create users1 user2 and user3

R1

```
aaa new-model
Tacacs-server host 10.1.1.10 single-connection
Tacacs-server key cisco123
aaa authentication login default group tacacs+ local
aaa authentication login lauth group tacacs+
username user1 password user1

Line vty 0 4
Login authentication lauth
```

When the tool is installed on PC 1, it prompts for passwords, specify the same password configured as the tacacs-server key on the router (cisco123).
Follow the steps in configuring users and other parameters :
User setup
Add user → username : user 1 & password : user 1
User account is created for user1 and click submit
Click list all users.
-The output displays all the users and their status
Network configuration
Add AAA client
Client : Router
AAA client
IP address : 10.1.1.1
Key : Cisco123
Authenticate using : TACACS+
Click submit + apply button to save the entry
Add AAA server
Server : PC
AAA server
IP add : 10.1.1.10
Key : cisco123
AAA server type : TACACS+
Traffic type : inbound / outbound
Click submit + apply

Verification :

Telnet from PC 1 (10.1.1.10) to router R1:
The router prompts for username and password:
Specify the username and password created on the TACACS+
Server.
Authentication is approved and gains access to R1.

R1 # debug aaa authentication
Jul 7 20:29:49.139: AAA: parse name=tty0 idb type=-1 tty=-1
*Jul 7 20:29:49.139: AAA: name=tty0 flags=0x11 type=4 shelf=0 slot=0 adapter=0 port=0 channel=0
*Jul 7 20:29:49.139: AAA/MEMORY: create_user (0x65477DC0) user='raduser1' ruser ='NULL' ds0=0 port='tty0' rem_addr='async' authen_type=ASCII service=ENABLE priv =15 initial_task_id='0', vrf= (id=0)
*Jul 7 20:29:49.139: AAA/AUTHEN/START (2180557774): port='tty0' list='' action= LOGIN service=ENABLE
*Jul 7 20:29:49.143: AAA/AUTHEN/START (2180557774): console enable - default to enable password (if any)
*Jul 7 20:29:49.143: AAA/AUTHEN/START (2180557774): Method=ENABLE

*Jul 7 20:29:49.143: AAA/AUTHEN(2180557774): can't find any passwords
*Jul 7 20:29:49.143: AAA/AUTHEN(2180557774): Status=ERROR
*Jul 7 20:29:49.143: AAA/AUTHEN/START (2180557774): Method=NONE
*Jul 7 20:29:49.143: AAA/AUTHEN(2180557774): Status=PASS
The output displays the status PASS indicates successful authentication.

Task 2
(Scenario Based On Task 1)
Configure the AAA server on R1.
Configure AAA login authentication.
Install Cisco secure ACS 4.0 version on PC 1 and create users1 user2 and user3

R1

aaa new-model
Radius-server host 10.1.1.10
Radius-server key cisco123
aaa authentication login r1 group radius local
aaa authentication login default local group radius

Line vty 0 4
Login authentication r1

Install the Cisco Secure ACS on the PC and complete the parameters.
User setup
Add user → username : user 2 & password : user 2
username : user 3 & password : user 3
password authentication → specify ACS Internal Database
User account is created for user 2, user 3 and click submit
Click list all users.
-The output displays all the users and their status
Network Management :-
Add AAA client
Client : Router
AAA client
IP address : 10.1.1.1
Key : Cisco123
Authenticate using : RADIUS (Cisco IOS)
Click submit + apply button to save the entry
Add AAA server
Server : PC
AAA server
IP add : 10.1.1.10
Key : cisco123

AAA server type : RADIUS
Traffic type : inbound / outbound
Click submit + apply

Verification:

Telnet from PC 1 (10.1.1.10) to router R1:
The router prompts for username and password:
Specify the username and password created on the RADIUS Server.
Authentication is approved and gains access to R1.

Router# debug aaa authentication

*Jul 7 20:12:53.355: AAA: parse name=tty0 idb type=-1 tty=-1
*Jul 7 20:12:53.355: AAA: name=tty0 flags=0x11 type=4 shelf=0 slot=0 adapter=0 port=0 channel=0
*Jul 7 20:12:53.359: AAA/MEMORY: create_user (0x65477DC0) user='raduser1' ruser ='NULL' ds0=0 port='tty0' rem_addr='async' authen_type=ASCII service=ENABLE priv =15 initial_task_id='0', vrf= (id=0)
*Jul 7 20:12:53.359: AAA/AUTHEN/START (1211612866): port='tty0' list='' action= LOGIN service=ENABLE
*Jul 7 20:12:53.359: AAA/AUTHEN/START (1211612866): console enable - default to enable password (if any)
*Jul 7 20:12:53.359: AAA/AUTHEN/START (1211612866): Method=ENABLE
*Jul 7 20:12:53.359: AAA/AUTHEN(1211612866): can't find any passwords
*Jul 7 20:12:53.359: AAA/AUTHEN(1211612866): Status=ERROR
*Jul 7 20:12:53.359: AAA/AUTHEN/START (1211612866): Method=NONE
*Jul 7 20:12:53.359: AAA/AUTHEN(1211612866): Status=PASS

The output displays the status PASS indicates successful authentication.

Lab 17– DISABLING UNUSED CISCO ROUTERS USING NETWORK SERVICES AND INTERFACES

LOCKING DOWN ROUTERS WITH AUTO SECURE:

```
Router#auto secure
        --- AutoSecure Configuration ---

*** AutoSecure configuration enhances the security of
the router, but it will not make it absolutely resistant
to all security attacks ***

AutoSecure will modify the configuration of your device.
All configuration changes will be shown.

At any prompt you may enter '?' for help.
Use ctrl-c to abort this session at any prompt.

Gathering information about the router for AutoSecure

Is this router connected to internet? [no]: y
Enter the number of interfaces facing the internet [1]: 1

Interface        IP-Address   OK?  Method   Status     Protocol
Serial2/0        1.1.1.1      YES  manual     up       down

Ethernet3/0      20.1.1.1     YES manual      up         up

Enter the interface name that is facing the internet: Ethernet3/0

Securing Management plane services...

Disabling service finger
Disabling service pad
Disabling udp & tcp small servers
Enabling service password encryption
Enabling service tcp-keepalives-in
Enabling service tcp-keepalives-out
Disabling the cdp protocol
Disabling the bootp server
Disabling the http server
Disabling the finger service
Disabling source routing
Disabling gratuitous arp
```

Here is a sample Security Banner to be shown
at every access to device. Modify it to suit your
enterprise requirements.

Authorized Access only
  This system is the property of So-&-So-Enterprise.

Enter the security banner {Put the banner between
k and k, where k is any character}:
% This system is the property of Netmetric Solutions.
Please Handle With Care %
Enable secret is either not configured or
 is the same as enable password
Enter the new enable secret: netmetrics
Confirm the enable secret : netmetrics
Enter the new enable password: solutions
Confirm the enable password: solutions

Configuration of local user database
Enter the username: User1
Enter the password: password
Confirm the password: password
Configuring AAA local authentication
Configuring Console, Aux and VTY lines for
local authentication, exec-timeout, and transport
Securing device against Login Attacks
Configure the following parameters

Blocking Period when Login Attack detected: 300

Maximum Login failures with the device: 3

Maximum time period for crossing the failed login attempts: 60

Configuring interface specific AutoSecure services

Disabling the following ip services on all interfaces:

 no ip redirects
 no ip proxy-arp
 no ip unreachables
 no ip directed-broadcast
 no ip mask-reply
Disabling mop on Ethernet interfaces

Securing Forwarding plane services...

Enabling CEF (This might impact the memory requirements for your platform)
Enabling unicast rpf on all interfaces connected
to internet
Tcp intercept feature is used prevent tcp syn attack
on the servers in the network. Create autosec_tcp_intercept_list
to form the list of servers to which the tcp traffic is to
be observed

Enable tcp intercept feature? [yes/no]: y

This is the configuration generated:

```
no service finger
no service pad
no service udp-small-servers
no service tcp-small-servers
service password-encryption
service tcp-keepalives-in
service tcp-keepalives-out
no cdp run
no ip bootp server
no ip http server
no ip finger
no ip source-route
no ip gratuitous-arps
no ip identd
banner motd ^C This system is the property of Netmetric Solutions.
Please Handle With Care ^C
security passwords min-length 6
security authentication failure rate 10 log
enable secret 5 $1$TnMh$9BZLJz5BhTyu9wjqJ9DXF/
enable password 7 105D061510031B040217
username User1 password 7 01030717481C091D25
aaa new-model
aaa authentication login local_auth local
line con 0
 login authentication local_auth
 exec-timeout 5 0
 transport output telnet
line aux 0
 login authentication local_auth
 exec-timeout 10 0
 transport output telnet
```

```
line vty 0 4
 login authentication local_auth
 transport input telnet
login block-for 300 attempts 3 within 60
service timestamps debug datetime msec localtime show-timezone
service timestamps log datetime msec localtime show-timezone
logging facility local2
logging trap debugging
service sequence-numbers
logging console critical
logging buffered
interface Serial2/0
 no ip redirects
 no ip proxy-arp
 no ip unreachables
 no ip directed-broadcast
no ip mask-reply
interface Serial2/1
 no ip redirects
 no ip proxy-arp
 no ip unreachables
 no ip directed-broadcast
no ip mask-reply
interface Serial2/2
 no ip redirects
 no ip proxy-arp
 no ip unreachables
 no ip directed-broadcast
no ip mask-reply
interface Serial2/3
 no ip redirects
 no ip proxy-arp
 no ip unreachables
 no ip directed-broadcast
no ip mask-reply
interface Ethernet3/0
 no ip redirects
 no ip proxy-arp
 no ip unreachables
 no ip directed-broadcast
 no ip mask-reply
 no mop enabled
interface TokenRing3/0
no ip redirects
 no ip proxy-arp
```

```
 no ip unreachables
 no ip directed-broadcast
 no ip mask-reply
ip cef
access-list 100 permit udp any any eq bootpc
interface Ethernet3/0
 ip verify unicast source reachable-via rx allow-default 100
ip tcp intercept list autosec_tcp_intercept_list
ip tcp intercept drop-mode random
ip tcp intercept watch-timeout 15
ip tcp intercept connection-timeout 3600
ip tcp intercept max-incomplete low 450
ip tcp intercept max-incomplete high 550
!
end

Apply this configuration to running-config? [yes]: y

Router#sh flash

System flash directory:
File  Length   Name/status
  1   26749788  c3640-js-mz.124-7.bin
  2   944      pre_autosec.cfg
[26750860 bytes used, 6279280 available, 33030140 total]
32768K bytes of processor board System flash (Read/Write)
```

1. CONFIGURING ROUTER PASSWORDS:

- Every router needs a locally configured router for privilege access.
- Passwords are maintained on an AAA server.
- Different ways to gain administrative access to the router are :

    1. Console port
    2. Telnet
    3. Secure shell (SSH)
    4. Simple Network Management Protocol (SNMP)
    5. Cisco Security Device Manager (SDM) access using HTTP and HTTPS
- Passwords can be 1 to 25 characters in length.
- Passwords can include alphanumeric characters, uppercase and lowercase characters, symbols and spaces.
- Passwords cannot have a number as the first character.
- Password-leading spaces are ignored, but all spaces after the first character are not ignored.
- Best practice is to frequently change the passwords.

COMMANDS:

- (config) # enable secret ccnp

    1. Is used to enter the enable mode or privilege exec mode.
    2. This uses a one-way encryption hash based on MD5.

- (config) # enable password ccnp

    1. This is also used to enter the enable mode or privilege mode, but if “enable secret ccnp “configured will override the “enable password ccnp “.

    2. By default this is not encrypted in the router configuration.

    3. The virtual terminal password is not encrypted.

2. CONFIGURE THE LINE-LEVEL PASSWORD:

Configuration: The commands are same for line auxillary 0 and line vty 0 4

```
R1

Line console 0
Login
Password ccnp
```

- CONSOLE PORT :

  1. If a router is configured with the "*no service password-recovery*" , all access to the ROM monitor (ROMMON) is disabled.

- VTY LINES :

  1. You must configure a vty password before attempting to access the router using telnet.
  2. If you fail to set an enable password for the router, you will not be able to access privileged-exec mode using Telnet.
  3. Allow Telnet access from specific hosts only.
  4. You must configure passwords for all the vty lines on the router.

- Auxillary Lines :

  1. If you wish to turn off the EXEC process for the aux port, use the "*no exec*" command within the auxillary line configuration mode.

Configuration for line auxillary line 0 :

```
R1

Line aux 0
Modem input
Speed 9600
Transport input all
Flowcontrol hardware
Login
Password ccnp
```

3. PASSWORD MINIMUM LENGTH ENFORCEMENT:

- Cisco IOS software release 12.3(1) and later allows to set the minimum character length for all router passwords.

- It is recommended that you set your minimum password length to at least 10 characters.

Command:

```
R1

Config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Security passwords min-length 10
Enable secret ccnp
% Password too short - must be at least 10 characters. Password configuration failed
Enable secret netmetrics
```

- If the password is not meeting the specified characters mentioned then an error message is displayed on the console as shown in the above configuration.

4. ENCRYPTING PASSWORDS:

- A PROPRIETARY Cisco algorithm based on Vigenere cipher (indicated by the number 7 when viewd in the configuration) allows the "*service password-encryption*" command to encrypt all passwords (except the previously encrypted enable secret passwords).
- When you remove the "*service password-encryption*" command with the "*no*" from, this does not decrypt the passwords.

```
R1

Service password-encryption
```

5. ENHANCED USERNAME PASSWORD SECURITY:

Command:

1. R1 (config) # username ccnp password 0 ccnp

0 Specifies an UNENCRYPTED password will follow

OR

R1 (config) # username ccnp password 7 kfhkjfhkrhfr

7 allows you to enter the ciphertext computed by the service password-encryption command.

2. R1 (config) # username ccnp secret 0 ccnp

0 Indicates that the following clear text password is to be hashed using MD5.

OR

R1 (config) # username ccnp secret 5 fhsdjhfsdfkjsdkfskfh

5 indicates that the following encrypted secret password was hashed using MD5

The jumbled word followed by the number 5 should be copied from the running configuration. This is the encrypted password from the enable secret command.

6. SETTING A LOGIN FAILURE:

- Cisco IOS Software releases 12.3(1) supports to configure the number of allowable unsuccessful login attempts by using the "*security authentication failure rate*" from the global configuration mode.
- By default, router allows 10 login failures before initiating a 15-second delay.
- Generates a syslog message when rate is exceeded.

Command:

R1 Security authentication failure rate 10 threshold-rate log

- Threshold-rate is the number of allowable unsuccessful login attempts. The default is 10 and the range is from 2 to 1024.
- The *log* keyword is required. Results in a generated syslog event.

R1

Config terminal
Enter configuration commands, one per line. End with CNTL/Z.
aaa new-model
aaa authentication login local_auth local
username user1 password cisco
security authentication failure rate 2 log

line console 0
login authentication local_auth

- To verify the above configuration, exit from the router and try to log in again.
- Login with incorrect password twice and try again for the third time.
- When the number of failed login attempts reaches the configured rate , two events occur:
    1. An error message is sent by the router.
    2. A 15-second delay timer starts. After the 15-second delay has passes, the user may continue to attempt to log in to the router.

Verification:

User Access Verification

Username: user1
Password: (*incorrect password)*
% Authentication failed
Username: user1
Password: (*incorrect password)*
% Authentication failed

*Mar 2 17:32:02.939: %LOGIN-3-TOOMANY_AUTHFAILS: Too many Login Authentication failures have occurred in the last one minute on the line 0.

7. SETTING A LOGIN FAILURE BLOCKING PERIOD:

- With this login enhancement command available in Cisco IOS software release 12.3(4) T and later, the router will not accept any additional login connections for a "quiet period", if the configured number of connection attempts fail within a specified time period.
- But, Hosts that are permitted by a predefined ACL are excluded from the quiet period by the global config command "*login quiet-mode access-class".*
- Mitigates DoS and break-in attacks.

- All login attempts made via Telnet, Secure Shell (SSH) and HTTP are denied during the quiet period.

Command:

R1 login block-for *seconds* attempts *tries* within *seconds*

- Seconds: specifies the duration of time, or quiet period, during which login attempts are denied.
- Attempts: maximum number of failed login attempts that triggers the quiet period.
- Within: duration of time in seconds during which the allowed number of failed login attempts must be made before the quiet period is triggered.

R1 username *user1* password *user1* Enable secret *cisco* Login block-for 30 attempts 4 within 20 Line vty 0 4 Login local

Verify the above configuration:

- Telnet from R2 (1.1.1.2) to R1(1.1.1.1)
- The router R1 prompts for username and password.
- Try logging with the incorrect password for 4 times as the attempt mentioned is 4.
- After the 4 unsuccessful attempts access to the router is denied and the router is in a quiet period for 30 seconds.
- Can be verified by the following ;

R1#show login

A default login delay of 1 second is applied.
No Quiet-Mode access list has been configured.

Router enabled to watch for login Attacks.
If more than 4 login failures occur in 20 seconds or less,
logins will be disabled for 30 seconds.

Router presently in Quiet-Mode.
Will remain in Quiet-Mode for 18 seconds.
Denying logins from all sources
(18 seconds indicates the remaining time left form the 30 seconds to come out of the quiet period.)

R1#show login failures

Total failed logins: 28
Detailed information about last 50 failures

Username	SourceIPAddr	lPort	Count	TimeStamp
user1	1.1.1.2	23	8	19:07:58 UTC Sat Jul 7 2007
user2	1.1.1.2	23	3	19:06:15 UTC Sat Jul 7 2007
user3	1.1.1.2	23	1	19:04:40 UTC Sat Jul 7 2007

- The output displays number of users tried to login unsuccessfully via Telnet.

System logging messages for a quiet period :

- login on-success : Generated for successful login
- login on-failure : Generated for failed login requests.

8. EXCLUDING ADDRESSES FROM LOGIN BLOCKING:

- In Cisco IOS software release 12.3(4) T, the IOS router will use the configured ACL to permit login attempts when the router switches to quiet mode.

Command:

R1 (config) # login quiet-mode access-class {acl-name | acl-number}

- Configure an ACL permitting network 20.0.0.0 to R1.
- Configure login block-for 30 seconds

R1

Username *user1* password *user1*
Enable secret *cisco*
Login block-for 30 attempts 4 within 20

Line vty 0 4
Login local

Acess-list 1 permit 20.0.0.0 0.255.255.255
Login quiet-mode access-class 1

Verify the above configuration:

- Telnet from R2 (1.1.1.2) to R1 (1.1.1.1)
- R1 prompts for username and password.
- Try logging with incorrect password for 4 times as the attempts mentioned above is 4.
- After the 4 unsuccessful attempts access to the router is denied and the router is in a quiet period for 30 seconds.
- But with the login quiet-mode access-class command users from network 20.0.0.0 can try logging into the router even if the router is in the quiet period.
- Can be verified by the flowing: Try Telnet from the PC (20.1.1.20) to the router R1 and access is permitted though the router is in the quiet period.

9. SETTING A LOGIN DELAY:

- A Cisco IOS device can accept login connections such as Telnet, SSH and HTTP as fast as they can be processed.
- The *login delay* command introduces a uniform delay between successive login attempts.
- The delay occurs for all login attempts (failed and successful attempts).
- Secure the device from dictionary attacks, which are an attempt to gain username and password access to your device.
- The command was introduced in Cisco IOS software release 12.3(4)T.
- If not set, a default delay of one second is enforced.

10. SETTING TIMEOUTS:

- By default, an administrative interface stays active for 10 minutes after the last session activity.
- After that the interface times out and logs out of the session.

- Recommended to tune these timers for extra safety when an administrator walks away from an active console session.
- Do not set the exec-timeout value to 0 as it indicates that there will be no timeout and the session will stay active for unlimited time.

Command:

R1 (config-line) # exec-timeout minutes [seconds]

- Minutes: specifies the number of minutes the session will be terminated.

11. SETTING MULTIPLE PRIVILEGE LEVELS

- Cisco routers enable you to configure various privilege levels for your administrators.
- Different passwords can be configured to control who has access to the various privilege levels.
- Three types of levels :
    1. Level 0 : predefined for user-level access privileges.
    2. Level 2 to 14 : customized for user-level privileges.
    3. Level 15 |: predefined for enable mode.

Command:

R1 (config) # privilege mode {level level command | reset command}

- Mode : specifies the configuration mode.
- Level : enables setting a privilege level .
- Command : sets the command to which privilege level is associated.
- Reset : command resets the privilege level command.

Scenario:

Assign “ping” and “show” command to the privilege level 2 and establish “cisco” as the secret password for the users to enter the privilege level 2.

```
R1

Config t
Enter configuration commands, one per line.  End with CNTL/Z.
Privilege exec level 2 ping
Privilege exec level 2 show
Enable secret level 2 cisco
```

Verify the above configuration :

- Using the enable (level) command router will prompt for password to enter into the privilege level 2.
- The users at this level are only restricted for exec commands only and not allowed access to the configuration mode as the mode specified is only exec mode.

Verified by the following:

```
R1>enable 2
Password:cisco
R1#show privilege

Current privilege level is 2
R1#config t
     ^
% Invalid input detected at '^' marker.
```

- This error message indicates that the user is restricted to only exec mode and not other modes.

12. CONFIGURE BANNER MESSAGES:

- Banner messages specify what the proper use of the system is.
- Specifies that the system is being monitored.
- Specifies that privacy should not be expected when using this system.

Command :

```
R1 (config) # banner {exec | incoming | login | motd | slip-ppp}
                %message%
```

Where the character (%) mentioned before the start of the message and end of message should be the same and must not be in the message, otherwise the message ends where the character (%) is seen in the line.

Example:

```
R1 (config) # banner motd % This device is netmetric property. Please handle with care.
%
```

13. CONFIGURING ROLE-BASED CLI :

- The role-based CLI access feature allows you to define “views” which are a set of operational commands and configuration capabilities that provide selective or partial access to Cisco IOS EXEC and configuration mode commands.
- Views restrict user access to Cisco IOS CLI and configuration information.
- View can define which commands are accepted and what configuration information is visible.
- Cisco IOS software release 12.3(11)T can also specify an interface or a group of interfaces to a view, allowing access based on specified interfaces.
- Access to the view is protected with a password.
- To simplify view management, views can be grouped to superviews to create large sets of commands and interfaces.
- Root view is the highest administrative view and creating and modifying a view or superview is possible only from root view.
- CLI views require AAA new-model.
- A maximum of 15 CLI views can exist in addition to the root view.

Scenario:

- Enable aaa new-model and create a view.
- Specify the mode in which the specified command exists.

```
R1

aaa new-model
exit

enable view
configure terminal
parser view view1
secret 0 cisco
command exec include show version
command exec include configure terminal
command exec include all show ip
exit
```

Verify the above configuration:

- If the user wants to enter into the root view.

R1 (config) # aaa new-model
R1 (config) # exit
R1 # enable view view1
The router prompts for password

```
Password: cisco
R1 #
```

- If the user wants to view the available commands in the view.

```
R1#?
Exec commands:
  <1-99>     Session number to resume
  configure  Enter configuration mode0
  enable     Turn on privileged commands
  exit       Exit from the EXEC
  show       Show running system information
```

- The output displays available commands in the exec mode .

```
R1#show ?
  flash:  display information about flash: file system
  ip     IP information
  parser   Display parser information
  slot0:  display information about slot0: file system
  slot1:  display information about slot1: file system
  version  System hardware and software status
```

- The output displays configured keywords ip and version apart form parser which is always available.

```
R1#show ip ?

  accounting            The active IP accounting database
  aliases               IP alias table
  arp                   IP ARP table
  as-path-access-list      List AS path access lists
  bgp                   BGP information
  cache                 IP fast-switching route cache
  casa                  display casa information
  cef                   Cisco Express Forwarding
  ddns                  Dynamic DNS
  dfp                   DFP information
  extcommunity-list        List extended-community list
   --More--
```

- The output displays all the sub-options available in the view.

Note :

- Role-based CLI facilitates the concept of grouping CLI views into view supersets , called superviews.
- A superview consists of one or more CLI views.
- CLI view can be shared among multiple superviews.
- Each superview has a password .
- If a superview is deleted , all CLI views associated with that deleted superview will not be deleted.

Configuration:

```
R1

aaa new-model
exit

enable view

configure terminal
parser view view1
secret 0 cisco
command exec include show version
command exec include configure terminal
command exec include all show ip
exit

parser view view2
secret 0 ccnp
command exec include show flash
command exec include ping
exit

parser view superview1
password 0 ccnp1
view view1
view view2
```

Verify:

R1 # show parser view [all]

The output will display all the CLI views configured on the router.

14. SECURE CONFIGURATION FILES :

- The Cisco resilient configuration feature enables a router to secure and maintain a working copy of the running image and configuration so that those files can withstand malicious attempts to erase the contents of persistent storage in NVRAM and flash.
- This set of image and router running configuration is referred to as the primary bootset.
- This feature is available only on platforms that support a PCMCIA card.

Command:

```
R1

secure boot-image
secure boot-config
```

- The above configuration can be verified :

R1 # show secure bootset

- The output displays the status of the configuration resilience and the primary bootset filename.

Secure configuration files recovery :

- Use the reload command in the privilege mode to restart it and interrupt the boot sequence to enter the ROMMON mode .
- In the ROMMON , use the dir and boot commands to view the contents of the file system and select a secure image to boot the router from .

Command:

```
rommon 1 > dir slot0:
rommon 2 > boot slot0:c3745-js2-mz
```

- If the startup configuration was deleted, the router will prompt for interactive configuration input.
- You should decline to enter an interactive configuration session in setup mode if you secured the configuration file.
- Use the secure boot-config restore command to recover the secured startup configuration and save it under a specified filename.
- Finally copy the recovered file to the running configuration to resume normal operations.

R1

```
secure boot-config restore slot0:rescue
copy slot0:rescue running-config
```

- Restores the secure configuration to a filename.