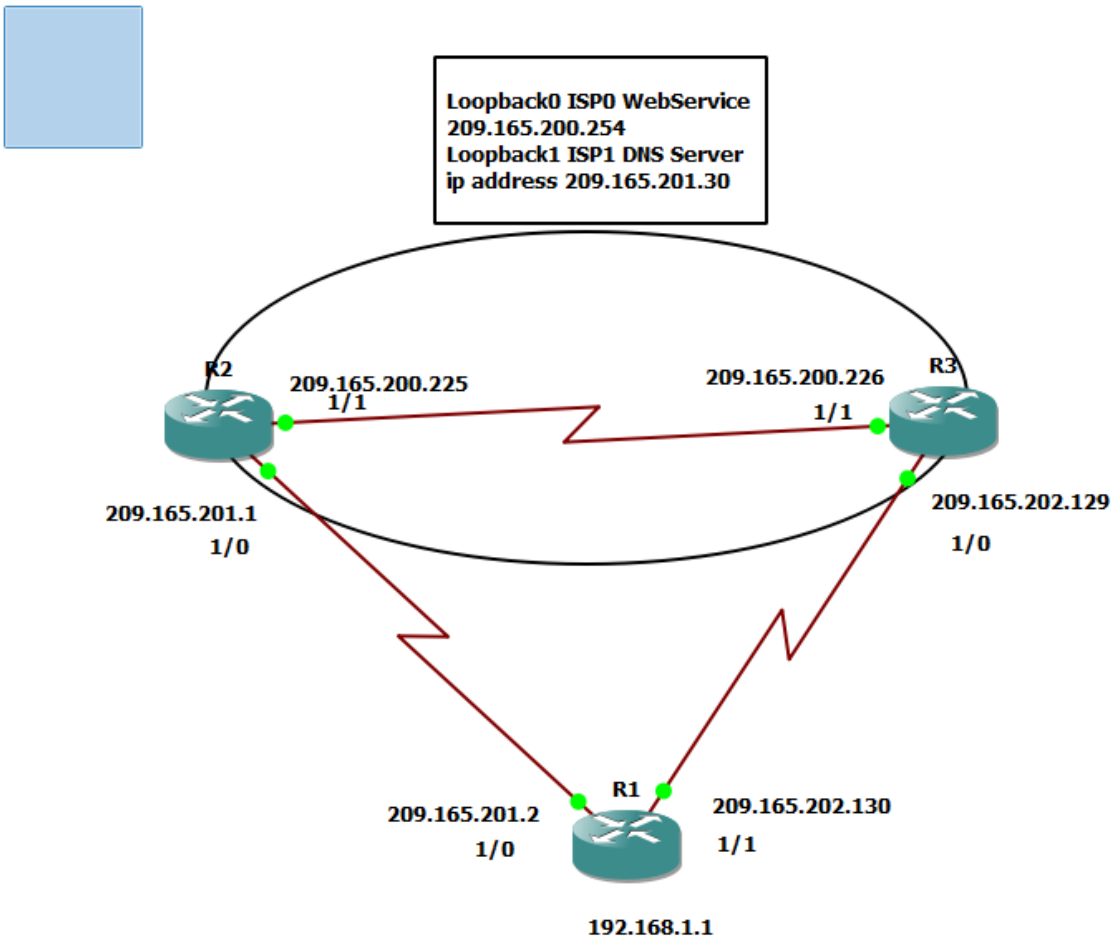
Practical No. 1

Objectives: Implement IP SLA

- **Configure and verify the IP SLA feature.**
- **Test the IP SLA tracking feature.**
- **Verify the configuration and operation using show and debug commands.**

Topology:



Step 1: Configure loopbacks and assign addresses.

```
R1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#hostname R1
R1(config)#interface loopback 0
R1(config-if)#
*Sep 28 14:09:36.619: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R1(config-if)#description R1 LAN
R1(config-if)#ip address 192.168.1.1 255.255.255.0
R1(config-if)#interface serial 1/0
R1(config-if)#description R1 ->ISP1
R1(config-if)#ip address 209.165.201.2 255.255.255.255
Bad mask /32 for address 209.165.201.2
R1(config-if)#clock rate 128000
R1(config-if)#bandwidth 128
R1(config-if)#no shutdown
```

Router R1

```
R1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0
```

```
R1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#interface serial 1/1
R1(config-if)#
*Sep 28 14:33:10.299: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
R1(config-if)#interface Serial1/1
R1(config-if)#description R1 --> ISP2
R1(config-if)#ip address 209.165.202.130 255.255.255.252
R1(config-if)#bandwidth 128
R1(config-if)#no shutdown
```

Router ISP1 (R2)

```
R2(config)#hostname ISP1
ISP1(config)#interface Loopback0
ISP1(config-if)#
*Sep 28 14:26:25.155: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
ISP1(config-if)#description simulation internet web service
ISP1(config-if)#ip address 209.165.200.254 255.255.255.255
ISP1(config-if)#interface Loopback1
ISP1(config-if)#
*Sep 28 14:29:02.155: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
ISP1(config-if)#description ISP1 DNS Server
ISP1(config-if)#ip address 209.165.201.30 255.255.255.255
ISP1(config-if)#interface serial 1/0
ISP1(config-if)#description ISP1 --> R1
ISP1(config-if)#ip address 209.165.201.1 255.255.255.252
ISP1(config-if)#bandwidth 128
ISP1(config-if)#no shutdown
ISP1(config-if)#
*Sep 28 14:32:58.571: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
ISP1(config-if)#
*Sep 28 14:32:59.579: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
ISP1(config-if)#interface Serial 1/1
ISP1(config-if)#description ISP1 --> ISP2
ISP1(config-if)#ip address 209.165.200.225 255.255.255.252
ISP1(config-if)#clock rate 128000
ISP1(config-if)#bandwidth 128
ISP1(config-if)#no shutdown
```

Router ISP2 (R3)

```
R3#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R3(config)#interface Loopback0
R3(config-if)#
*Sep 28 14:44:13.347: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
R3(config-if)#description Simulated Internet Web Server
R3(config-if)#ip address 209.165.200.254 255.255.255.255
R3(config-if)#interface Loopback1
R3(config-if)#
*Sep 28 14:44:29.327: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to up
R3(config-if)#description ISP2 DNS Server
R3(config-if)#ip address 209.165.202.158 255.255.255.255
R3(config-if)#interface Serial1/0
R3(config-if)#description ISP2 --> R1
R3(config-if)#ip address 209.165.202.129 255.255.255.252
R3(config-if)#clock rate 128000
R3(config-if)#bandwidth 128
R3(config-if)#no shutdown
```

Verify the configuration by using the show interfaces description command. The output from router R1 is shown here as an example.

```
*Sep 28 14:49:16.195: %SYS-5-CONFIG_I: Configured from console by console
R1#show interfaces description | include up
Se1/0                          up             up       R1 ->ISP1
Se1/1                          up             up       R1 --> ISP2
Lo0                            up             up       R1 LAN
```

Step 2: Configure static routing.

Router R1

```
R1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1
R1(config)#exit
R1#
```

Router ISP1 (R2)

```
ISP1(config)#router eigrp 1
ISP1(config-router)#network 209.165.200.224 0.0.0.3
ISP1(config-router)#network 209.165.201.0 0.0.0.31
ISP1(config-router)#no auto-summary
ISP1(config-router)#exit
ISP1(config)#ip route 192.168.1.0 255.255.255.0 209.165.201.2
ISP1(config)#exit
ISP1#
```

Router ISP2 (R3)

```
ISP2(config)#router eigrp 1
ISP2(config-router)#network 209.165.200.224 0.0.0.3
ISP2(config-router)#
*Sep 28 15:08:36.071: %DUAL-5-NBRCHANGE: EIGRP-IPv4 1: Neighbor 209.165.200.2
cy
ISP2(config-router)#network 209.165.202.128 0.0.0.31
ISP2(config-router)#no auto-summary
ISP2(config-router)#exit
ISP2(config)#ip route 192.168.1.0 255.255.255.0 209.165.202.130
ISP2(config)#exit
ISP2#
```

Before implementing the Cisco IOS SLA feature, you must verify reachability to the Internet servers. From router R1, ping the web server, ISP1 DNS server, and ISP2 DNS server to verify connectivity. You can copy the following Tcl script and paste it into R1.

foreach address {

209.165.200.254

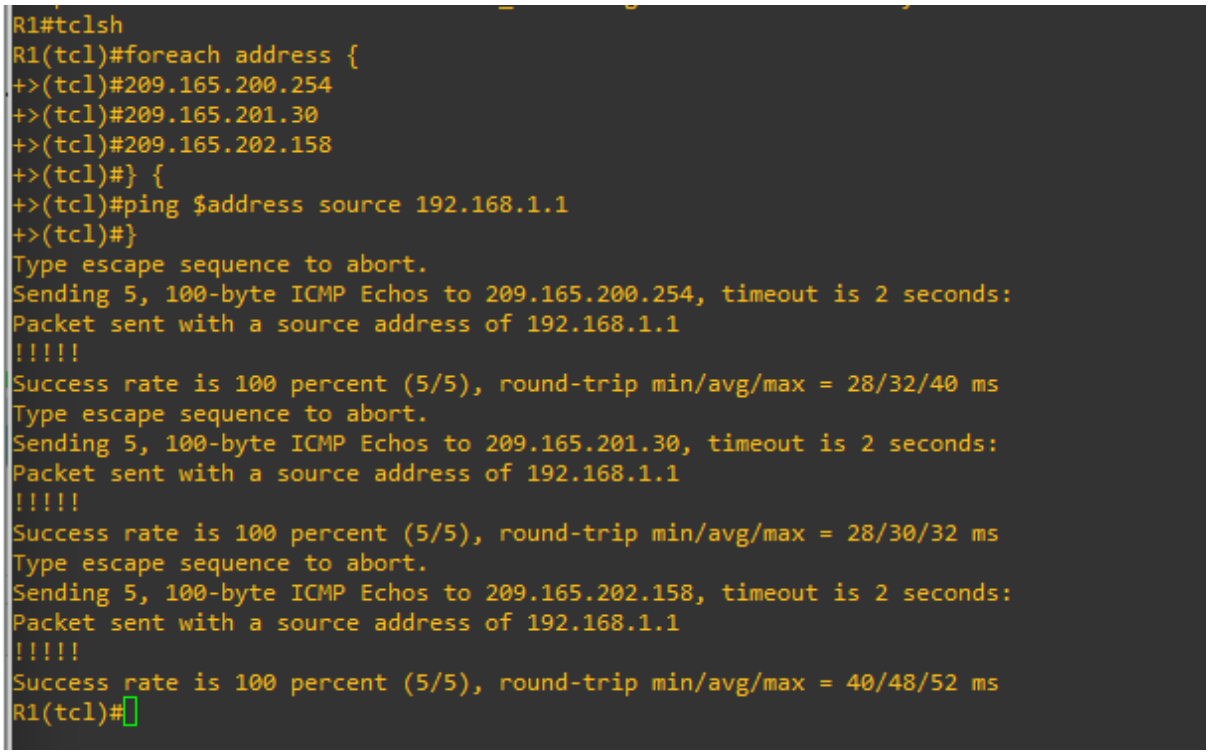
209.165.201.30

209.165.202.158

} {

ping $address source 192.168.1.1

}



Trace the path taken to the web server, ISP1 DNS server, and ISP2 DNS server. You can copy the following Tcl script and paste it into R1.

foreach address {

209.165.200.254

209.165.201.30

209.165.202.158

} {

trace $address source 192.168.1.1

}

```
R1(tcl)#foreach address {
+>(tcl)#209.165.200.254
+>(tcl)#209.165.201.30
+>(tcl)#209.165.202.158
+>(tcl)#} {
+>(tcl)#trace $address source 192.168.1.1
+>(tcl)#}
Type escape sequence to abort.
Tracing the route to 209.165.200.254
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.201.1 32 msec 32 msec 32 msec
Type escape sequence to abort.
Tracing the route to 209.165.201.30
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.201.1 32 msec 32 msec 32 msec
Type escape sequence to abort.
Tracing the route to 209.165.202.158
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.201.1 28 msec 28 msec 36 msec
  2 209.165.200.226 44 msec 48 msec 48 msec
R1(tcl)#
```

Step 3: Configure IP SLA probes.

a. Create an ICMP echo probe on R1 to the primary DNS server on ISP1 using the ip sla command.

```
R1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#ip sla 11
R1(config-ip-sla)#icmp-echo 209.165.201.30
R1(config-ip-sla-echo)#frequency 10
R1(config-ip-sla-echo)#exit
R1(config)#ip sla schedule 11 life forever start-time now
R1(config)#show ip sla configuration 11
           ^
% Invalid input detected at '^' marker.

R1(config)#exit
R1#exit
*Sep 28 15:37:27.483: %SYS-5-CONFIG_I: Configured from console by console
```

b. Verify the IP SLAs configuration of operation 11 using the show ip sla configuration 11 command.

```
R1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#ip sla 11
R1(config-ip-sla)#icmp-echo 209.165.201.30
R1(config-ip-sla-echo)#frequency 10
R1(config-ip-sla-echo)#exit
R1(config)#ip sla schedule 11 life forever start-time now
```

c. Issue the show ip sla statistics command to display the number of successes, failures, and results of the latest operations.

R1# show ip sla statistics

```
R1#show ip sla configuration 11
IP SLAs Infrastructure Engine-III
Entry number: 11
Owner:
Tag:
Operation timeout (milliseconds): 5000
Type of operation to perform: icmp-echo
Target address/Source address: 209.165.201.30/0.0.0.0
Type Of Service parameter: 0x0
Request size (ARR data portion): 28
Verify data: No
Vrf Name:
Schedule:
   Operation frequency (seconds): 10  (not considered if randomly scheduled)
   Next Scheduled Start Time: Start Time already passed
   Group Scheduled : FALSE
   Randomly Scheduled : FALSE
   Life (seconds): Forever
   Entry Ageout (seconds): never
   Recurring (Starting Everyday): FALSE
   Status of entry (SNMP RowStatus): Active
Threshold (milliseconds): 5000
Distribution Statistics:
   Number of statistic hours kept: 2
   Number of statistic distribution buckets kept: 1
   Statistic distribution interval (milliseconds): 20
Enhanced History:
History Statistics:
   Number of history Lives kept: 0
   Number of history Buckets kept: 15
   History Filter Type: None
```

d. Although not actually required because IP SLA session 11 alone could provide the desired fault tolerance, create a second probe, 22, to test connectivity to the second DNS server located on router ISP2.

```
R1#show ip sla statistics
IPSLAs Latest Operation Statistics

IPSLA operation id: 11
        Latest RTT: 40 milliseconds
Latest operation start time: 15:39:51 UTC Sat Sep 28 2024
Latest operation return code: OK
Number of successes: 17
Number of failures: 0
Operation time to live: Forever
```

Verify the new probe using the show ip sla configuration and show ip sla statistics commands.

R1# show ip sla configuration 22

```
R1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#ip sla 22
R1(config-ip-sla)#icmp-echo 209.165.202.158
R1(config-ip-sla-echo)#frequency 10
R1(config-ip-sla-echo)#exit
R1(config)#ip sla schedule 22 life forever start-time now
R1(config)#end
R1#
*Sep 28 15:41:27.851: %SYS-5-CONFIG_I: Configured from console by console
```

R1# show ip sla configuration 22

```
R1#show ip sla configuration 22
IP SLAs Infrastructure Engine-III
Entry number: 22
Owner:
Tag:
Operation timeout (milliseconds): 5000
Type of operation to perform: icmp-echo
Target address/Source address: 209.165.202.158/0.0.0.0
Type Of Service parameter: 0x0
Request size (ARR data portion): 28
Verify data: No
Vrf Name:
Schedule:
   Operation frequency (seconds): 10  (not considered if randomly scheduled)
   Next Scheduled Start Time: Start Time already passed
   Group Scheduled : FALSE
   Randomly Scheduled : FALSE
   Life (seconds): Forever
   Entry Ageout (seconds): never
   Recurring (Starting Everyday): FALSE
   Status of entry (SNMP RowStatus): Active
Threshold (milliseconds): 5000
Distribution Statistics:
   Number of statistic hours kept: 2
   Number of statistic distribution buckets kept: 1
   Statistic distribution interval (milliseconds): 20
Enhanced History:
History Statistics:
   Number of history Lives kept: 0
   Number of history Buckets kept: 15
   History Filter Type: None
```

R1# show ip sla statistics 22

```
R1#
R1#show ip sla statistics 22
IPSLAs Latest Operation Statistics

IPSLA operation id: 22
        Latest RTT: 55 milliseconds
Latest operation start time: 15:42:43 UTC Sat Sep 28 2024
Latest operation return code: OK
Number of successes: 9
Number of failures: 0
Operation time to live: Forever
```

Step 4: Configure tracking options.

a. On R1, remove the current default route and replace it with a floating static route having an administrative distance of 5.

```
R1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#no ip route 0.0.0.0 0.0.0.0 209.165.201.1
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.201.1 5
R1(config)#exit
R1#
*Sep 28 15:44:17.743: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip route | begin Gateway
Gateway of last resort is 209.165.201.1 to network 0.0.0.0

S*    0.0.0.0/0 [5/0] via 209.165.201.1
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0
      209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.201.0/30 is directly connected, Serial1/0
L        209.165.201.2/32 is directly connected, Serial1/0
      209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.202.128/30 is directly connected, Serial1/1
L        209.165.202.130/32 is directly connected, Serial1/1
```

b. Verify the routing table.

R1# show ip route | begin Gateway

```
R1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#track 1 ip sla 11 reachability
R1(config-track)#delay down 10 up 1
R1(config-track)#exit
```

c. From global configuration mode on R1, use the track 1 ip sla 11 reachability command to enter the config-track subconfiguration mode.

R1(config)# track 1 ip sla 11 reachability

```
R1#debug ip routing
IP routing debugging is on
R1#
```

d. Specify the level of sensitivity to changes of tracked objects to 10 seconds of down delay and 1 second of up delay using the delay down 10 up 1 command. The delay helps to alleviate the effect of flapping objects—objects that are going down and up rapidly. In this situation, if the DNS server fails momentarily and comes back up within 10 seconds, there is no impact.

R1(config-track)# delay down 10 up 1

e. To view routing table changes as they happen, first enable the debug ip routing command.

R1# debug ip routing

IP routing debugging is on

R1#

```
R1#config t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#track 2 ip sla 22 reachability
R1(config-track)#delay down 10 up 1
R1(config-track)#exit
R1(config)#ip route 0.0.0.0 0.0.0.0 209.165.202.129 3 track 2
R1(config)#
*Sep 28 15:47:08.295: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.201.1   1048578

*Sep 28 15:47:08.303: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.202.129   1048578

*Sep 28 15:47:08.307: RT: closer admin distance for 0.0.0.0, flushing 1 routes
*Sep 28 15:47:08.311: RT: add 0.0.0.0/0 via 209.165.202.129, static metric [3/0]
*Sep 28 15:47:08.311: RT: updating static 0.0.0.0/0 (0x0):
    via 209.165.201.1   1048578

*Sep 28 15:47:08.311: RT: rib update return code: 17
```

f. Configure the floating static route that will be implemented when tracking object 1 is active. Use the ip route 0.0.0.0 0.0.0.0 209.165.201.1 2 track 1 command to create a floating static default route via 209.165.201.1 (ISP1).

Notice that this command references the tracking object number 1, which in turn references IP SLA operation number 11.

R1(config)# ip route 0.0.0.0 0.0.0.0 209.165.201.1 2 track 1

```
ISP1(config)#interface loopback1
ISP1(config-if)#int lo1
ISP1(config-if)#shutdown
ISP1(config-if)#
*Sep 28 15:52:44.123: %LINEPROTO-5-UPDOWN: Line protocol on Interface Loopback1, changed state to down
*Sep 28 15:52:44.127: %LINK-5-CHANGED: Interface Loopback1, changed state to administratively down
ISP1(config-if)#
```

g. Repeat the steps for operation 22, track number 2, and assign the static route an admin distance higher than track 1 and lower than 5. On R1, copy the following configuration, which sets an admin distance of 3.

R1(config)# track 2 ip sla 22 reachability

```
*Sep 28 15:47:08.311: RT: rib update return code: 17
R1(config)#
*Sep 28 15:53:06.019: %TRACKING-5-STATE: 1 ip sla 11 reachability Up->Down
R1(config)#
```

h. Verify the routing table again.

R1#show ip route | begin Gateway

```
R1#show ip route | begin Gateway
Gateway of last resort is 209.165.202.129 to network 0.0.0.0

S*    0.0.0.0/0 [3/0] via 209.165.202.129
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0
      209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.201.0/30 is directly connected, Serial1/0
L        209.165.201.2/32 is directly connected, Serial1/0
      209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.202.128/30 is directly connected, Serial1/1
L        209.165.202.130/32 is directly connected, Serial1/1
```

Step 5: Verify IP SLA operation.

a. On ISP1, disable the loopback interface 1.

b. On R1, observe the debug output being generated. Recall that R1 will wait up to 10 seconds before initiating action therefore several seconds will elapse before the output is generated.

c. On R1, verify the routing table.

R1# show ip route | begin Gateway

```
R1#show ip sla statistics
IPSLAs Latest Operation Statistics

IPSLA operation id: 11
        Latest RTT: NoConnection/Busy/Timeout
Latest operation start time: 15:54:01 UTC Sat Sep 28 2024
Latest operation return code: Timeout
Number of successes: 93
Number of failures: 9
Operation time to live: Forever



IPSLA operation id: 22
        Latest RTT: 31 milliseconds
Latest operation start time: 15:54:03 UTC Sat Sep 28 2024
Latest operation return code: OK
Number of successes: 77
Number of failures: 0
Operation time to live: Forever
```

d. Verify the IP SLA statistics.

e. On R1, initiate a trace to the web server from the internal LAN IP address.

R1# show ip sla statistics

R1# trace 209.165.200.254 source 192.168.1.1

```
R1#show ip sla statistics
IPSLAs Latest Operation Statistics

IPSLA operation id: 11
        Latest RTT: NoConnection/Busy/Timeout
Latest operation start time: 15:54:01 UTC Sat Sep 28 2024
Latest operation return code: Timeout
Number of successes: 93
Number of failures: 9
Operation time to live: Forever



IPSLA operation id: 22
        Latest RTT: 31 milliseconds
Latest operation start time: 15:54:03 UTC Sat Sep 28 2024
Latest operation return code: OK
Number of successes: 77
Number of failures: 0
Operation time to live: Forever


R1#trace 209.165.200.254 source 192.168.1.1
Type escape sequence to abort.
Tracing the route to 209.165.200.254
VRF info: (vrf in name/id, vrf out name/id)
  1 209.165.202.129 32 msec 28 msec 24 msec
R1#
```

f. On ISP1, re-enable the DNS address by issuing the no shutdown command on the loopback 1 interface to examine the routing behavior when connectivity to the ISP1 DNS is restored.

ISP1(config-if)# no shutdown

```
ISP1(config-if)#no shutdown
ISP1(config-if)#
*Sep 28 15:55:14.867: %LINEPROTO-5-UPDOWN: Line protocol on Interf
ISP1(config-if)#
*Sep 28 15:55:14.871: %LINK-3-UPDOWN: Interface Loopback1, changed
ISP1(config-if)#
```

Notice the output of the debug ip routing command on R1.

g. Again examine the IP SLA statistics.

R1# show ip sla statistics

```
R1#debug ip routing
IP routing debugging is on
R1#show ip sla statistics
IPSLAs Latest Operation Statistics

IPSLA operation id: 11
        Latest RTT: 64 milliseconds
Latest operation start time: 15:56:21 UTC Sat Sep 28 2024
Latest operation return code: OK
Number of successes: 100
Number of failures: 16
Operation time to live: Forever



IPSLA operation id: 22
        Latest RTT: 39 milliseconds
Latest operation start time: 15:56:23 UTC Sat Sep 28 2024
Latest operation return code: OK
Number of successes: 91
Number of failures: 0
Operation time to live: Forever
```

h. Verify the routing table.

R1# show ip route | begin Gateway

```
R1#show ip route | begin Gateway
Gateway of last resort is 209.165.202.129 to network 0.0.0.0

S*    0.0.0.0/0 [3/0] via 209.165.202.129
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0
      209.165.201.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.201.0/30 is directly connected, Serial1/0
L        209.165.201.2/32 is directly connected, Serial1/0
      209.165.202.0/24 is variably subnetted, 2 subnets, 2 masks
C        209.165.202.128/30 is directly connected, Serial1/1
L        209.165.202.130/32 is directly connected, Serial1/1
R1#
```