

**Introduction – Segment routing for Policy Aware Network**

**LABRST-1015**

***Senthil Palanisamy – Sr. Solutions Integration Architect, Services***

***Yogi Raghunathan – Sr. Solutions Integration Architect, Services***

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Learning Objectives

The objective of this session is to provide you hands-on experience in deploying Segment Routing (SR) to build scalable internetworks.  You will gain a better understanding of the different components of SR technology (SR Forwarding, XTC Controllers, Traffic Steering and Traffic Engineering), how to configure them, and understand the packet flow in a MPLS-SR environment. During this session, you will have the opportunity to configure SR functions on IOS-XR Cisco operating systems and program the paths using the controllers.The lab consists of multiple modules that cover key functionality and common use-cases of SR. You will be guided to complete the initial module and any subsequent modules/use-cases of interest in the given session time

## Prerequisites

General knowledge of IP routing protocol – OSPF, or ISIS and BGP

General understanding of MPLS

Note: This lab is built around ISIS. SR is supported for OSPF as well.

## Disclaimer

This lab is not a design guide. The topology and configurations implemented in this lab were constructed to demonstrate specific aspects of MPLS-SR technology; they do not implement the proper redundancy or high availability features for a production network.

This training document is to familiarize with Segment Routing, configuration, and functionality. Although the lab design and configuration examples could be used as a reference, it’s not a real design. Not all recommended features are used or enabled optimally. The IP addresses used in these lab scenarios might be combination of both private RFC1918 addresses and public addresses for ease of route differentiations. These addresses are used in a controlled lab environment here for learning purpose only and it may not be used in the production environment. For the design, related questions please contact your representative at Cisco, or a Cisco partner.

## Related Sessions at Cisco Live

Segment Routing Demo - CAMDEM 1081

MPLS SR Introduction - LABSPG-1020

Troubleshooting Segment Routing -BRKRST-3009

# Segment Routing

## Introduction

Segment routing is a method of forwarding packets on the network based on the source routing paradigm. The source chooses a path and encodes it in the packet header as an ordered list of segments. Segments are an identifier for any type of instruction. A segment is encoded as an MPLS label. An ordered list of segments is encoded as a stack of labels. This part of lab focusses on this.

Interior gateway protocol (IGP) distributes two types of segments: prefix segments and adjacency segments. Each router (node) and each link (adjacency) has an associated segment identifier (SID). By combining prefix (node) and adjacency segment IDs in an ordered list, any path within a network can be constructed.

## Traffic Steering

Segment Routing (SR) allows a headend node to steer a packet flow along any path. The header of a packet steered in an SR path is augmented with the ordered list of segments. Traffic can be steered onto an SR Policy path either by IGP Best path, SR policy defined locally via CLI, Netconf/Yang, BGP or via external SDN controller.

## Traffic Engineering

The Segment Routing Traffic Engineering (SRTE) process installs a Segment Routing Policy (SR Policy) in the forwarding plane (FIB). SRTE process MAY learn multiple candidate paths from different sources: NETCONF with OpenConfig or YANG model, PCEP, BGP or Local configuration. SRTE is an alternate solution to RSVP-TE with much less protocol overheads and intermediate states.

For this lab exercise, you will install SR-Policy via an XTC controller.

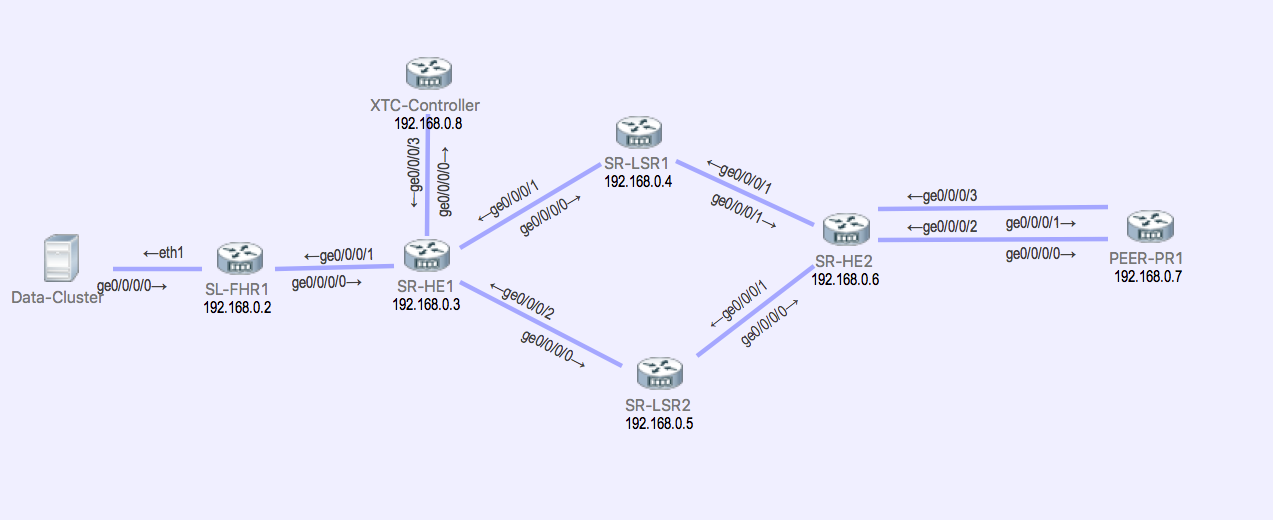
## Segment Routing Terminology

* **Source Routing**
  + the source chooses a path and encodes it in the packet header as an ordered list of segments
  + the rest of the network executes the encoded instructions
* **Segment: an identifier for any type of instruction**
  + forwarding or service
  + Segment is MPLS
  + Segment list is MPLS Label stacks
* **MPLS**
  + An ordered list of segments is represented as a stack of labels
* **Global Segment**
  + Any node in SR domain understands associated instruction
  + Global label value in Segment Routing Global Block (SRGB)
  + Label used from the default label allocation or customized allocation block
* **Local Segment**
  + Only originating node understands associated instruction
  + Local label value in Segment Routing Local Block (SRLB)
  + Label used from the Dynamics label allocation
* **LSD – Label Switching Database**
  + Local label allocation is managed by Label Switching Database (LSD)
  + Label range [0-15] reserved for special-purposes
  + Label range [16-15,999] reserved for static MPLS labels
  + Label range [16,000-23,999] preserved for SRGB by default
  + Label range [24,000-max] used for dynamic label allocation – LDP,RSVP, SRLB

# Network Topology

## Physical Network Topology

### 



**Figure 1 – Topology with flat ISIS Domain**

|  |  |
| --- | --- |
|  |  |

**Data-Cluster**

Simulates server in cluster environment hosting multiple applications

**SL-FHR1**

First hop router that imposes BSID (Binding SID) label based on destination address leveraging mpls static

**SR-HE1**

Headend router that’s hosts the applications centric Segment routing policy. SR policies are provisioned either through XTC controller or open source controller Voltron on head end.

**SR-LSR1**

Label switch router that switches MPLS 2 MPLS or MPLS2IP SWAP

**SR-LSR2**

Label switch router that switches MPLS 2 MPLS or MPLS2IP SWAP

**SR-HE2**

Tail-end router where the SR domain ends. SR policies are provisioned either through XTC controller or open source controller Voltron on head end.

**XTC-Controller**

XR based Transport controller is used for provisioning SR policies.

**PEER-P1**

External AS peering router simulating an Internet and End host environment.

Other Information

* Network elements username/passwords are **cisco/cisco**
* Information to validate is highlighted in green
* Host names are highlighted in red background.
* CLI command to be typed are highlighted in yellow

## Logical Topology

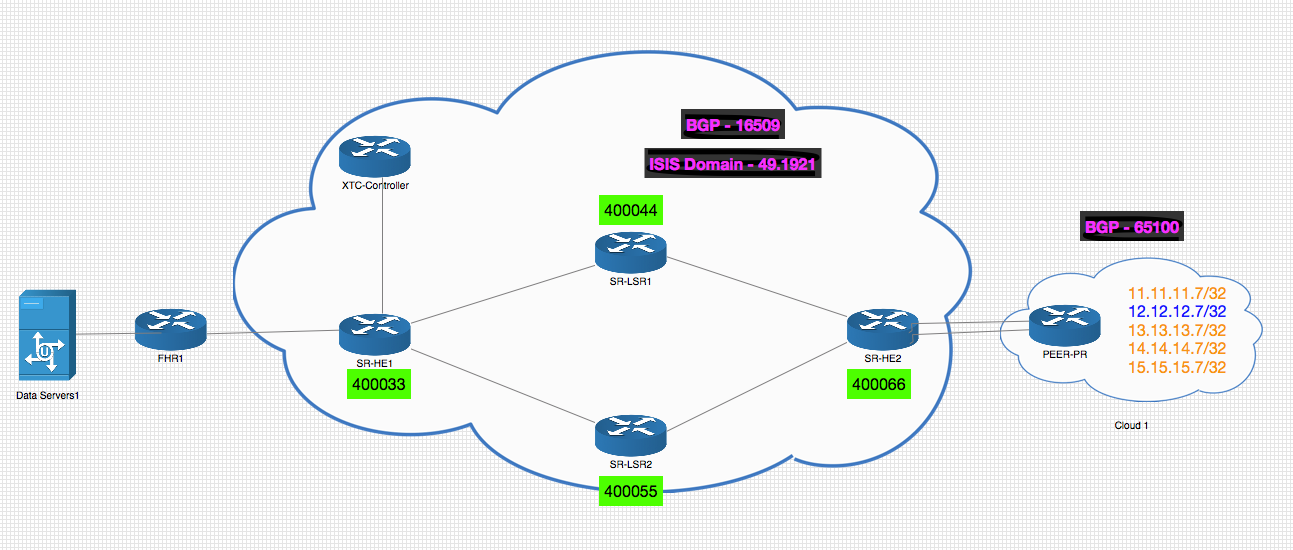


Figure 2 – Network Topology with IGP and Segment Routing enabled

## Preloaded IP addressing

Basic IP connectivity with infrastructure routing has already been configured between the devices, and should be verified prior to each lab module. The service provider internet cloud is already built and no need to modify any configuration. All configuration exercise need to be done only SR-HE1 and SR-HE2 routers.

Table 1:

|  |  |  |
| --- | --- | --- |
| **Device Name** | **Interface** | **IPv4 Address** |
| **Data Cluster** | **Ethernet1** | **10.0.0.5/30** |
| **FHR1** | **Loopback 0** | **192.168.0.2/32** |
| **SR-HE1** | **Loopback 0** | **192.168.0.3/32** |
| **SR-LSR1** | **Loopback 0** | **192.168.0.4/32** |
| **SR-LSR2** | **Loopback 0** | **192.168.0.5/32** |
| **SR-HE2** | **Loopback 0** | **192.168.0.6/32** |
| **PEER-P1** | **Loopback 0** | **192.168.0.7/32** |
| **XTC-Controller** | **Loopback 0** | **192.168.0.8/32** |

## Lab Access

The lab proctor will assign lab access information at the beginning of the session.

Step 1: Identify the user and VPN details you have been assigned.

VPN Login info:

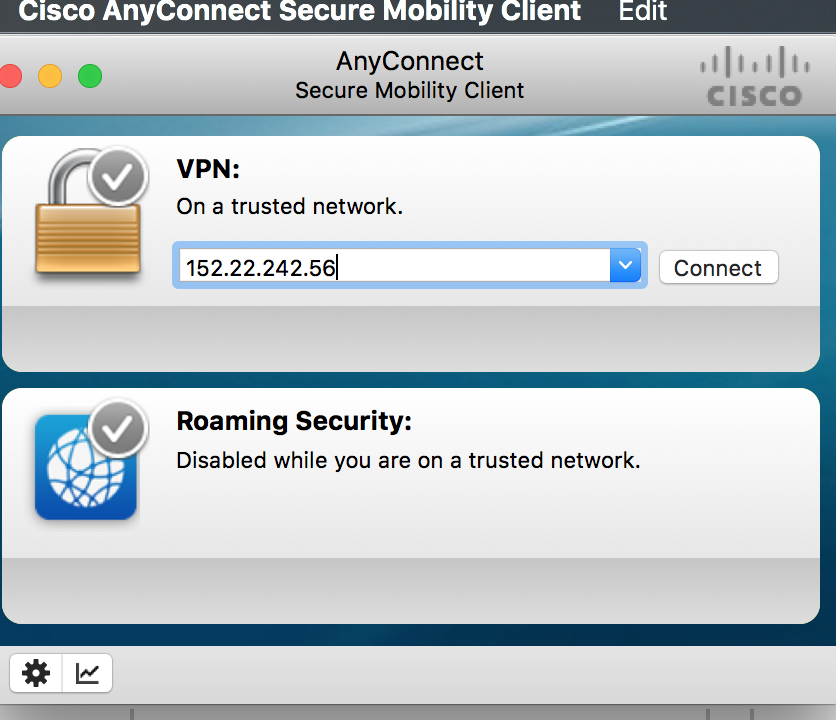
|  |  |  |  |
| --- | --- | --- | --- |
| User No: | Any connect VPN | Username | Password |
| “All Users” | 152.22.242.56 | clus2018 | CLUS2018isFUN! |

User-lab Login info:

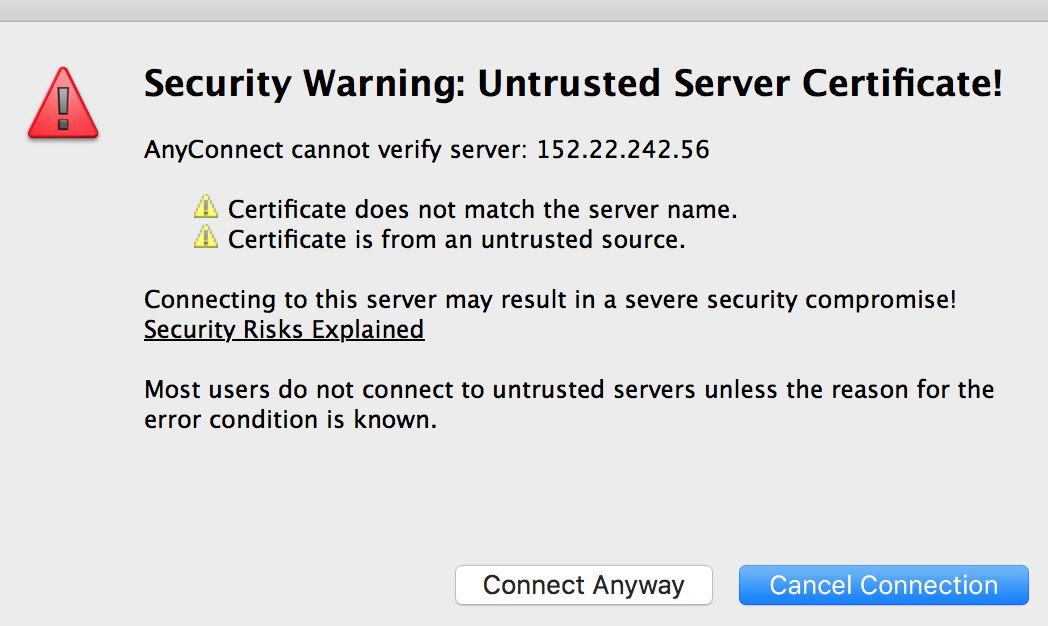
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Lab1 | Lab2 | Lab3 | Lab4 | Lab5 |
| XTC-Controller | 172.16.111.73 | 172.16.111.116 | 172.16.111.120 | 172.16.111.93 | 172.16.111.98 |
| Peer-PR1 | 172.16.111.67 | 172.16.111.104 | 172.16.111.110 | 172.16.111.81 | 172.16.111.99 |
| Data-Cluster | 172.16.111.74 | 172.16.111.103 | 172.16.111.109 | 172.16.111.94 | 172.16.111.100 |
| Server-2 | 172.16.111.75 |  |  | 172.16.111.95 | 172.16.111.88 |
| SR-HE1 | 172.16.111.69 | 172.16.111.106 | 172.16.111.112 | 172.16.111.82 | 172.16.111.89 |
| SR-HE2 | 172.16.111.70 | 172.16.111.113 | 172.16.111.117 | 172.16.111.83 | 172.16.111.90 |
| SR-LSR1 | 172.16.111.71 | 172.16.111.114 | 172.16.111.118 | 172.16.111.91 | 172.16.111.96 |
| SR-LSR2 | 172.16.111.72 | 172.16.111.115 | 172.16.111.119 | 172.16.111.92 | 172.16.111.97 |
| SL-FHR1 | 172.16.111.68 | 172.16.111.105 | 172.16.111.111 | 172.16.111.88 | 172.16.111.82 |

Step 2: Connect to Cisco DMZ zone where the lab is hosted:

1. Run Any connect client from the terminal

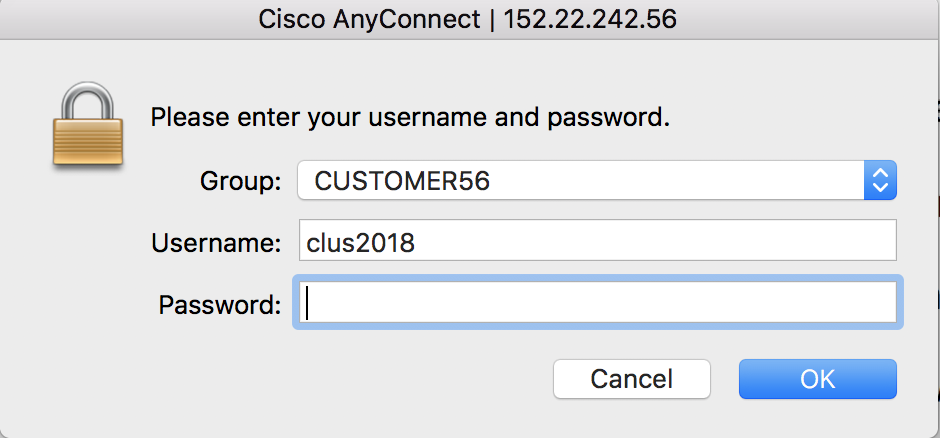


1. Add **152.22.242.56** as the destination IP address for the DMZ. Destination address will vary based on user assignment. Please reach out to proctor if required. **This is critical for landing in correct POD**
2. Click on connect
3. Select connect anyway on the security warning



1. Enter username/password: **clus2018/*****CLUS2018isFUN!***

*🖐: If you are assigned user1 or 2, then your target Any connect VPN address is 152.22.242.56, Username/password is clus2018/CLUS2018isFUN!*



1. On successful connection. You will see a successful icon on the upper bar as follows 
2. If it times out, retry it again
3. If you are unable to select, please reach out to lab proctor

# Lab Objectives:

Lab Module 1: In this lab you will review the base “ISIS-SR” segment routing configuration and validate traffic forwarding using labels.

Lab Module 2: In this lab you will advertise BGP prefixes with color, setup BGP address-family sr-policy between XTC controller and SR-Headend router – SR-HE1.

Lab Module 3: In this lab, you will enable SR policy such that different applications are treated differently within the network. Application is uniquely identified by its BSID. After validating the policy, remove policy. In this lab you can either use curl or Postman.

Lab 4: In this lab, you will enable Egress peer engineering, and push a policy where by as operator you determine which egress interface can be utilized

## Lab Module 1 – Configure Segment Routing and validate control and data plane

In this lab module, you will configure segment routing and validate the control and date plane. For convenience, user will enable segment routing for ISIS on SR-HE1 and SR-HE2 node. Nodes SR-LSR1 & SR-LSR2 have been preconfigured with segment routing.

## Logical Topology

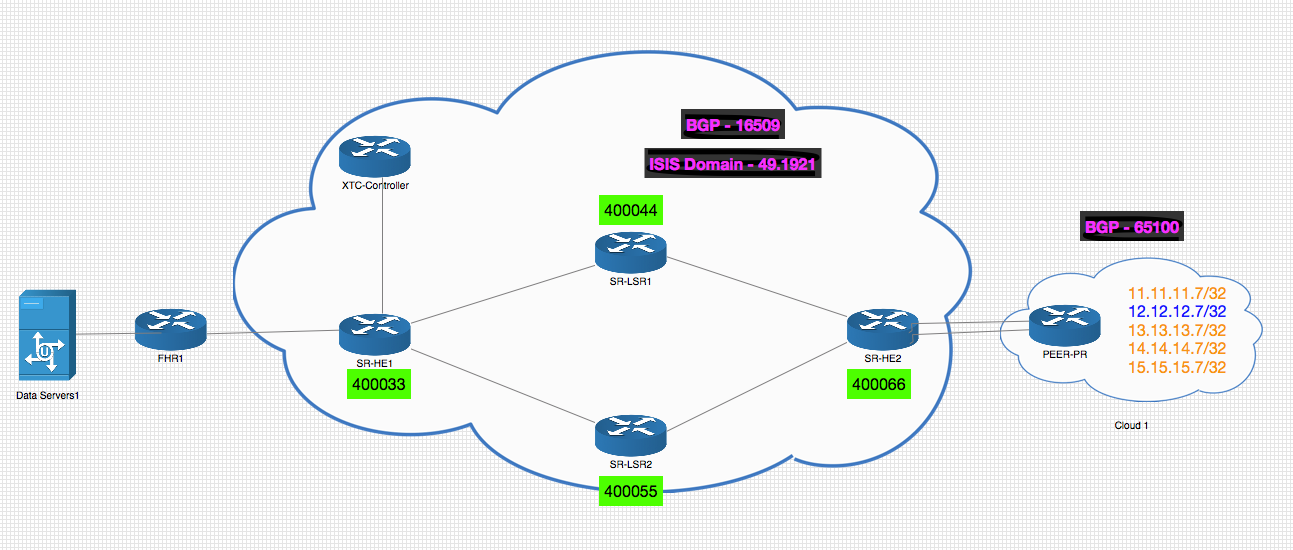


Figure 3 – Network Topology with IGP and Segment Routing enabled

1. **Configure SR-HE1 for Segment Routing in ISIS:**

Telnet to node SR-HE1 and enable segment routing as follows (username/password: cisco/cisco)

CL18-LABRST1015:~ yraghuna$ telnet 172.16.111.69

Trying 172.16.111.69...

Connected to 172.16.111.69.

Escape character is '^]'

…

User Access Verification

Username:

Username: cisco

Password:cisco

RP/0/0/CPU0:SR-HE1#

RP/0/0/CPU0:SR-HE1#conf t

Fri May 25 22:32:48.688 UTC

RP/0/0/CPU0:SR-HE1(config)#config-isis-sr-he1

RP/0/0/CPU0:SR-HE1(config)#router isis 16509

RP/0/0/CPU0:SR-HE1(config)#segment-routing global-block 400000 464000

RP/0/0/CPU0:SR-HE1(config)#address-family ipv4 unicast

RP/0/0/CPU0:SR-HE1(config)#segment-routing mpls

RP/0/0/CPU0:SR-HE1(config)#interface Loopback0

RP/0/0/CPU0:SR-HE1(config)#address-family ipv4 unicast

RP/0/0/CPU0:SR-HE1(config)#prefix-sid index 33

RP/0/0/CPU0:SR-HE1(config)#commit

Fri May 25 22:33:01.927 UTC

RP/0/0/CPU0:SR-HE1(config)#end

RP/0/0/CPU0:SR-HE1#

|  |  |
| --- | --- |
| segment-routing global-block 400000 464000 | Specifies the block of segment routing IDs that are allocated for the routers in the network.  [Node-SID] |
| segment-routing mpls | Enables segment routing for IPv4 addresses with MPLS data plane. |
| prefix-sid index 33 | Configures the segment ID (Node-SID)  With Index Node SID, SR routing id is derived from [400000+33] |

*👉: SR-HE1 has been enabled for Segment routing with MPLS as encapsulation. Prefix SID comes from custom configured block (SRGB+Index) for loopback0.*

1. **Configure SR-HE2 for Segment Routing in ISIS:**

Telnet to node SR-HE2 and enable segment routing as follows (username/password:cisco/cisco)

CL18-LABRST1015:~ yraghuna$ telnet 172.16.111.70

Trying 172.16.111.70...

Connected to 172.16.111.70.

Escape character is '^]'

…

User Access Verification

Username:

Username: cisco

Password:cisco

RP/0/0/CPU0:SR-HE2#conf t

Fri May 25 22:47:50.526 UTC

RP/0/0/CPU0:SR-HE2(config)#config-isis-sr-he2

RP/0/0/CPU0:SR-HE2(config)#router isis 16509

RP/0/0/CPU0:SR-HE2(config)#segment-routing global-block 400000 464000

RP/0/0/CPU0:SR-HE2(config)#address-family ipv4 unicast

RP/0/0/CPU0:SR-HE2(config)#segment-routing mpls

RP/0/0/CPU0:SR-HE2(config)#interface Loopback0

RP/0/0/CPU0:SR-HE2(config)#address-family ipv4 unicast

RP/0/0/CPU0:SR-HE2(config)#prefix-sid index 66

RP/0/0/CPU0:SR-HE2(config)#commit

Fri May 25 22:48:00.796 UTC

RP/0/0/CPU0:SR-HE2(config)#end

RP/0/0/CPU0:SR-HE2#

|  |  |
| --- | --- |
| segment-routing global-block 400000 464000 | Specifies the block of segment routing IDs that are allocated for the routers in the network.  [Node-SID] |
| segment-routing mpls | Enables segment routing for IPv4 addresses with MPLS data plane. |
| prefix-sid index 66 | Configures the segment ID (Node-SID)  With Index Node SID, SR routing id is derived from [400000+66] |

*👉: SR-HE2 has been enabled for Segment routing with MPLS as encapsulation. Prefix SID comes from custom configured block ( SRGB+Index) for loopback0.*

1. Review Segment routing configuration on SR-LSR1/SR-LSR2 ( No configuration required – Optional step to review )

SR-LSR1/SR-LSR2 has been configured with SR configuration. User can enter the terminal for LSR-PE2 and review the configuration using show run router ISIS (username/password:cisco/cisco)

CL18-LABRST1015:~ yraghuna$ telnet 172.16.111.71

Trying 172.16.111.71...

Connected to 172.16.111.71.

Escape character is '^]'

…

User Access Verification

Username:

Username: cisco

Password:

RP/0/0/CPU0:SR-LSR1#show-isis

RP/0/0/CPU0:SR-LSR1#show run router isis

Fri May 25 22:54:17.381 UTC

router isis 16509

net 49.1921.6800.0004.00

segment-routing global-block 400000 464000

address-family ipv4 unicast

metric-style wide

segment-routing mpls

!

interface Loopback0

passive

circuit-type level-2-only

address-family ipv4 unicast

prefix-sid index 44

!

!

interface GigabitEthernet0/0/0/0

circuit-type level-2-only

point-to-point

address-family ipv4 unicast

metric 1

!

!

interface GigabitEthernet0/0/0/1

circuit-type level-2-only

point-to-point

address-family ipv4 unicast

metric 1

!

!

!

1. Review routing configuration on XTC-Controller ( No configuration required – Optional step to review )

*👉: XTC-Controller ISIS enabled but has not been enabled for segment routing. XTC-controller needs IP connectivity to one of the routers in the SR-Domain to learns its IGP topology to push the policy*

CL18-LABRST1015:~ yraghuna$ telnet 172.16.111.73

Trying 172.16.111.73...

Connected to 172.16.111.73.

Escape character is '^]'

…

User Access Verification

Username:

Username: cisco

Password:

RP/0/0/CPU0:XTC-Controller#

RP/0/0/CPU0:XTC-Controller#show-isis

RP/0/0/CPU0:XTC-Controller#show run router isis

Fri May 25 23:00:25.576 UTC

router isis 16509

net 49.1921.6800.0008.00

address-family ipv4 unicast

metric-style wide

!

interface Loopback0

passive

circuit-type level-2-only

address-family ipv4 unicast

!

!

interface GigabitEthernet0/0/0/0

circuit-type level-2-only

point-to-point

address-family ipv4 unicast

metric 1

!

!

!

1. Review routing configuration on SR-FHR1 (No configuration required – Optional step to review )

CL18-LABRST1015:~ yraghuna$ telnet 172.16.111.68

Trying 172.16.111.68...

Connected to 172.16.111.68.

Escape character is '^]'

…

User Access Verification

Username:

Username: cisco

Password:

RP/0/0/CPU0:SR-FHR1#

RP/0/0/CPU0:SR-FHR1#show-isis

RP/0/0/CPU0:SR-FHR1#show run router isis

Fri May 25 23:09:52.624 UTC

% No such configuration item(s)

RP/0/0/CPU0:SR-FHR1#show-static

RP/0/0/CPU0:SR-FHR1#show run router static

Fri May 25 23:09:56.333 UTC

router static

address-family ipv4 unicast

192.168.0.0/24 GigabitEthernet0/0/0/1 10.0.0.10

!

vrf Mgmt-intf

address-family ipv4 unicast

0.0.0.0/0 MgmtEth0/0/CPU0/0 172.16.111.254

!

!

!

RP/0/0/CPU0:SR-FHR1#show-mpls-static

RP/0/0/CPU0:SR-FHR1#show run mpls static

Fri May 25 23:09:59.113 UTC

% No such configuration item(s)

RP/0/0/CPU0:SR-FHR1#

*👉: SR-FHR1 does not have any dynamic routing or segment routing enabled. The purpose of this node is to push IP2IP or IP2MPLS packets using static mpls. In the base configuration the node should be enabled only for static routing.*

1. Validate the control plane by running through following commands.
2. Check the ISIS neighbor is up and running from SR-HE1 Node.

RP/0/0/CPU0:SR-HE1#

RP/0/0/CPU0:SR-HE1#show-isis-nei

RP/0/0/CPU0:SR-HE1#show isis neighbors

Sat May 26 16:52:48.656 UTC

IS-IS 16509 neighbors:

System Id Interface SNPA State Holdtime Type IETF-NSF

XTC-Controller Gi0/0/0/3 \*PtoP\* Up 24 L2 Capable

SR-LSR1 Gi0/0/0/1 \*PtoP\* Up 25 L2 Capable

SR-MP-LSR2 Gi0/0/0/2 \*PtoP\* Up 21 L2 Capable

Total neighbor count: 3

1. Identify the LSP ID where the database contents are stored for the ISIS domain

RP/0/0/CPU0:SR-HE1#show-isis-db

RP/0/0/CPU0:SR-HE1#show isis database

Sat May 26 16:53:14.985 UTC

IS-IS 16509 (Level-1) Link State Database

LSPID LSP Seq Num LSP Checksum LSP Holdtime/Rcvd ATT/P/OL

SR-HE1.00-00 \* 0x000001c2 0x1bfa 539 /\* 0/0/0

Total Level-1 LSP count: 1 Local Level-1 LSP count: 1

IS-IS 16509 (Level-2) Link State Database

LSPID LSP Seq Num LSP Checksum LSP Holdtime/Rcvd ATT/P/OL

SR-HE1.00-00 \* 0x000001c6 0x97e9 920 /\* 0/0/0

SR-LSR1.00-00 0x000001c3 0xa328 494 /1199 0/0/0

SR-MP-LSR2.00-00 0x000001c4 0xd301 575 /1199 0/0/0

SR-HE2.00-00 0x000001ca 0x1188 564 /1199 0/0/0

XTC-Controller.00-00 0x000001c2 0xa68b 1068 /1199 0/0/0

Total Level-2 LSP count: 5 Local Level-2 LSP count: 1

RP/0/0/CPU0:SR-HE1#

RP/0/0/CPU0:SR-HE1#show-isis-db verbose SR-HE1.00-00 detail

RP/0/0/CPU0:SR-HE1#show isis database verbose SR-HE1.00-00 detail

Sat May 26 16:53:57.402 UTC

IS-IS 16509 (Level-1) Link State Database

LSPID LSP Seq Num LSP Checksum LSP Holdtime/Rcvd ATT/P/OL

SR-HE1.00-00 \* 0x000001c2 0x1bfa 496 /\* 0/0/0

Area Address: 49

NLPID: 0xcc

I – IPv4 Address Family

V – IPv6 Address Family

SRGB Block 400,000 -464000 – Custom defined in config

IP Address: 192.168.0.3

Hostname: SR-HE1

Router Cap: 192.168.0.3, D:0, S:0

Segment Routing: I:1 V:0, SRGB Base: 400000 Range: 64001

SR Local Block: Base: 15000 Range: 1000

SR Algorithm:

0 – Shortest Path First – Permits any node to overwrite the SPF Path

1 – Strict Shortest Path First – Permits All nodes need to honor the path, cannot overwrite the SPF 1 Path

Algorithm: 0

Algorithm: 1

Node Maximum SID Depth:

Subtype: 1, Value: 10

IS-IS 16509 (Level-2) Link State Database

LSPID LSP Seq Num LSP Checksum LSP Holdtime/Rcvd ATT/P/OL

SR-HE1.00-00 \* 0x000001c6 0x97e9 878 /\* 0/0/0

Area Address: 49

NLPID: 0xcc

IP Address: 192.168.0.3

Metric: 1 IP-Extended 10.0.0.8/30

Prefix Attribute Flags: X:0 R:0 N:0

Metric: 1 IP-Extended 10.0.0.12/30

Prefix Attribute Flags: X:0 R:0 N:0

Metric: 1 IP-Extended 10.0.0.16/30

Prefix Attribute Flags: X:0 R:0 N:0

Metric: 1 IP-Extended 10.0.0.20/30

Prefix Attribute Flags: X:0 R:0 N:0

Metric: 0 IP-Extended 192.168.0.3/32

Prefix-SID Index: 33, Algorithm:0, R:0 N:1 P:0 E:0 V:0 L:0

Prefix Attribute Flags: X:0 R:0 N:1

Hostname: SR-HE1

Router Cap: 192.168.0.3, D:0, S:0

Segment Routing: I:1 V:0, SRGB Base: 400000 Range: 64001

SR Local Block: Base: 15000 Range: 1000

SR Algorithm:

IPv4 adjacency SID

F:0, Address-family IPv4

B:0, unprotected

V:1, label value

L:1, local segment

S:0, not a set of adjacencies

Adjacency SID - comes from dynamic range

Algorithm: 0

Algorithm: 1

Node Maximum SID Depth:

Subtype: 1, Value: 10

Metric: 1 IS-Extended SR-LSR1.00

Interface IP Address: 10.0.0.13

Neighbor IP Address: 10.0.0.14

Link Maximum SID Depth:

Subtype: 1, Value: 10

ADJ-SID: F:0 B:0 V:1 L:1 S:0 P:0 weight:0 Adjacency-sid:24001

Metric: 1 IS-Extended SR-MP-LSR2.00

Interface IP Address: 10.0.0.17

Neighbor IP Address: 10.0.0.18

Link Maximum SID Depth:

Subtype: 1, Value: 10

ADJ-SID: F:0 B:0 V:1 L:1 S:0 P:0 weight:0 Adjacency-sid:24003

Metric: 1 IS-Extended XTC-Controller.00

Interface IP Address: 10.0.0.21

Neighbor IP Address: 10.0.0.22

Link Maximum SID Depth:

Subtype: 1, Value: 10

ADJ-SID: F:0 B:0 V:1 L:1 S:0 P:0 weight:0 Adjacency-sid:24005

RP/0/0/CPU0:SR-HE1#

1. Check for the isis Adjacency information

RP/0/0/CPU0:SR-HE1#show-isis-adj

RP/0/0/CPU0:SR-HE1#show isis adjacency detail

Sat May 26 16:52:59.196 UTC

IS-IS 16509 Level-1 adjacencies:

System Id Interface SNPA State Hold Changed NSF IPv4 IPv6

BFD BFD

IS-IS 16509 Level-2 adjacencies:

System Id Interface SNPA State Hold Changed NSF IPv4 IPv6

BFD BFD

XTC-Controller Gi0/0/0/3 \*PtoP\* Up 29 4d01h Yes None None

Area Address: 49

Neighbor IPv4 Address: 10.0.0.22\*

Adjacency SID: 24004

Non-FRR Adjacency SID: 24005

Topology: IPv4 Unicast

SR-LSR1 Gi0/0/0/1 \*PtoP\* Up 22 4d01h Yes None None

Area Address: 49

Neighbor IPv4 Address: 10.0.0.14\*

Adjacency SID: 24000

Non-FRR Adjacency SID: 24001

Topology: IPv4 Unicast

SR-MP-LSR2 Gi0/0/0/2 \*PtoP\* Up 29 4d01h Yes None None

Area Address: 49

Neighbor IPv4 Address: 10.0.0.18\*

Adjacency SID: 24002

Non-FRR Adjacency SID: 24003

Topology: IPv4 Unicast

Total adjacency count: 3

RP/0/0/CPU0:SR-HE1#

1. Validate the segment routing labels allocated per node

RP/0/0/CPU0:SR-HE1#show-mpls-isis

RP/0/0/CPU0:SR-HE1#show mpls label table application isis

Sat May 26 17:09:00.960 UTC

Table Label Owner State Rewrite

----- ------- ------------------------------- ------ -------

0 24000 ISIS(A):16509 InUse Yes

0 24001 ISIS(A):16509 InUse Yes

0 24002 ISIS(A):16509 InUse Yes

0 24003 ISIS(A):16509 InUse Yes

0 24004 ISIS(A):16509 InUse Yes

0 24005 ISIS(A):16509 InUse Yes

0 400000 ISIS(A):16509 InUse No

RP/0/0/CPU0:SR-HE1#

RP/0/0/CPU0:SR-HE1#

RP/0/0/CPU0:SR-HE1#show-mpls-table

RP/0/0/CPU0:SR-HE1#show mpls label table

Sat May 26 17:12:25.626 UTC

Table Label Owner State Rewrite

----- ------- ------------------------------- ------ -------

0 0 LSD(A) InUse Yes

0 1 LSD(A) InUse Yes

0 2 LSD(A) InUse Yes

0 13 LSD(A) InUse Yes

0 15000 LSD(A) InUse No

0 24000 ISIS(A):16509 InUse Yes

0 24001 ISIS(A):16509 InUse Yes

0 24002 ISIS(A):16509 InUse Yes

0 24003 ISIS(A):16509 InUse Yes

0 24004 ISIS(A):16509 InUse Yes

0 24005 ISIS(A):16509 InUse Yes

0 400000 ISIS(A):16509 InUse No

RP/0/0/CPU0:SR-HE1#

1. Validate the data plane by enabling end to end pings from the Datacenter server connected to FHR1 to target SR-HE2 – node [ 192.168.0.6 ]
2. Enable ping from the Server1 targeted towards SR-HE2 – node [ 192.168.0.6 ]

CL18-LABRST1015:$ ssh cisco@172.16.111.74

cisco@172.16.111.74's password:

Welcome to Ubuntu 14.04.5 LTS (GNU/Linux 3.13.0-119-generic x86\_64)

\* Documentation: https://help.ubuntu.com/

System information as of Wed May 23 00:32:58 UTC 2018

System load: 0.4 Processes: 112

Usage of /: 81.0% of 2.13GB Users logged in: 1

Memory usage: 30% IP address for eth0: 172.16.111.74

Swap usage: 0% IP address for eth1: 10.0.0.6

Graph this data and manage this system at:

https://landscape.canonical.com/

Get cloud support with Ubuntu Advantage Cloud Guest:

http://www.ubuntu.com/business/services/cloud

New release '16.04.4 LTS' available.

Run 'do-release-upgrade' to upgrade to it.

Last login: Wed May 23 00:32:58 2018 from 172.31.56.96

cisco@server-1:~$

cisco@server-1:~$ cisco@server-1:~$ ping 192.168.0.6

PING 192.168.0.8 (192.168.0.8) 56(84) bytes of data.

64 bytes from 192.168.0.8: icmp\_seq=1 ttl=253 time=3.61 ms

64 bytes from 192.168.0.8: icmp\_seq=2 ttl=253 time=3.27 ms

….

1. Validate intermediate data plane counters within SR Domain

As identified with host name, please execute the commands on the right host.

RP/0/0/CPU0:SR-HE1#show-route 192.168.0.6

RP/0/0/CPU0:SR-HE1#show route 192.168.0.6

Fri May 25 23:19:36.155 UTC

Routing entry for 192.168.0.6/32

Known via "isis 16509", distance 115, metric 2, labeled SR, type level-2

Installed May 25 22:22:33.000 for 00:57:03

Routing Descriptor Blocks

10.0.0.14, from 192.168.0.6, via GigabitEthernet0/0/0/1

Route metric is 2

10.0.0.18, from 192.168.0.6, via GigabitEthernet0/0/0/2

Route metric is 2

No advertising protos.

RP/0/0/CPU0:SR-HE1# show-cef 192.168.0.6

RP/0/0/CPU0:SR-HE1#show cef 192.168.0.6

Fri May 25 23:19:40.345 UTC

192.168.0.6/32, version 123, labeled SR, internal 0x1000001 0x81 (ptr 0xa14d9174) [1], 0x0 (0xa14be9e0), 0xa28 (0xa1956050)

Updated May 25 22:22:36.079

local adjacency 10.0.0.14

Prefix Len 32, traffic index 0, precedence n/a, priority 1

via 10.0.0.14/32, GigabitEthernet0/0/0/1, 9 dependencies, weight 0, class 0 [flags 0x0]

path-idx 0 NHID 0x0 [0xa1824250 0x0]

next hop 10.0.0.14/32

local adjacency

local label 400066 labels imposed {400066}

via 10.0.0.18/32, GigabitEthernet0/0/0/2, 9 dependencies, weight 0, class 0 [flags 0x0]

path-idx 1 NHID 0x0 [0xa18243f4 0x0]

next hop 10.0.0.18/32

local adjacency

local label 400066 labels imposed {400066}

RP/0/0/CPU0:SR-HE1#

RP/0/0/CPU0:SR-HE1#show-forward 400066

RP/0/0/CPU0:SR-HE1#show mpls forwarding labels 400066

Fri May 25 23:18:55.698 UTC

Local Outgoing Prefix Outgoing Next Hop Bytes

Label Label or ID Interface Switched

------ ----------- ------------------ ------------ --------------- ------------

400066 400066 SR Pfx (idx 66) Gi0/0/0/1 10.0.0.14 6047

400066 SR Pfx (idx 66) Gi0/0/0/2 10.0.0.18 0

RP/0/0/CPU0:SR-HE1#

RP/0/0/CPU0:SR-HE1#show-forward 400066

RP/0/0/CPU0:SR-HE1#show mpls forwarding labels 400066

Fri May 25 23:18:57.038 UTC

Local Outgoing Prefix Outgoing Next Hop Bytes

Label Label or ID Interface Switched

------ ----------- ------------------ ------------ --------------- ------------

400066 400066 SR Pfx (idx 66) Gi0/0/0/1 10.0.0.14 6223

400066 SR Pfx (idx 66) Gi0/0/0/2 10.0.0.18 0

RP/0/0/CPU0:SR-HE1#

RP/0/0/CPU0:SR-LSR1#

RP/0/0/CPU0:SR-LSR1#show-route 192.168.0.6

RP/0/0/CPU0:SR-LSR1#show route 192.168.0.6

Fri May 25 23:24:01.698 UTC

Routing entry for 192.168.0.6/32

Known via "isis 16509", distance 115, metric 1, labeled SR, type level-2

Installed May 25 22:22:33.321 for 01:01:28

Routing Descriptor Blocks

10.0.0.26, from 192.168.0.6, via GigabitEthernet0/0/0/1

Route metric is 1

No advertising protos.

RP/0/0/CPU0:SR-LSR1#

RP/0/0/CPU0:SR-LSR1#show-cef 192.168.0.6

RP/0/0/CPU0:SR-LSR1#show cef 192.168.0.6

Fri May 25 23:24:06.508 UTC

192.168.0.6/32, version 56, labeled SR, internal 0x1000001 0x81 (ptr 0xa14d8ecc) [1], 0x0 (0xa14be5f0), 0xa20 (0xa1678190)

Updated May 25 22:22:33.341

local adjacency 10.0.0.26

Prefix Len 32, traffic index 0, precedence n/a, priority 1

via 10.0.0.26/32, GigabitEthernet0/0/0/1, 9 dependencies, weight 0, class 0 [flags 0x0]

path-idx 0 NHID 0x0 [0xa18022a4 0xa18022f8]

next hop 10.0.0.26/32

local adjacency

local label 400066 labels imposed {ImplNull}

RP/0/0/CPU0:SR-LSR1#

RP/0/0/CPU0:SR-LSR1#show-forward 400066

RP/0/0/CPU0:SR-LSR1#show mpls forwarding labels 400066

Fri May 25 23:24:11.318 UTC

Local Outgoing Prefix Outgoing Next Hop Bytes

Label Label or ID Interface Switched

------ ----------- ------------------ ------------ --------------- ------------

400066 Pop SR Pfx (idx 66) Gi0/0/0/1 10.0.0.26 48212

RP/0/0/CPU0:SR-LSR1#

RP/0/0/CPU0:SR-LSR1#show-forward-400066

RP/0/0/CPU0:SR-LSR1#show mpls forwarding labels 400066

Fri May 25 23:24:13.338 UTC

Local Outgoing Prefix Outgoing Next Hop Bytes

Label Label or ID Interface Switched

------ ----------- ------------------ ------------ --------------- ------------

400066 Pop SR Pfx (idx 66) Gi0/0/0/1 10.0.0.26 48380

RP/0/0/CPU0:SR-LSR1#

Key Learning from LAB Module 1:

* Each SR node assigns an unique node identifier that is drivered by combing the SRGB Global block and Prefix Index.
* Node SID’s are exchanged within ISIS using new TLV’s there by eliminating the requirement for any label distribution protocol
* With SR based on IGP forward, labels are imposed based on IGP best path.

## Lab Module 2: Enable BGP Control plane for pushing SR Policies from XTC Controller

## Logical Topology

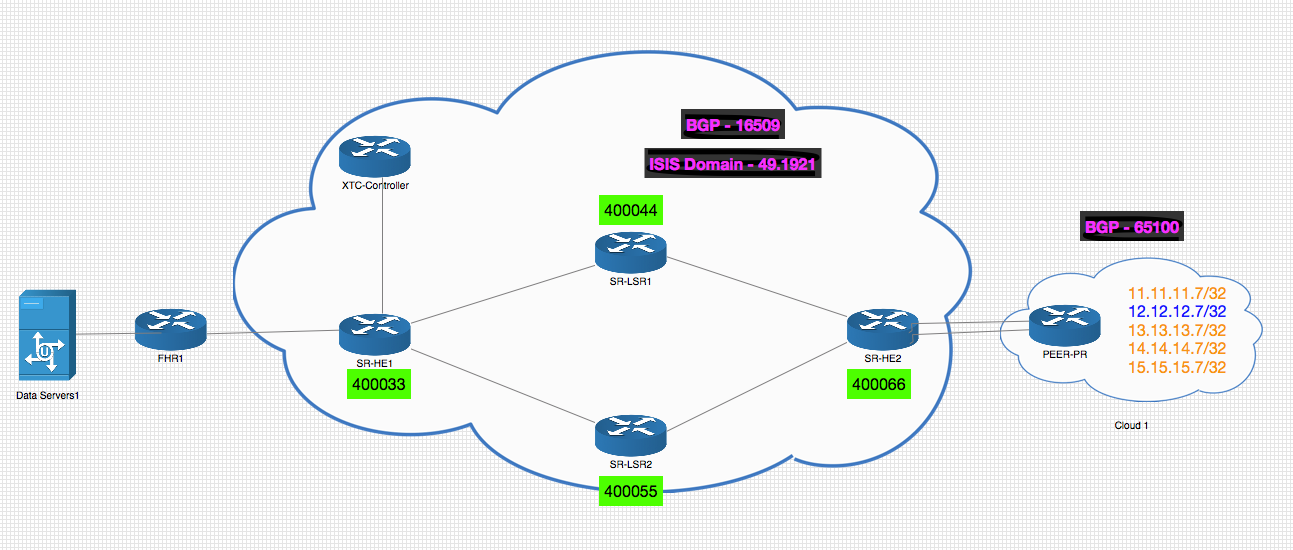


Figure 4 – Network Topology with IGP and Segment Routing enabled

In this lab, You will configure Internet prefixes simulated through (x.x.x.x.7/32) subnets to be colored and enable necessary control plane configuration between XTC-Controller and SR-TE1.

1. Peering is preconfigured between SR-TE2 and Peer-PR and subnets with x.x.x.7/32 advertised. Validate that BGP Internet prefixes are received on SR-HE1 router.

RP/0/0/CPU0:SR-HE1#show-bgp

RP/0/0/CPU0:SR-HE1#show bgp

Sat May 26 18:00:38.638 UTC

BGP router identifier 192.168.0.3, local AS number 16509

BGP generic scan interval 60 secs

Non-stop routing is enabled

BGP table state: Active

Table ID: 0xe0000000 RD version: 76

BGP main routing table version 76

BGP NSR Initial initsync version 2 (Reached)

BGP NSR/ISSU Sync-Group versions 0/0

BGP scan interval 60 secs

Status codes: s suppressed, d damped, h history, \* valid, > best

i - internal, r RIB-failure, S stale, N Nexthop-discard

Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path

\*>i11.11.11.7/32 192.168.0.6 0 100 0 65100 i

\*>i12.12.12.7/32 192.168.0.6 0 100 0 65100 i

\*>i13.13.13.7/32 192.168.0.6 0 100 0 65100 i

\*>i14.14.14.7/32 192.168.0.6 0 100 0 65100 i

\*>i15.15.15.7/32 192.168.0.6 0 100 0 65100 i

\*> 192.168.0.3/32 0.0.0.0 0 32768 i

\*>i192.168.0.6/32 192.168.0.6 0 100 0 i

\*>i192.168.0.7/32 192.168.0.6 0 100 0 65100 i

\*>i192.168.0.8/32 192.168.0.8 0 100 0 i

Processed 9 prefixes, 9 paths

RP/0/0/CPU0:SR-HE1#

1. Enable the BGP color configuration so prefixes are appropriately colored as per design. XTC Segment routing Policy will route traffic based on color and end point. For the lab purpose, we will color internet prefixes with color 1 & 2.
   1. Ext-community-set with color mapping is preconfigured on SR-HE1 router

RP/0/0/CPU0:SR-HE1#show run extcommunity-set opaque color1

Sun May 27 01:11:52.595 UTC

extcommunity-set opaque color1

1

end-set

!

RP/0/0/CPU0:SR-HE1#show run extcommunity-set opaque color2

Sun May 27 01:11:54.365 UTC

extcommunity-set opaque color2

2

end-set

!

* 1. Prefixes-set has been preconfigured for internet prefixes with x.x.x.x/32

RP/0/0/CPU0:SR-HE1#show run prefix-set epe-prefixes

epe-prefixes epe-prefixes-12

RP/0/0/CPU0:SR-HE1#show run prefix-set epe-prefixes-12

Sun May 27 01:14:05.096 UTC

prefix-set epe-prefixes-12

12.12.12.7/32

end-set

* 1. Ext-community-set with color mapping is preconfigured on SR-HE1 router

!

RP/0/0/CPU0:SR-HE1#sho run route-policy color-policy

Sun May 27 01:12:23.893 UTC

route-policy color-policy

if destination in epe-prefixes-12 then

set extcommunity color color2

else

set extcommunity color color1

endif

end-policy

!

* 1. Configure route-policy such that prefix 12.12.12.7/32 has been set with color 2, and remaining BGP internet prefixes from AS 65000 are set with Color one.

RP/0/0/CPU0:SR-HE1#conf t

Sun May 27 01:26:11.676 UTC

RP/0/0/CPU0:SR-HE1(config)#

RP/0/0/CPU0:SR-HE1(config)#config-bgp-color

RP/0/0/CPU0:SR-HE1(config)#router bgp 16509

RP/0/0/CPU0:SR-HE1(config)#neighbor 192.168.0.8

RP/0/0/CPU0:SR-HE1(config)#address-family ipv4 unicast

RP/0/0/CPU0:SR-HE1(config)#route-policy color-policy in

RP/0/0/CPU0:SR-HE1(config)#commit

Sun May 27 01:32:42.690 UTC

RP/0/0/CPU0:SR-HE1(config)#end

RP/0/0/CPU0:SR-HE1#

1. Validate the simulated BGP prefixes are colored as designed.

RP/0/0/CPU0:SR-HE1#show-bgp 11.11.11.7

RP/0/0/CPU0:SR-HE1#show bgp 11.11.11.7

Sun May 27 01:47:49.257 UTC

BGP routing table entry for 11.11.11.7/32

Versions:

Process bRIB/RIB SendTblVer

Speaker 70 70

Last Modified: May 26 17:59:09.756 for 07:48:39

Paths: (1 available, best #1)

Not advertised to any peer

Path #1: Received by speaker 0

Not advertised to any peer

65100

192.168.0.6 (metric 2) from 192.168.0.8 (192.168.0.6)

Origin IGP, metric 0, localpref 100, valid, internal, best, group-best

Received Path ID 0, Local Path ID 1, version 70

Extended community: Color:1

Originator: 192.168.0.6, Cluster list: 192.168.0.8

RP/0/0/CPU0:SR-HE1#.

RP/0/0/CPU0:SR-HE1#show-bgp 12.12.12.7

RP/0/0/CPU0:SR-HE1#show bgp 12.12.12.7

Sun May 27 01:47:58.587 UTC

BGP routing table entry for 12.12.12.7/32

Versions:

Process bRIB/RIB SendTblVer

Speaker 71 71

Last Modified: May 26 17:59:09.756 for 07:48:48

Paths: (1 available, best #1)

Not advertised to any peer

Path #1: Received by speaker 0

Not advertised to any peer

65100

192.168.0.6 (metric 2) from 192.168.0.8 (192.168.0.6)

Origin IGP, metric 0, localpref 100, valid, internal, best, group-best

Received Path ID 0, Local Path ID 1, version 71

Extended community: Color:2

Originator: 192.168.0.6, Cluster list: 192.168.0.8

RP/0/0/CPU0:SR-HE1#

1. Configure and SR Address-family between XTC-Controller and SR-HE1. XTC has been preconfigured.

Config t

RP/0/0/CPU0:SR-HE1(config)#config-bgp-srpolicy

RP/0/0/CPU0:SR-HE1(config)#router bgp 16509

RP/0/0/CPU0:SR-HE1(config)#address-family ipv4 sr-policy

RP/0/0/CPU0:SR-HE1(config)#neighbor 192.168.0.8

RP/0/0/CPU0:SR-HE1(config)#address-family ipv4 sr-policy

RP/0/0/CPU0:SR-HE1(config)#commit

Sun May 27 02:05:42.614 UTC

RP/0/0/CPU0:SR-HE1(config)#end

1. Review the BGP configuration on XTC-Controller

RP/0/0/CPU0:XTC-Controller#show-bgp

RP/0/0/CPU0:XTC-Controller#show run router bgp

Sun May 27 02:09:14.451 UTC

router bgp 16509

bgp router-id 192.168.0.8

address-family ipv4 unicast

network 192.168.0.8/32

!

address-family link-state link-state

!

address-family ipv4 sr-policy

!

neighbor 192.168.0.3

remote-as 16509

description iBGP peer SR-HE-LER1

update-source Loopback0

address-family ipv4 unicast

route-reflector-client

!

address-family ipv4 sr-policy

!

!

neighbor 192.168.0.6

remote-as 16509

description iBGP peer SR-HE-LER2

update-source Loopback0

address-family ipv4 unicast

route-reflector-client

!

1. Validate that neighbours are up and running.

IPv4 address family and SR-Policy address family is up and running. XTC will utilize the SR-Policy address family to push the policy to the headend

RP/0/0/CPU0:SR-HE1#show-bgp-sum-filter

RP/0/0/CPU0:SR-HE1#show bgp all all summary | inc "Address|192.168.0.8"

Sun May 27 02:12:53.584 UTC

Address Family: IPv4 Unicast

192.168.0.8 0 16509 6444 6427 108 0 0 00:06:45 8

Address Family: IPv4 SR-policy

192.168.0.8 0 16509 6444 6427 2 0 0 00:06:45 0

RP/0/0/CPU0:SR-HE1#

Key Learning from LAB Module 2:

* Apply route-policy on BGP In-bound coming from route reflector.
* Leverage Color community to each of the external prefixes to be policy routed.

## Lab Module 3: Provision an SR-Policy via XTC Controller

## Network Topology:

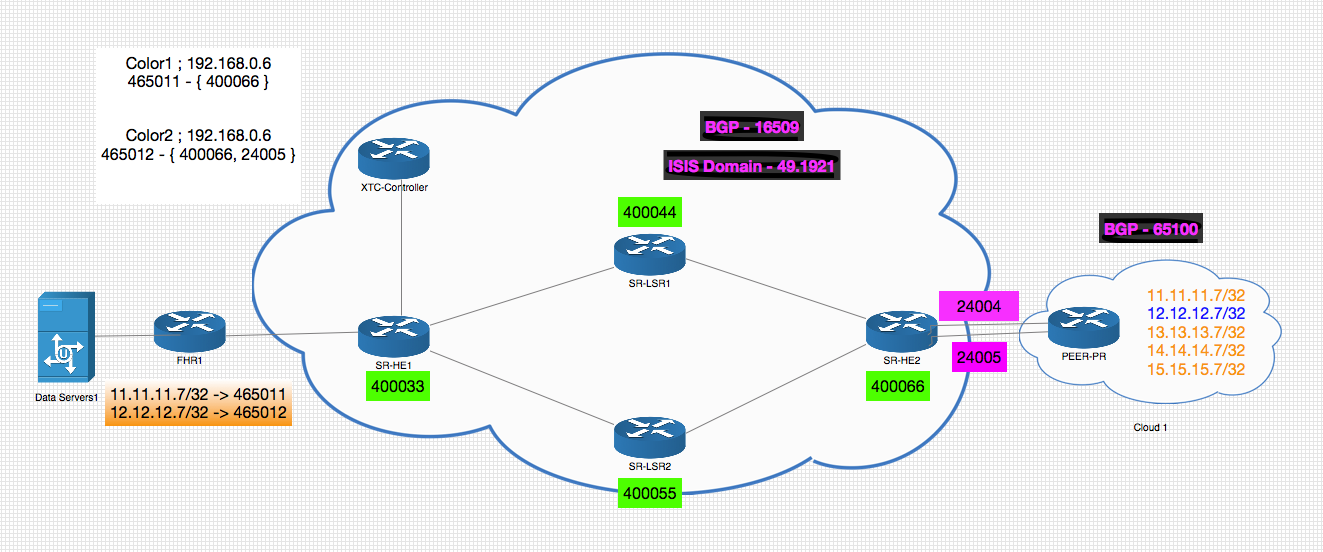


Figure 5 – Network Topology with SR Policy Provisioned.

In this lab module, you will enable SR policy such that different applications are treated differently within the network. Application is uniquely identified by its BSID (Binding SID). After validating the policy, remove policy.

SR-Policy can be provisioned statically or through Controller. For this exercise, we will push the policy using either curl or Postman.

1. Push the following policy from the Server-1 device using Curl command. Server-1 configures the policy on XTC and it advertises through the BGP neighbour.

cisco@server-1:~$ curl --request POST --url http://192.168.0.8:8080/srpolicy-install --header 'cache-control: no-cache' --header 'content-type: application/json' --data '{"source" : "192.168.0.3", "end-point" : "192.168.0.6", "binding-sid" : 465011, "color" : 1, "preference" : 100, "route-distinguisher" : 2, "path-list" : [{"label-stack" : [400066], "weight" : 1}]}'

1. On successful provision, you will receive a success message. For false response, please reach out to proctor. There is a problem in the syntax

{"success": true}cisco@server-1:~$

1. Validate the policy being provisioned on XTC-Controller

RP/0/0/CPU0:XTC-Controller#show-xtc-policy

RP/0/0/CPU0:XTC-Controller#show segment-routing traffic-eng controller policy-$

Sun May 27 02:28:24.022 UTC

Policy request database:

----------------------

Color: 1 End-Point: 192.168.0.6

Source: 192.168.0.3

Binding SID: 465011

Preference: 100

Route distinguisher: 2

Creation Time: Sun May 27 02:23:30 UTC 2018

Paths:

Preference 100:

Explicit: segment-list (active)

Weight: 1, Metric Type: Unknown

400066

1. Validate the policy being provisioned on SR-HE1

RP/0/0/CPU0:SR-HE1#show-xtc-policy

RP/0/0/CPU0:SR-HE1#show segment-routing traffic-eng policy

Sun May 27 02:35:22.862 UTC

SR-TE policy database

---------------------

Name: bgp\_AP\_5 (Color: 1, End-point: 192.168.0.6)

Status:

Admin: up Operational: up for 00:11:52 (since May 27 02:23:30.061)

Candidate-paths:

Preference 100:

Explicit: segment-list Autolist\_5\_1\* (active)

Weight: 1, Metric Type: IGP

400066

Attributes:

Binding SID: 465011

Allocation mode: explicit

State: Programmed

Policy selected: yes

Forward Class: 0

Steering BGP disabled: no

IPv6 caps enable: yes

Distinguisher: 2

Auto-policy info:

Creator: BGP

RP/0/0/CPU0:SR-HE1#

1. Check the BGP to validate proper color has been set for BGP Prefixes

RP/0/0/CPU0:SR-HE1#show-bgp

RP/0/0/CPU0:SR-HE1#show bgp

Sun May 27 02:31:50.806 UTC

….

Status codes: s suppressed, d damped, h history, \* valid, > best

i - internal, r RIB-failure, S stale, N Nexthop-discard

Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path

\*>i11.11.11.7/32 192.168.0.6 C:1 0 100 0 65100 i

\*>i12.12.12.7/32 192.168.0.6 0 100 0 65100 i

\*>i13.13.13.7/32 192.168.0.6 C:1 0 100 0 65100 i

\*>i14.14.14.7/32 192.168.0.6 C:1 0 100 0 65100 i

\*>i15.15.15.7/32 192.168.0.6 C:1 0 100 0 65100 i

\*> 192.168.0.3/32 0.0.0.0 0 32768 i

\*>i192.168.0.6/32 192.168.0.6 C:1 0 100 0 i

\*>i192.168.0.7/32 192.168.0.6 C:1 0 100 0 65100 i

\*>i192.168.0.8/32 192.168.0.8 0 100 0 i

Processed 9 prefixes, 9 paths

RP/0/0/CPU0:SR-HE1#

1. Validate the SR-Policy has been programmed on forwarding plane

RP/0/0/CPU0:SR-HE1#show-mpls-labels 465011

RP/0/0/CPU0:SR-HE1#show mpls forwarding labels 465011

Sun May 27 02:46:26.786 UTC

Local Outgoing Prefix Outgoing Next Hop Bytes

Label Label or ID Interface Switched

------ ----------- ------------------ ------------ --------------- ------------

465011 Pop No ID bgp\_AP\_5 point2point 0

RP/0/0/CPU0:SR-HE1#

RP/0/0/CPU0:SR-HE1#show-sr-tunnel bgp\_AP\_5

RP/0/0/CPU0:SR-HE1#show mpls forwarding tunnels sr-policy name bgp\_AP\_5

Sun May 27 02:46:33.476 UTC

Tunnel Outgoing Outgoing Next Hop Bytes

Name Label Interface Switched

------------- ----------- ------------ --------------- ------------

bgp\_AP\_5 (SR) 400066 Gi0/0/0/1 10.0.0.14 0

400066 Gi0/0/0/2 10.0.0.18 0

RP/0/0/CPU0:SR-HE1#

1. Configure FHR1 to push the BSID for the traffic originating from the host application. The purpose of the step is to simulate application coming from server sending with BSID Label

RP/0/0/CPU0:SR-FHR1(config)#

RP/0/0/CPU0:SR-FHR1(config)#config-mpls-static

RP/0/0/CPU0:SR-FHR1(config)#mpls static

RP/0/0/CPU0:SR-FHR1(config)#interface GigabitEthernet0/0/0/1

RP/0/0/CPU0:SR-FHR1(config)#address-family ipv4 unicast

RP/0/0/CPU0:SR-FHR1(config)#local-label 465011 allocate per-prefix 11.11.11.7/32

RP/0/0/CPU0:SR-FHR1(config)#forward

RP/0/0/CPU0:SR-FHR1(config)#path 1 nexthop GigabitEthernet0/0/0/1 10.0.0.10 out-label 465011

RP/0/0/CPU0:SR-FHR1(config)#local-label 465012 allocate per-prefix 12.12.12.7/32

RP/0/0/CPU0:SR-FHR1(config)#forward

RP/0/0/CPU0:SR-FHR1(config)#path 1 nexthop GigabitEthernet0/0/0/1 10.0.0.10 out-label 465012

RP/0/0/CPU0:SR-FHR1(config)#commit

Sun May 27 02:52:56.188 UTC

RP/0/0/CPU0:SR-FHR1(config)#end

1. Validate the data plane traffic is going through the SR Policy
   1. Enable end to end ping to a prefix with color mapping of 1. For the purpose of the test we will send traffic to 11.11.11.7

cisco@server-1:~$ ping 11.11.11.7

PING 11.11.11.7 (11.11.11.7) 56(84) bytes of data.

64 bytes from 11.11.11.7: icmp\_seq=1 ttl=251 time=35.7 ms

64 bytes from 11.11.11.7: icmp\_seq=2 ttl=251 time=32.1 ms

64 bytes from 11.11.11.7: icmp\_seq=3 ttl=251 time=34.5 ms

* 1. Validate the forwarding counters on SR-HE1 increments. We can see traffic coming from server with BSID of 465011 are forwarded via SR-Policy.

RP/0/0/CPU0:SR-HE1#show mpls forwarding tunnels sr-policy name bgp\_AP\_5

Sun May 27 02:56:57.953 UTC

Tunnel Outgoing Outgoing Next Hop Bytes

Name Label Interface Switched

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bgp\_AP\_5 (SR) 400066 Gi0/0/0/1 10.0.0.14 8536

400066 Gi0/0/0/2 10.0.0.18 0

RP/0/0/CPU0:SR-HE1#

1. Remove the SR-policy for baseline the config for next lab setup

cisco@server-1:~$ curl --request DELETE --url http://192.168.0.8:8080/srpolicy-install --header 'cache-control: no-cache' --header 'content-type: application/json' --data '{"source" : "192.168.0.3", "end-point" : "192.168.0.6", "binding-sid" : 465011, "color" : 1, "preference" : 100, "route-distinguisher" : 2, "path-list" : [{"label-stack" : [400066], "weight" : 1}]}'

{"success": true}cisco@server-1:~$

1. Validate the policy has been removed from the SR-HE1.

RP/0/0/CPU0:SR-HE1#show-xtc-policy

RP/0/0/CPU0:SR-HE1#show segment-routing traffic-eng policy

Sun May 27 03:08:26.696 UTC

RP/0/0/CPU0:SR-HE1#

Key learning from Module 3:

* XTC Controller can be accessed via Curl or Postman.
* SR Policy is provisioned through XTC controller on to head-end device
* By sending the application with appropriate BDID, it can be policy routed across the network

## Module Lab 4: Egress Peer Engineering

## Network Topology:

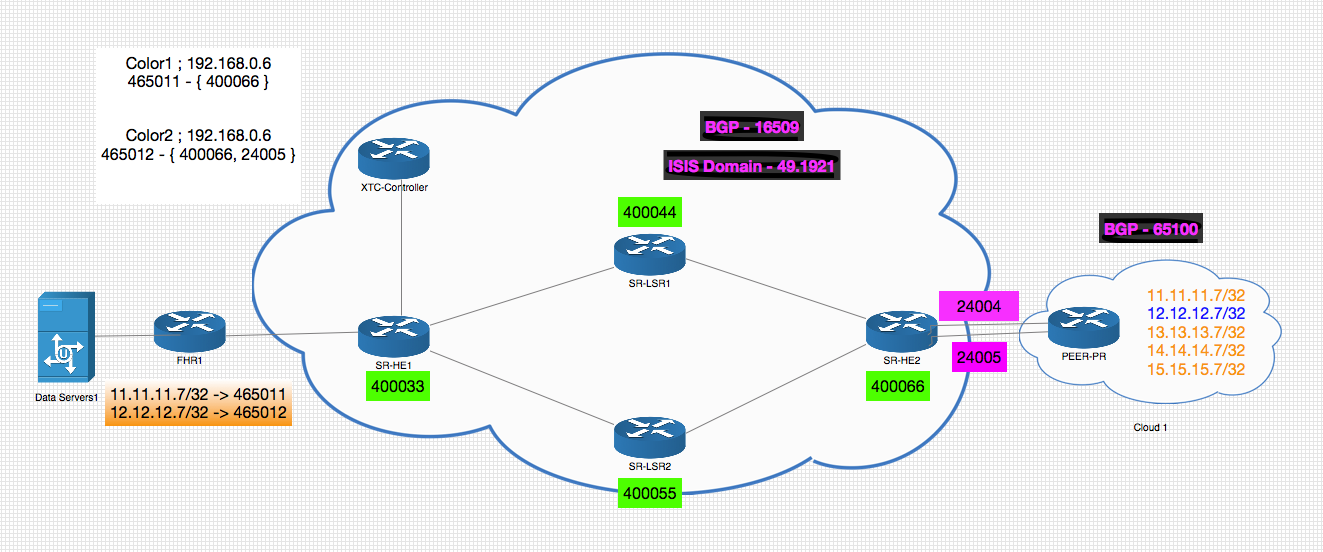


Figure 6 – Network Topology with SR Policy Provisioned with EPE

In this lab, you will enable Egress peer engineering, and push a policy where by as operator you determine which egress interface can be utilized

1. Configure EPE peer engineering on SR-HE2

RP/0/0/CPU0:SR-HE2(config)#configure-epe

RP/0/0/CPU0:SR-HE2(config)#router bgp 16509

RP/0/0/CPU0:SR-HE2(config)#neighbor 10.0.0.34

RP/0/0/CPU0:SR-HE2(config)#egress-engineering

RP/0/0/CPU0:SR-HE2(config)#neighbor 10.0.0.38

RP/0/0/CPU0:SR-HE2(config)#egress-engineering

RP/0/0/CPU0:SR-HE2(config)#commit

Sun May 27 19:10:17.033 UTC

RP/0/0/CPU0:SR-HE2(config)#end

1. Validate the EPE, and identify the labels being assigned to interface peer.

RP/0/0/CPU0:SR-HE2#show bgp egress-engineering

Sun May 27 19:15:46.930 UTC

Egress Engineering Peer Set: 10.0.0.34/32 (14637008)

Nexthop: 10.0.0.34

Version: 2, rn\_version: 2

Flags: 0x00000006

Local ASN: 16509

Remote ASN: 65100

Local RID: 192.168.0.6

Remote RID: 192.168.0.7

Local Address: 10.0.0.33

First Hop: 10.0.0.34

NHID: 2

IFH: 0x80

Label: 24004, Refcount: 3

rpc\_set: 14d0a378, ID: 1

Egress Engineering Peer Set: 10.0.0.38/32 (14636f64)

Nexthop: 10.0.0.38

Version: 3, rn\_version: 3

Flags: 0x00000006

Local ASN: 16509

Remote ASN: 65100

Local RID: 192.168.0.6

Remote RID: 192.168.0.7

Local Address: 10.0.0.37

First Hop: 10.0.0.38

NHID: 3

IFH: 0xa0

Label: 24005, Refcount: 3

rpc\_set: 14d0a3f0, ID: 2

1. Identify the best path and the next hop. EPE-HE2 through BGP best practice choose by default on 10.0.0.34.

RP/0/0/CPU0:SR-HE2#show bgp

Sun May 27 19:24:57.263 UTC

BGP router identifier 192.168.0.6, local AS number 16509

BGP generic scan interval 60 secs

Non-stop routing is enabled

BGP table state: Active

Table ID: 0xe0000000 RD version: 34

BGP main routing table version 34

BGP NSR Initial initsync version 2 (Reached)

BGP NSR/ISSU Sync-Group versions 0/0

BGP scan interval 60 secs

Status codes: s suppressed, d damped, h history, \* valid, > best

i - internal, r RIB-failure, S stale, N Nexthop-discard

Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path

\*>i0.0.0.0/0 192.168.0.3 100 0 i

\*> 11.11.11.7/32 10.0.0.34 0 0 65100 i

\* 10.0.0.38 0 0 65100 i

\*> 12.12.12.7/32 10.0.0.34 0 0 65100 i

\* 10.0.0.38 0 0 65100 i

\*> 13.13.13.7/32 10.0.0.34 0 0 65100 i

\* 10.0.0.38 0 0 65100 i

\*> 14.14.14.7/32 10.0.0.34 0 0 65100 i

\* 10.0.0.38 0 0 65100 i

\*> 15.15.15.7/32 10.0.0.34 0 0 65100 i

\* 10.0.0.38 0 0 65100 i

\*>i192.168.0.3/32 192.168.0.3 0 100 0 i

\*> 192.168.0.6/32 0.0.0.0 0 32768 i

\*> 192.168.0.7/32 10.0.0.34 0 0 65100 i

\* 10.0.0.38 0 0 65100 i

\*>i192.168.0.8/32 192.168.0.8 0 100 0 i

Processed 10 prefixes, 16 paths

RP/0/0/CPU0:SR-HE2#

1. Provision 2 policy on the XTC such that, traffic destined to node 11.11.11.7/32 is preferred over BGP Next hop; traffic destined to node 12.12.12.7/32 is preferred over BGP Next hop;
   1. Push Policy 1 – BSID 465011 for { 1, 192.168.0.6 } forwarded with Label of {400066}

cisco@server-1:~$ curl --request POST --url http://192.168.0.8:8080/srpolicy-install --header 'cache-control: no-cache' --header 'content-type: application/json' --data '{"source" : "192.168.0.3", "end-point" : "192.168.0.6", "binding-sid" : 465011, "color" : 1, "preference" : 100, "route-distinguisher" : 2, "path-list" : [{"label-stack" : [400066], "weight" : 1}]}'

{"success": true}cisco@server-1:~$

* 1. Push Policy 2 – BSID 465012 for { 2, 192.168.0.6 } forwarded with Label of {400066, 24005}. Note Prefix 12.12.12.7 is tagged with Color or 2.

cisco@server-1:~$ curl --request POST --url http://192.168.0.8:8080/srpolicy-install --header 'cache-control: no-cache' --header 'content-type: application/json' --data '{"source" : "192.168.0.3", "end-point" : "192.168.0.6", "binding-sid" : 465012, "color" : 2, "preference" : 100, "route-distinguisher" : 2, "path-list" : [{"label-stack" : [400066, 24005], "weight" : 1}]}'

{"success": true}cisco@server-1:~$

1. Validate on SR-HE1, the policy has been provisioned.

RP/0/0/CPU0:SR-HE1#show segment-routing traffic-eng policy

Sun May 27 20:13:21.563 UTC

SR-TE policy database

---------------------

Name: bgp\_AP\_6 (Color: 1, End-point: 192.168.0.6)

Status:

Admin: up Operational: up for 00:07:43 (since May 27 20:05:38.325)

Candidate-paths:

Preference 100:

Explicit: segment-list Autolist\_6\_1\* (active)

Weight: 1, Metric Type: IGP

400066

Attributes:

Binding SID: 465011

Allocation mode: explicit

State: Programmed

Policy selected: yes

Forward Class: 0

Steering BGP disabled: no

IPv6 caps enable: yes

Distinguisher: 2

Auto-policy info:

Creator: BGP

Name: bgp\_AP\_7 (Color: 2, End-point: 192.168.0.6)

Status:

Admin: up Operational: up for 00:06:09 (since May 27 20:07:12.659)

Candidate-paths:

Preference 100:

Explicit: segment-list Autolist\_7\_1\* (active)

Weight: 1, Metric Type: IGP

400066

24005

Attributes:

Binding SID: 465012

Allocation mode: explicit

State: Programmed

Policy selected: yes

Forward Class: 0

Steering BGP disabled: no

IPv6 caps enable: yes

Distinguisher: 2

Auto-policy info:

Creator: BGP

1. Originate traffic from Server destined towards 11.11.11.7, and validate the traffic goes over the BGP preferred next hop interface.

cisco@server-1:~$ ping 11.11.11.7

PING 11.11.11.7 (11.11.11.7) 56(84) bytes of data.

64 bytes from 11.11.11.7: icmp\_seq=1 ttl=251 time=34.7 ms

64 bytes from 11.11.11.7: icmp\_seq=2 ttl=251 time=59.5 ms

64 bytes from 11.11.11.7: icmp\_seq=3 ttl=251 time=33.0 ms

64 bytes from 11.11.11.7: icmp\_seq=4 ttl=251 time=29.9 ms

64 bytes from 11.11.11.7: icmp\_seq=5 ttl=251 time=37.5 ms

RP/0/0/CPU0:SR-HE1#show mpls forwarding tunnels sr-policy name bgp\_AP\_6

Sun May 27 20:18:30.792 UTC

Tunnel Outgoing Outgoing Next Hop Bytes

Name Label Interface Switched

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bgp\_AP\_6 (SR) 400066 Gi0/0/0/1 10.0.0.14 8976

400066 Gi0/0/0/2 10.0.0.18 0

RP/0/0/CPU0:SR-HE1#show mpls forwarding tunnels sr-policy name bgp\_AP\_6

Sun May 27 20:18:32.572 UTC

Tunnel Outgoing Outgoing Next Hop Bytes

Name Label Interface Switched

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bgp\_AP\_6 (SR) 400066 Gi0/0/0/1 10.0.0.14 9064

400066 Gi0/0/0/2 10.0.0.18 0

RP/0/0/CPU0:SR-HE1#

1. Originate traffic from Server destined towards 12.12.12.7, and validate the traffic goes over the Policy routed interface

RP/0/0/CPU0:SR-HE1#show mpls forwarding tunnels sr-policy name bgp\_AP\_7

Sun May 27 20:23:21.362 UTC

Tunnel Outgoing Outgoing Next Hop Bytes

Name Label Interface Switched

------------- ----------- ------------ --------------- ------------

bgp\_AP\_7 (SR) 400066 Gi0/0/0/1 10.0.0.14 792

400066 Gi0/0/0/2 10.0.0.18 0

RP/0/0/CPU0:SR-HE1#

RP/0/0/CPU0:SR-HE1#show mpls forwarding tunnels sr-policy name bgp\_AP\_7

Sun May 27 20:23:23.532 UTC

Tunnel Outgoing Outgoing Next Hop Bytes

Name Label Interface Switched

------------- ----------- ------------ --------------- ------------

bgp\_AP\_7 (SR) 400066 Gi0/0/0/1 10.0.0.14 968

400066 Gi0/0/0/2 10.0.0.18 0

RP/0/0/CPU0:SR-HE1#

RP/0/0/CPU0:SR-HE2#show mpls forwarding labels 24005

Sun May 27 20:23:46.211 UTC

Local Outgoing Prefix Outgoing Next Hop Bytes

Label Label or ID Interface Switched

------ ----------- ------------------ ------------ --------------- ------------

24005 Pop No ID Gi0/0/0/3 10.0.0.38 2772

RP/0/0/CPU0:SR-HE2#show mpls forwarding labels 24005

Sun May 27 20:23:50.841 UTC

Local Outgoing Prefix Outgoing Next Hop Bytes

Label Label or ID Interface Switched

------ ----------- ------------------ ------------ --------------- ------------

24005 Pop No ID Gi0/0/0/3 10.0.0.38 3108

RP/0/0/CPU0:SR-HE2#show mpls forwarding labels 24005

Sun May 27 20:23:52.821 UTC

Local Outgoing Prefix Outgoing Next Hop Bytes

Label Label or ID Interface Switched

------ ----------- ------------------ ------------ --------------- ------------

24005 Pop No ID Gi0/0/0/3 10.0.0.38 3276

RP/0/0/CPU0:SR-HE2#

1. Delete the 2 policies from the servers.
   1. Delete Policy 1 – BSID 465011 for { 1, 192.168.0.6 } forwarded with Label of {400066}

cisco@server-1:~$ curl --request DELETE --url http://192.168.0.8:8080/srpolicy-install --header 'cache-control: no-cache' --header 'content-type: application/json' --data '{"source" : "192.168.0.3", "end-point" : "192.168.0.6", "binding-sid" : 465011, "color" : 1, "preference" : 100, "route-distinguisher" : 2, "path-list" : [{"label-stack" : [400066], "weight" : 1}]}'

{"success": true}cisco@server-1:~$

* 1. Delete Policy 2 – BSID 465012 for { 2, 192.168.0.6 } forwarded with Label of {400066, 24005}. Note Prefix 12.12.12.7 is tagged with Color or 2.

cisco@server-1:~$ curl --request Delete --url http://192.168.0.8:8080/srpolicy-install --header 'cache-control: no-cache' --header 'content-type: application/json' --data '{"source" : "192.168.0.3", "end-point" : "192.168.0.6", "binding-sid" : 465012, "color" : 2, "preference" : 100, "route-distinguisher" : 2, "path-list" : [{"label-stack" : [400066, 24005], "weight" : 1}]}'

{"success": true}cisco@server-1:~$

Key learning from lab module 4:

* Based on business decision, by leveraging controller, end user can choose a file based on explicit path different from BGP best path.