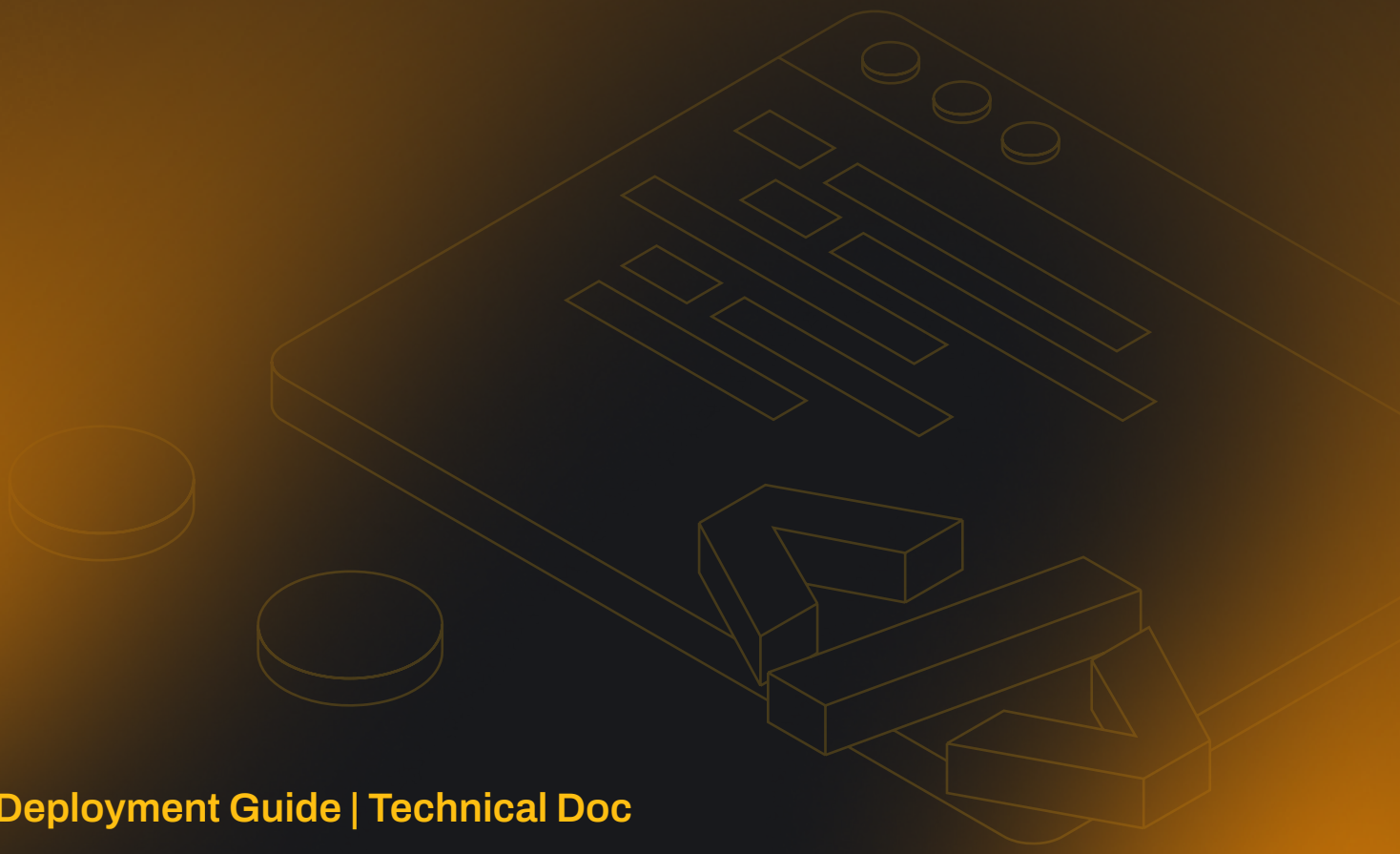
VyOS Networks



Deployment Guide | Technical Doc

SEGMENT ROUTING - TE USING SDN CONTROLLER - TRAFFIC DICTATOR

2026

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Introduction

In this document we are going to talk about SR-TE on VyOS, VyOS supports modern traffic engineering architectures based on Segment Routing (SR). Segment Routing Traffic Engineering (SR-TE) provides deterministic path control without the signaling complexity of traditional RSVP-TE, enabling simpler and more scalable network designs.

Centralized SR-TE

In centralized SR-TE, path computation and segment list generation are performed by an external controller. In this model, the router is responsible for the following functions:

- Advertising the IGP topology to the controller
- Receiving calculated SR-TE policies from the controller
- Steering traffic into the appropriate SR-TE policies

Although centralized SR-TE is simpler than RSVP-TE, the router must support several protocols and mechanisms, including:

- **BGP-LS** for topology advertisement
- **BGP SR-TE** or **PCEP** for receiving SR-TE policies
- Automated traffic steering

External controller, this case is important who defines our policies and give our routers the path to follow, this is covered by the traffic dictator, which we talked about later.

SR-TE Considerations

Segment Routing provides operational and scalability advantages over RSVP-TE; however, not all Segment Routing implementations fully support SR-TE. VyOS focuses on standards-based protocol support and interoperability, allowing SR-TE to be integrated into both distributed and controller-based traffic engineering architectures.

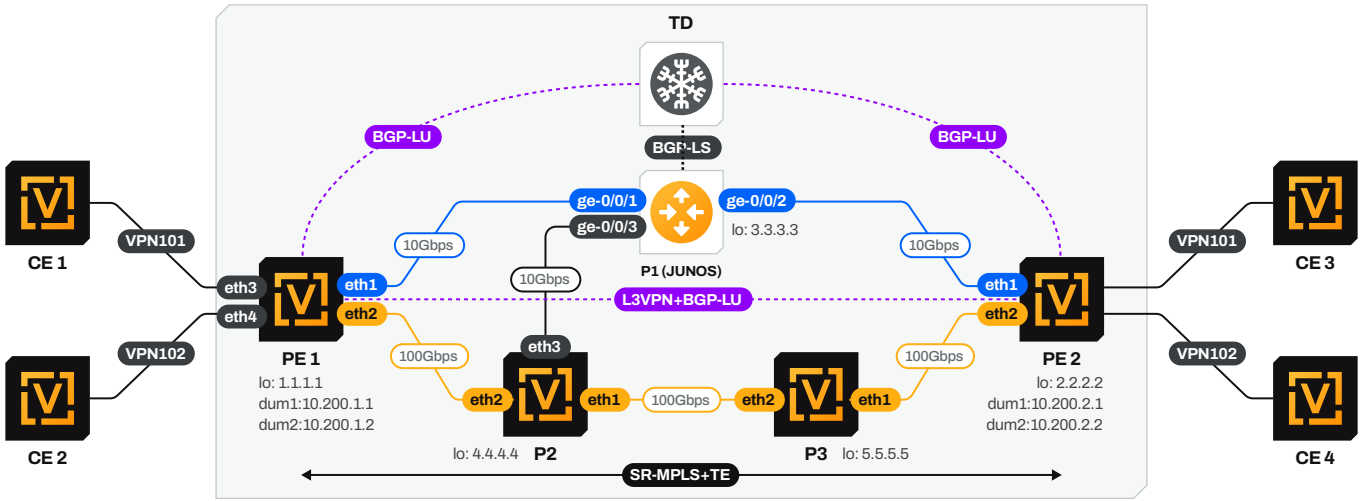
Scenario/Topology

This lab demonstrates a simple scenario in which multiple VRFs are configured on the same Provider Edge (PE) routers, a common use case in ISP environments.

On PE1 and PE2, two VRFs are configured: **VPN101** and **VPN102**.

- **CE1** and **CE3** belong to VRF **VPN101**
- **CE2** and **CE4** belong to VRF **VPN102**

Traffic engineering is used to steer traffic from each VRF over different network paths.



The primary objective of this design is to simplify the topology in order to support multiple types of use cases. As illustrated in the topology, there are two distinct paths in which affinity can be applied. Specifically, the BLUE path can be used to associate VPN101 with the service loopback interface (dum1), while the YELLOW path can be used to associate VPN102 with service loopback interface (dum2).

The goal is to deploy traffic engineering using affinity and bandwidth constraints, map different types of traffic to different policies, and ensure there is a predictable failure scenario if some links/router fail, or if the controller fails completely.

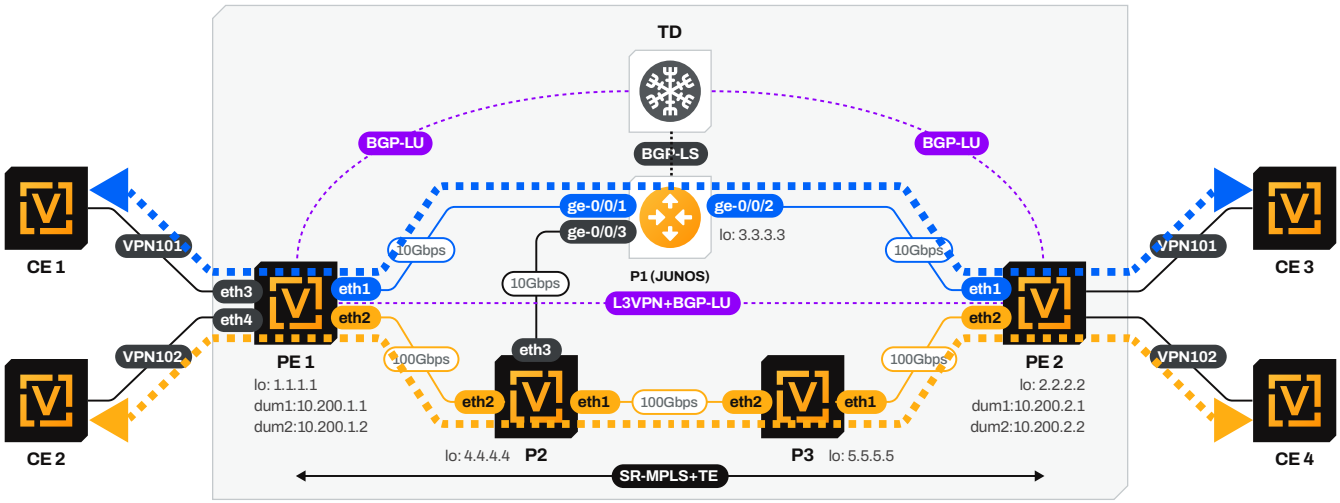
Traffic Dictator is used as a controller. It is easy to deploy and configure, and supports the most basic SR implementations.

> ⚠ This guide is not focused on installation of Traffic Dictator, we are to apply specific configuration to our use cases.This guide focuses only on applying specific configurations for our use cases and does not cover the installation of Traffic Dictator.

For more information about the deployment of Traffic Dictator, refer to https://vegvisir.ie/installation-and-upgrade/

Configurations and Deployment

BGP-LU policy with dynamic path (BLUE/YELLOW)



In this topology, PE2 has a “service-loopback” 10.200.2.1. It is not advertised into IGP but advertised into BGP-LU with nexthop of 2.2.2.2 which is the main PE2 loopback reachable via IGP.

Traffic Dictator sends a BGP-LU route to PE1, with prefix 10.200.2.1. and nexthop of P1 interface address. This way, the same behaviour as automated steering can be achieved even if routers do not support BGP SR-TE.

This example prefix that we received from CE3 , it will use the next-hop 10.200.2.1 goes trough eth1 which belong to P1

In the yellow scenario, PE2 has a **service loopback** at 10.200.2.2. This address is not injected into the IGP; instead, it is announced via BGP-LU with a next hop of 2.2.2.2, which corresponds to PE2’s primary loopback and is reachable through the IGP. As a result, VPN102 traffic will follow the **YELLOW** path.

Basic IGP configuration (CORE):
VyOS:

```
P2:

set system host-name P2
set interfaces ethernet eth1 address '10.100.4.4/24'
set interfaces ethernet eth2 address '10.100.2.4/24'
set interfaces ethernet eth3 address '10.100.10.4/24'
set interfaces loopback lo address '4.4.4.4/32'
set protocols traffic-engineering admin-group YELLOW bit-position '1'
set protocols traffic-engineering interface eth1 admin-group 'YELLOW'
set protocols traffic-engineering interface eth1 max-bandwidth '100000'
set protocols traffic-engineering interface eth1 max-reservable-bandwidth '100000'
set protocols traffic-engineering interface eth2 admin-group 'YELLOW'
set protocols traffic-engineering interface eth2 max-bandwidth '100000'
set protocols traffic-engineering interface eth2 max-reservable-bandwidth '100000'
```

```
set protocols traffic-engineering interface eth3 max-bandwidth '10000'
set protocols traffic-engineering interface eth3 max-reservable-bandwidth '10000'
set protocols isis interface eth1 network point-to-point
set protocols isis interface eth2 network point-to-point
set protocols isis interface eth3 network point-to-point
set protocols isis interface lo passive
set protocols isis level 'level-2'
set protocols isis lsp-mtu '1300'
set protocols isis net '49.0004.0004.0004.00'
set protocols isis segment-routing global-block high-label-value '865534'
set protocols isis segment-routing global-block low-label-value '800000'
set protocols isis segment-routing prefix 4.4.4.4/32 index value '4'
set protocols isis traffic-engineering enable
set protocols isis traffic-engineering export
set protocols mpls interface 'eth2'
set protocols mpls interface 'eth3'
set protocols mpls interface 'eth1'
set protocols mpls interface 'lo'

P3:

set system host-name 'P3'
set interfaces ethernet eth1 address '10.100.5.5/24'
set interfaces ethernet eth2 address '10.100.4.5/24'
set interfaces loopback lo address '5.5.5.5/32'
set protocols traffic-engineering admin-group YELLOW bit-position '1'
set protocols traffic-engineering interface eth1 admin-group 'YELLOW'
set protocols traffic-engineering interface eth1 max-bandwidth '100000'
set protocols traffic-engineering interface eth1 max-reservable-bandwidth '100000'
set protocols traffic-engineering interface eth2 admin-group 'YELLOW'
set protocols traffic-engineering interface eth2 max-bandwidth '100000'
set protocols traffic-engineering interface eth2 max-reservable-bandwidth '100000'
set protocols isis interface eth1 network point-to-point
set protocols isis interface eth2 network point-to-point
set protocols isis interface lo passive
set protocols isis level 'level-2'
set protocols isis lsp-mtu '1300'
set protocols isis net '49.0005.0005.0005.00'
set protocols isis segment-routing global-block high-label-value '865534'
set protocols isis segment-routing global-block low-label-value '800000'
set protocols isis segment-routing prefix 5.5.5.5/32 index value '5'
set protocols isis traffic-engineering enable
set protocols isis traffic-engineering export
set protocols mpls interface 'eth2'
set protocols mpls interface 'eth1'
set protocols mpls interface 'lo'
```

P1 (JUNOS):

```
set system host-name P1

set system services ssh root-login allow
set system management-instance
set chassis fpc 0 pic 0 number-of-ports 12
set interfaces ge-0/0/1 unit 0 family inet address 10.100.1.3/24
set interfaces ge-0/0/1 unit 0 family iso
set interfaces ge-0/0/1 unit 0 family mpls
set interfaces ge-0/0/2 unit 0 family inet address 10.100.3.3/24
set interfaces ge-0/0/2 unit 0 family iso
```

```
set interfaces ge-0/0/2 unit 0 family mpls
set interfaces ge-0/0/3 unit 0 family inet address 10.100.10.3/24
set interfaces ge-0/0/3 unit 0 family iso
set interfaces ge-0/0/3 unit 0 family mpls
set interfaces ge-0/0/5 unit 0 family inet address 192.168.0.103/24

set protocols isis interface ge-0/0/1.0 point-to-point
set protocols isis interface ge-0/0/2.0 point-to-point
set protocols isis interface ge-0/0/3.0 point-to-point
set protocols isis interface lo0.0
set protocols isis source-packet-routing node-segment ipv4-index 3
set protocols isis level 1 disable
set protocols isis level 2 wide-metrics-only
set protocols isis traffic-engineering l3-unicast-topology
set protocols mpls lsp-external-controller pccd
set protocols mpls traffic-engineering database import policy GET-TED
set protocols mpls traffic-engineering database import identifier 101
set protocols mpls traffic-engineering database import bgp-ls-identifier 101
set protocols mpls admin-groups BLUE 0
set protocols mpls admin-groups YELLOW 1
set protocols mpls interface ge-0/0/1.0 admin-group BLUE
set protocols mpls interface ge-0/0/2.0 admin-group BLUE
set protocols mpls interface ge-0/0/3.0
set protocols rsvp interface ge-0/0/1.0 bandwidth 10g
set protocols rsvp interface ge-0/0/2.0 bandwidth 10g
set protocols rsvp interface ge-0/0/3.0 bandwidth 10g
set interfaces lo0 unit 0 family inet address 3.3.3.3/32
set interfaces lo0 unit 0 family iso address 49.0003.0003.0003.00
set policy-options policy-statement EXPORT-BGP-LS from family traffic-engineering
set policy-options policy-statement EXPORT-BGP-LS from protocol isis
set policy-options policy-statement EXPORT-BGP-LS then accept
set policy-options policy-statement GET-TED term 1 from protocol isis
set policy-options policy-statement GET-TED term 1 then accept
set routing-instances mgmt_junos routing-options rib mgmt_junos.inet6.0 static route ::/0 next-hop 2001:db8::1
set routing-instances mgmt_junos routing-options static route 0.0.0.0/0 next-hop 10.0.0.2
set routing-options router-id 3.3.3.3
set routing-options autonomous-system 65002
set protocols bgp group TD family traffic-engineering unicast
set protocols bgp group TD export EXPORT-BGP-LS
set protocols bgp group TD peer-as 65001
set protocols bgp group TD neighbor 192.168.0.1
set protocols source-packet-routing lsp-external-controller pccd
set protocols lldp interface all
```

We are going to start with our PE1/2 configuration

VyOS-PE1

```
### PE1

### interfaces

set interfaces dummy dum1 address '10.200.1.1/32'
set interfaces dummy dum2 address '10.200.1.2/32'
set interfaces ethernet eth1 address '10.100.1.1/24'
set interfaces ethernet eth2 address '10.100.2.1/24'
set interfaces ethernet eth3 address '10.100.6.1/24'
set interfaces ethernet eth3 vrf 'VPN101'
set interfaces ethernet eth4 address '10.100.7.1/24'
```

```
set interfaces ethernet eth4 vrf 'VPN102'
set interfaces ethernet eth5 address '192.168.0.101/24'
set interfaces loopback lo address '1.1.1.1/32'

## BGP policy :

set policy prefix-list VPN101 rule 10 action 'permit'
set policy prefix-list VPN101 rule 10 prefix '192.168.1.1/32'
set policy prefix-list VPN102 rule 10 action 'permit'
set policy prefix-list VPN102 rule 10 prefix '192.168.2.2/32'
set policy route-map DENY_ALL rule 10 action 'deny'
set policy route-map LP500 rule 10 action 'permit'
set policy route-map LP500 rule 10 set local-preference '500'
set policy route-map PASS rule 10 action 'permit'
set policy route-map VPN_EXPORT rule 10 action 'permit'
set policy route-map VPN_EXPORT rule 10 match ip address prefix-list 'VPN101'
set policy route-map VPN_EXPORT rule 10 set ip-next-hop '10.200.1.1'
set policy route-map VPN_EXPORT rule 20 action 'permit'
set policy route-map VPN_EXPORT rule 20 match ip address prefix-list 'VPN102'
set policy route-map VPN_EXPORT rule 20 set ip-next-hop '10.200.1.2'
set policy route-map VPN_EXPORT rule 30 action 'permit'

set policy route-map VPN_EXPORT rule 30 set

### BGP-LU configuration:

set protocols bgp address-family ipv4-labeled-unicast network 10.200.1.1/32
set protocols bgp address-family ipv4-labeled-unicast network 10.200.1.2/32
set protocols bgp address-family ipv4-unicast network 10.200.1.1/32
set protocols bgp address-family ipv4-unicast network 10.200.1.2/32
set protocols bgp address-family ipv4-vpn
set protocols bgp interface eth5 mpls forwarding
set protocols bgp neighbor 2.2.2.2 address-family ipv4-labeled-unicast
set protocols bgp neighbor 2.2.2.2 address-family ipv4-vpn route-map export 'VPN_EXPORT'
set protocols bgp neighbor 2.2.2.2 remote-as '65002'
set protocols bgp neighbor 2.2.2.2 update-source 'lo'
set protocols bgp neighbor 192.168.0.1 address-family ipv4-labeled-unicast route-map export 'DENY_ALL'
set protocols bgp neighbor 192.168.0.1 address-family ipv4-labeled-unicast route-map import 'LP500'
set protocols bgp neighbor 192.168.0.1 remote-as '65001'
set protocols bgp parameters router-id '1.1.1.1'
set protocols bgp system-as '65002'

## ISIS and SR-TE

set protocols traffic-engineering admin-group BLUE bit-position '0'
set protocols traffic-engineering admin-group YELLOW bit-position '1'
set protocols traffic-engineering interface eth1 admin-group 'BLUE'
set protocols traffic-engineering interface eth1 max-bandwidth '10000'
set protocols traffic-engineering interface eth1 max-reservable-bandwidth '10000'
set protocols traffic-engineering interface eth2 admin-group 'YELLOW'
set protocols traffic-engineering interface eth2 max-bandwidth '100000'
set protocols traffic-engineering interface eth2 max-reservable-bandwidth '100000'
set protocols isis interface eth1 network point-to-point
set protocols isis interface eth2 network point-to-point
set protocols isis interface lo passive
set protocols isis level 'level-2'
set protocols isis lsp-mtu '1300'
set protocols isis net '49.0001.0001.0001.00'
set protocols isis segment-routing global-block high-label-value '865534'
set protocols isis segment-routing global-block low-label-value '800000'
set protocols isis segment-routing prefix 1.1.1.1/32 index value '1'
set protocols isis traffic-engineering enable
set protocols isis traffic-engineering export
```

```
set protocols mpls interface 'eth1'
set protocols mpls interface 'eth2'
set protocols mpls interface 'eth5'
set protocols mpls interface 'lo'
set protocols mpls interface 'dum1'
set protocols mpls interface 'dum2'
set system host-name 'PE1'
```

VyOS-PE2

```
### PE2

### interfaces

set interfaces dummy dum1 address '10.200.2.1/32'
set interfaces dummy dum2 address '10.200.2.2/32'
set interfaces ethernet eth1 address '10.100.3.2/24'
set interfaces ethernet eth2 address '10.100.5.2/24'
set interfaces ethernet eth3 address '10.100.8.2/24'
set interfaces ethernet eth3 vrf 'VPN101'
set interfaces ethernet eth4 address '10.100.9.2/24'
set interfaces ethernet eth4 vrf 'VPN102'
set interfaces ethernet eth5 address '192.168.0.102/24'
set interfaces loopback lo address '2.2.2.2/32'

# BGP policy;

set policy prefix-list VPN101 rule 10 action 'permit'
set policy prefix-list VPN101 rule 10 prefix '192.168.3.3/32'
set policy prefix-list VPN102 rule 10 action 'permit'
set policy prefix-list VPN102 rule 10 prefix '192.168.4.4/32'
set policy route-map DENY_ALL rule 10 action 'deny'
set policy route-map LP500 rule 10 action 'permit'
set policy route-map LP500 rule 10 set local-preference '500'
set policy route-map PASS rule 10 action 'permit'
set policy route-map VPN_EXPORT rule 10 action 'permit'
set policy route-map VPN_EXPORT rule 10 match ip address prefix-list 'VPN101'
set policy route-map VPN_EXPORT rule 10 set ip-next-hop '10.200.2.1'
set policy route-map VPN_EXPORT rule 20 action 'permit'
set policy route-map VPN_EXPORT rule 20 match ip address prefix-list 'VPN102'
set policy route-map VPN_EXPORT rule 20 set ip-next-hop '10.200.2.2'
set policy route-map VPN_EXPORT rule 30 action 'permit'
set policy route-map VPN_EXPORT rule 30 set

### BGP-LU configuration:

set protocols bgp address-family ipv4-labeled-unicast network 10.200.2.1/32
set protocols bgp address-family ipv4-labeled-unicast network 10.200.2.2/32
set protocols bgp address-family ipv4-unicast network 10.200.2.1/32
set protocols bgp address-family ipv4-unicast network 10.200.2.2/32
set protocols bgp address-family ipv4-vpn
set protocols bgp interface eth5 mpls forwarding
set protocols bgp neighbor 1.1.1.1 address-family ipv4-labeled-unicast
set protocols bgp neighbor 1.1.1.1 address-family ipv4-vpn route-map export 'VPN_EXPORT'
set protocols bgp neighbor 1.1.1.1 remote-as '65002'
set protocols bgp neighbor 1.1.1.1 update-source 'lo'
set protocols bgp neighbor 192.168.0.1 address-family ipv4-labeled-unicast route-map export 'DENY_ALL'
set protocols bgp neighbor 192.168.0.1 address-family ipv4-labeled-unicast route-map import 'LP500'
set protocols bgp neighbor 192.168.0.1 remote-as '65001'
set protocols bgp parameters router-id '2.2.2.2'
```

```
set protocols bgp system-as '65002'

## ISIS and SR-TE

set protocols traffic-engineering admin-group BLUE bit-position '0'
set protocols traffic-engineering admin-group YELLOW bit-position '1'
set protocols traffic-engineering interface eth1 admin-group 'BLUE'
set protocols traffic-engineering interface eth1 max-bandwidth '10000'
set protocols traffic-engineering interface eth1 max-reservable-bandwidth '10000'
set protocols traffic-engineering interface eth2 admin-group 'YELLOW'
set protocols traffic-engineering interface eth2 max-bandwidth '100000'
set protocols traffic-engineering interface eth2 max-reservable-bandwidth '100000'
set protocols isis interface eth1 network point-to-point
set protocols isis interface eth2 network point-to-point
set protocols isis interface lo passive
set protocols isis level 'level-2'
set protocols isis lsp-mtu '1300'
set protocols isis net '49.0002.0002.0002.00'
set protocols isis segment-routing global-block high-label-value '865534'
set protocols isis segment-routing global-block low-label-value '800000'
set protocols isis segment-routing prefix 2.2.2.2/32 index value '2'
set protocols isis traffic-engineering enable
set protocols isis traffic-engineering export
set protocols mpls interface 'eth1'
set protocols mpls interface 'eth2'
set protocols mpls interface 'eth5'
set protocols mpls interface 'lo'
set protocols mpls interface 'dum1'
set protocols mpls interface 'dum2'
```

VRF+L3VPN in PE1/PE2

```
#VyOS-PE1:

set vrf name VPN101 protocols bgp address-family ipv4-unicast export vpn
set vrf name VPN101 protocols bgp address-family ipv4-unicast import vpn
set vrf name VPN101 protocols bgp address-family ipv4-unicast label vpn export 'auto'
set vrf name VPN101 protocols bgp address-family ipv4-unicast network 10.100.6.0/24
set vrf name VPN101 protocols bgp address-family ipv4-unicast rd vpn export '65002:101'
set vrf name VPN101 protocols bgp address-family ipv4-unicast route-target vpn both '65002:101'
set vrf name VPN101 protocols bgp neighbor 10.100.6.6 address-family ipv4-unicast
set vrf name VPN101 protocols bgp neighbor 10.100.6.6 remote-as '65101'
set vrf name VPN101 protocols bgp parameters router-id '1.1.1.1'
set vrf name VPN101 protocols bgp system-as '65002'
set vrf name VPN101 table '101'
set vrf name VPN102 protocols bgp address-family ipv4-unicast export vpn
set vrf name VPN102 protocols bgp address-family ipv4-unicast import vpn
set vrf name VPN102 protocols bgp address-family ipv4-unicast label vpn export 'auto'
set vrf name VPN102 protocols bgp address-family ipv4-unicast network 10.100.7.0/24
set vrf name VPN102 protocols bgp address-family ipv4-unicast rd vpn export '65002:102'
set vrf name VPN102 protocols bgp address-family ipv4-unicast route-target vpn both '65002:102'
set vrf name VPN102 protocols bgp neighbor 10.100.7.7 address-family ipv4-unicast
set vrf name VPN102 protocols bgp neighbor 10.100.7.7 remote-as '65102'
set vrf name VPN102 protocols bgp parameters router-id '1.1.1.1'
set vrf name VPN102 protocols bgp system-as '65002'
set vrf name VPN102 table '102'

#VyOS-PE2:

set vrf name VPN101 protocols bgp address-family ipv4-unicast export vpn
```

```
set vrf name VPN101 protocols bgp address-family ipv4-unicast import vpn
set vrf name VPN101 protocols bgp address-family ipv4-unicast label vpn export 'auto'
set vrf name VPN101 protocols bgp address-family ipv4-unicast network 10.100.8.0/24
set vrf name VPN101 protocols bgp address-family ipv4-unicast rd vpn export '65002:101'
set vrf name VPN101 protocols bgp address-family ipv4-unicast route-target vpn both '65002:101'
set vrf name VPN101 protocols bgp neighbor 10.100.8.8 address-family ipv4-unicast
set vrf name VPN101 protocols bgp neighbor 10.100.8.8 remote-as '65111'
set vrf name VPN101 protocols bgp parameters router-id '2.2.2.2'
set vrf name VPN101 protocols bgp system-as '65002'
set vrf name VPN101 table '101'
set vrf name VPN102 protocols bgp address-family ipv4-unicast export vpn
set vrf name VPN102 protocols bgp address-family ipv4-unicast import vpn
set vrf name VPN102 protocols bgp address-family ipv4-unicast label vpn export 'auto'
set vrf name VPN102 protocols bgp address-family ipv4-unicast network 10.100.9.0/24
set vrf name VPN102 protocols bgp address-family ipv4-unicast rd vpn export '65002:102'
set vrf name VPN102 protocols bgp address-family ipv4-unicast route-target vpn both '65002:102'
set vrf name VPN102 protocols bgp neighbor 10.100.9.9 address-family ipv4-unicast
set vrf name VPN102 protocols bgp neighbor 10.100.9.9 remote-as '65112'
set vrf name VPN102 protocols bgp parameters router-id '2.2.2.2'
set vrf name VPN102 protocols bgp system-as '65002'
set vrf name VPN102 table '102'
```

CE1/CE2/CE3/CE4 Configurations

```
#CE1

#interfaces
set interfaces ethernet eth1 address '10.100.6.6/24'
set interfaces loopback lo address '6.6.6.6/32'
set interfaces dummy dum1 address '192.168.1.1/32'

#bgp
set policy route-map PASS rule 10 action 'permit'
set protocols bgp address-family ipv4-unicast network 192.168.1.1/32
set protocols bgp neighbor 10.100.6.1 address-family ipv4-unicast route-map import 'PASS'
set protocols bgp neighbor 10.100.6.1 address-family ipv4-unicast route-map export 'PASS'
set protocols bgp neighbor 10.100.6.1 remote-as '65002'
set protocols bgp parameters router-id '6.6.6.6'
set protocols bgp system-as '65101'

set system host-name CE1

#CE2

#interfaces
set interfaces ethernet eth1 address '10.100.7.7/24'
set interfaces loopback lo address '7.7.7.7/32'
set interfaces dummy dum1 address '192.168.2.2/32'

#bgp
set policy route-map PASS rule 10 action 'permit'
set protocols bgp address-family ipv4-unicast network 192.168.2.2/32
set protocols bgp neighbor 10.100.7.1 address-family ipv4-unicast route-map import 'PASS'
set protocols bgp neighbor 10.100.7.1 address-family ipv4-unicast route-map export 'PASS'
set protocols bgp neighbor 10.100.7.1 remote-as '65002'
set protocols bgp parameters router-id '7.7.7.7'
set protocols bgp system-as '65102'

set system host-name CE2
```

```
#CE3
#interfaces
set interfaces ethernet eth1 address '10.100.8.8/24'
set interfaces loopback lo address '8.8.8.8/32'
set interfaces dummy dum1 address '192.168.3.3/32'

#bgp
set policy route-map PASS rule 10 action 'permit'
set protocols bgp address-family ipv4-unicast network 192.168.3.3/32
set protocols bgp neighbor 10.100.8.2 address-family ipv4-unicast route-map import 'PASS'
set protocols bgp neighbor 10.100.8.2 address-family ipv4-unicast route-map export 'PASS'
set protocols bgp neighbor 10.100.8.2 remote-as '65002'
set protocols bgp parameters router-id '8.8.8.8'
set protocols bgp system-as '65111'

set system host-name CE3

#CE4

#interfaces
set interfaces ethernet eth1 address '10.100.9.9/24'
set interfaces loopback lo address '9.9.9.9/32'
set interfaces dummy dum1 address '192.168.4.4/32'

#bgp
set policy route-map PASS rule 10 action 'permit'
set protocols bgp address-family ipv4-unicast network 192.168.4.4/32
set protocols bgp neighbor 10.100.9.2 address-family ipv4-unicast route-map import 'PASS'
set protocols bgp neighbor 10.100.9.2 address-family ipv4-unicast route-map export 'PASS'
set protocols bgp neighbor 10.100.9.2 remote-as '65002'
set protocols bgp parameters router-id '9.9.9.9'
set protocols bgp system-as '65112'

set system host-name CE4
```

Traffic Dictator Policies/Mapping traffic

In this section, after completing the basic environment setup, we will configure the traffic dictator parameters to define traffic engineering policies and establish color-coded paths for each service loopback.

```
### Basic BGP-LU/LS configuration:

router general
   spf delay 200
   spf holddown 5000
   spf rapid-runs 3
   srte distinguisher 1
   reoptimization interval 3600
!
router bgp 65001
   router-id 192.168.0.1
   !
   neighbor 192.168.0.101
      remote-as 65002
      address-family ipv4-labeled-unicast
   !
   neighbor 192.168.0.102
      remote-as 65002
```

```
      address-family ipv4-labeled-unicast
   !
   neighbor 192.168.0.103
      remote-as 65002
      address-family link-state
!

## defined affinities groups.
traffic-eng affinities
   affinity-map
      name BLUE bit-position 0
      name YELLOW bit-position 1
   !
   srlg-map
   !
   affinity-set BLUE_ONLY
      constraint include-all
      name BLUE
   !
   affinity-set YELLOW_ONLY
      constraint include-all
      name YELLOW
!

# define traffic engineering polices:

traffic-eng policies
   !
   policy PE1_PE2_BLUE
      headend 1.1.1.1 topology-id 101
      endpoint 2.2.2.2 service-loopback 10.200.2.1
      install direct labeled-unicast 192.168.0.101
      !
      candidate-path preference 100
         affinity-set BLUE_ONLY
   !
   policy PE1_PE2_YELLOW
      headend 1.1.1.1 topology-id 101
      endpoint 2.2.2.2 service-loopback 10.200.2.2
      install direct labeled-unicast 192.168.0.101
      !
      candidate-path preference 100
         affinity-set YELLOW_ONLY
   !
   policy PE2_PE1_BLUE
      headend 2.2.2.2 topology-id 101
      endpoint 1.1.1.1 service-loopback 10.200.1.1
      install direct labeled-unicast 192.168.0.102
      !
      candidate-path preference 100
         affinity-set BLUE_ONLY
   !
   policy PE2_PE1_YELLOW
      headend 2.2.2.2 topology-id 101
      endpoint 1.1.1.1 service-loopback 10.200.1.2
      install direct labeled-unicast 192.168.0.102
      !
      candidate-path preference 100
         affinity-set YELLOW_ONLY
!
```

Validation and troubleshooting

This section validates our approach by illustrating how the network operator can design and adjust network paths using service loopbacks.

Traffic Dictactor

```
TD#show bgp summary
BGP summary information
Router identifier 192.168.0.1, local AS number 65001
  Neighbor            V    AS          MsgRcvd  MsgSent      InQ     OutQ      Up/Down    State          Received NLRI    Active AF
  192.168.0.101       4    65002          9791    10125        0        0      6d18h      Established                0    IPv4-LU
  192.168.0.102       4    65002          9788    10115        0        0      6d19h      Established                0    IPv4-LU
  192.168.0.103       4    65002         21771    19570        0        0      6d19h      Established               22    LS

TD#show bgp link-state

BGP-LS routing table information
Router identifier 192.168.0.1, local AS number 65001
Status codes: * valid, > best
Origin codes: i - IGP, e - EGP, ? - incomplete
Prefix codes: E link, V node, T IP reacheable route, S SRv6 SID, u/U unknown,
          I Identifier, N local node, R remote node, L link, P prefix, S SID,
          L1/L2 ISIS level-1/level-2, O OSPF, D direct, S static/peer-node,
          a area-ID, l link-ID, t topology-ID, s ISO-ID,
          c confed-ID/ASN, b bgp-identifier, r router-ID, s SID,
          i if-address, n nbr-address, o OSPF Route-type, p IP-prefix,
          d designated router address

          Network                Next Hop              Metric        LocPref  Weigth   Path
       [V][L2][I101][N[c65002][b101][s0001.0001.0001.00]]
*>                          192.168.0.103                   0            100       0   65002  i
       [V][L2][I101][N[c65002][b101][s0002.0002.0002.00]]
*>                          192.168.0.103                   0            100       0   65002  i
       [V][L2][I101][N[c65002][b101][s0003.0003.0003.00]]
*>                          192.168.0.103                   0            100       0   65002  i
       [V][L2][I101][N[c65002][b101][s0004.0004.0004.00]]
*>                          192.168.0.103                   0            100       0   65002  i
       [V][L2][I101][N[c65002][b101][s0005.0005.0005.00]]
*>                          192.168.0.103                   0            100       0   65002  i
       [E][L2][I101][N[c65002][b101][s0002.0002.0002.00]][R[c65002][b101][s0003.0003.0003.00]][L[i10.100.3.2][n10.100.3.3]]
*>                          192.168.0.103                   0            100       0   65002  i
       [E][L2][I101][N[c65002][b101][s0001.0001.0001.00]][R[c65002][b101][s0003.0003.0003.00]][L[i10.100.1.1][n10.100.1.3]]
*>                          192.168.0.103                   0            100       0   65002  i
       [E][L2][I101][N[c65002][b101][s0005.0005.0005.00]][R[c65002][b101][s0004.0004.0004.00]][L[i10.100.4.5][n10.100.4.4]]
*>                          192.168.0.103                   0            100       0   65002  i
       [E][L2][I101][N[c65002][b101][s0004.0004.0004.00]][R[c65002][b101][s0005.0005.0005.00]][L[i10.100.4.4][n10.100.4.5]]
*>                          192.168.0.103                   0            100       0   65002  i
       [E][L2][I101][N[c65002][b101][s0002.0002.0002.00]][R[c65002][b101][s0005.0005.0005.00]][L[i10.100.5.2][n10.100.5.5]]
*>                          192.168.0.103                   0            100       0   65002  i
       [E][L2][I101][N[c65002][b101][s0001.0001.0001.00]][R[c65002][b101][s0004.0004.0004.00]][L[i10.100.2.1][n10.100.2.4]]
*>                          192.168.0.103                   0            100       0   65002  i
       [E][L2][I101][N[c65002][b101][s0003.0003.0003.00]][R[c65002][b101][s0001.0001.0001.00]][L[i10.100.1.3][n10.100.1.1]]
*>                          192.168.0.103                   0            100       0   65002  i
       [E][L2][I101][N[c65002][b101][s0003.0003.0003.00]][R[c65002][b101][s0002.0002.0002.00]][L[i10.100.3.3][n10.100.3.2]]
*>                          192.168.0.103                   0            100       0   65002  i
       [E][L2][I101][N[c65002][b101][s0003.0003.0003.00]][R[c65002][b101][s0004.0004.0004.00]][L[i10.100.10.3][n10.100.10.4]]
*>                          192.168.0.103                   0            100       0   65002  i
       [E][L2][I101][N[c65002][b101][s0005.0005.0005.00]][R[c65002][b101][s0002.0002.0002.00]][L[i10.100.5.5][n10.100.5.2]]
```

```
*>                      192.168.0.103                0          100      0   65002  i
      [E][L2][I101][N[c65002][b101][s0004.0004.0004.00]][R[c65002][b101][s0001.0001.0001.00]][L[i10.100.2.4][n10.100.2.1]]
*>                      192.168.0.103                0          100      0   65002  i
      [E][L2][I101][N[c65002][b101][s0004.0004.0004.00]][R[c65002][b101][s0003.0003.0003.00]][L[i10.100.10.4][n10.100.10.3]]
*>                      192.168.0.103                0          100      0   65002  i
      [T][L2][I101][N[c65002][b101][s0001.0001.0001.00]][P[p1.1.1.1/32]]
*>                      192.168.0.103                0          100      0   65002  i
      [T][L2][I101][N[c65002][b101][s0002.0002.0002.00]][P[p2.2.2.2/32]]
*>                      192.168.0.103                0          100      0   65002  i
      [T][L2][I101][N[c65002][b101][s0003.0003.0003.00]][P[p3.3.3.3/32]]
*>                      192.168.0.103                0          100      0   65002  i
      [T][L2][I101][N[c65002][b101][s0004.0004.0004.00]][P[p4.4.4.4/32]]
*>                      192.168.0.103                0          100      0   65002  i
      [T][L2][I101][N[c65002][b101][s0005.0005.0005.00]][P[p5.5.5.5/32]]
*>                      192.168.0.103                0          100      0   65002  i
```

This section validates our approach by illustrating how the network operator can design and adjust network paths using service loopbacks.

```
#Basic check:

TD#show traffic-eng policy PE1_PE2_BLUE
Traffic-eng policy information
Status codes: * active, > installed, r - RSVP-TE, e - EPE only, s - admin down, m - multi-topology
Endpoint codes: * active override
       Policy name                          Headend            Endpoint           Color/Service loopback   Protocol
  Reserved bandwidth       Priority   Status/Reason
    *>  PE1_PE2_BLUE                      1.1.1.1            2.2.2.2            10.200.2.1               LU/direct
  N/A                      7/7        Active/Installed
TD#
TD#show traffic-eng policy PE1_PE2_YELLOW
Traffic-eng policy information
Status codes: * active, > installed, r - RSVP-TE, e - EPE only, s - admin down, m - multi-topology
Endpoint codes: * active override
       Policy name                          Headend            Endpoint           Color/Service loopback   Protocol
  Reserved bandwidth       Priority   Status/Reason
    *>  PE1_PE2_YELLOW                    1.1.1.1            2.2.2.2            10.200.2.2               LU/direct
  N/A                      7/7        Active/Installed
TD#
```

In this output, we extend the policy to demonstrate how the **path option, affinity set**, and **label stack** are applied in **BGP-LU**. This shows the active policy and includes all the relevant details required for verification.

```
#BLUE Policy

TD#show traffic-eng policy PE1_PE2_BLUE detail
Detailed traffic-eng policy information:

Traffic engineering policy "PE1_PE2_BLUE"

    Valid config, Active, Installed
    Headend 1.1.1.1, topology-id 101
    Endpoint 2.2.2.2, service-loopback 10.200.2.1
        Endpoint type: Node, Topology-id: 101, Protocol: isis, Router-id: 0002.0002.0002.00

    Setup priority: 7, Hold priority: 7
    Reserved bandwidth bps: 0
```

```
    Install direct, protocol labeled-unicast, peer 192.168.0.101
    Policy index: 0, SR-TE distinguisher: 16777216
    Route-key: [16777216][10.200.2.1/32]

    Candidate paths:
        Candidate-path preference 100
            Path config valid
            Metric: igp
            Path-option: dynamic
            Affinity-set: BLUE_ONLY
                Constraint: include-all
                List: ['BLUE']
                Value: 0x1
            This path is currently active

    Calculation results:
        Aggregate metric: 20
        Topologies: ['101']
        Segment lists:
            [800002]
        BGP-LU next-hop: 10.100.1.3

    Policy statistics:
        Last config update: 2025-12-17 21:18:25,471
        Last recalculation: 2025-12-30 13:26:16.752
        Policy calculation took 0 miliseconds

# YELLOW  Policy:

TD#show traffic-eng policy PE1_PE2_YELLOW detail
Detailed traffic-eng policy information:

Traffic engineering policy "PE1_PE2_YELLOW"

    Valid config, Active, Installed
    Headend 1.1.1.1, topology-id 101
    Endpoint 2.2.2.2, service-loopback 10.200.2.2
        Endpoint type: Node, Topology-id: 101, Protocol: isis, Router-id: 0002.0002.0002.00

    Setup priority: 7, Hold priority: 7
    Reserved bandwidth bps: 0
    Install direct, protocol labeled-unicast, peer 192.168.0.101
    Policy index: 1, SR-TE distinguisher: 16777217
    Route-key: [16777217][10.200.2.2/32]

    Candidate paths:
        Candidate-path preference 100
            Path config valid
            Metric: igp
            Path-option: dynamic
            Affinity-set: YELLOW_ONLY
                Constraint: include-all
                List: ['YELLOW']
                Value: 0x2
            This path is currently active

    Calculation results:
        Aggregate metric: 30
        Topologies: ['101']
        Segment lists:
            [800005, 800002]
        BGP-LU next-hop: 10.100.2.4

    Policy statistics:
```

```
        Last config update: 2025-12-17 21:18:25,570
        Last recalculation: 2025-12-30 13:26:16.752
        Policy calculation took 0 miliseconds
```

Now, let's check in our PE1 if our VPN101/VPN102 are taking the path that we've assigned by our controller.

```
#VPN101:

vyos@PE1:~$ show ip route vrf VPN101
Codes: K - kernel route, C - connected, L - local, S - static,
       R - RIP, O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric, t - Table-Direct,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

VRF VPN101:
C>* 10.100.6.0/24 is directly connected, eth3, weight 1, 01w5d16h
K * 10.100.6.0/24 [0/0] is directly connected, eth3, weight 1, 01w5d16h
L * 10.100.6.1/32 is directly connected, eth3, weight 1, 01w5d16h
L>* 10.100.6.1/32 is directly connected, eth3, weight 1, 01w5d16h
B>  10.100.8.0/24 [200/0] via 2.2.2.2 (vrf default) (recursive), label 81, weight 1, 6d19h05m
  *                         via 10.100.1.3, eth1 (vrf default), label 800002/81, weight 1, 6d19h05m
B>* 192.168.1.1/32 [20/0] via 10.100.6.6, eth3, weight 1, 6d18h19m
B>  192.168.3.3/32 [200/0] via 10.200.2.1 (vrf default) (recursive), label 81, weight 1, 6d18h13m
  *                          via 10.100.1.3, eth1 (vrf default), label 800002/81, weight 1, 6d18h13m

vyos@PE1:~$ show ip route  10.200.2.1
Routing entry for 10.200.2.1/32
  Known via "bgp", distance 20, metric 0, best
  Last update 6d19h06m ago
  * 10.100.1.3, via eth1, label 800002, weight 1

#VPN102

vyos@PE1:~$ show ip route vrf VPN102
Codes: K - kernel route, C - connected, L - local, S - static,
       R - RIP, O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric, t - Table-Direct,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

VRF VPN102:
C>* 10.100.7.0/24 is directly connected, eth4, weight 1, 01w5d16h
K * 10.100.7.0/24 [0/0] is directly connected, eth4, weight 1, 01w5d16h
L * 10.100.7.1/32 is directly connected, eth4, weight 1, 01w5d16h
L>* 10.100.7.1/32 is directly connected, eth4, weight 1, 01w5d16h
B>  10.100.9.0/24 [200/0] via 2.2.2.2 (vrf default) (recursive), label 80, weight 1, 6d19h09m
  *                         via 10.100.1.3, eth1 (vrf default), label 800002/80, weight 1, 6d19h09m
B>* 192.168.2.2/32 [20/0] via 10.100.7.7, eth4, weight 1, 6d18h12m
B>  192.168.4.4/32 [200/0] via 10.200.2.2 (vrf default) (recursive), label 80, weight 1, 6d18h07m
  *                          via 10.100.2.4, eth2 (vrf default), label 800005/800002/80, weight 1, 6d18h07m

vyos@PE1:~$ show ip route 10.200.2.2
Routing entry for 10.200.2.2/32
  Known via "bgp", distance 20, metric 0, best
  Last update 6d19h13m ago
  * 10.100.2.4, via eth2, label 800005/800002, weight 1
```

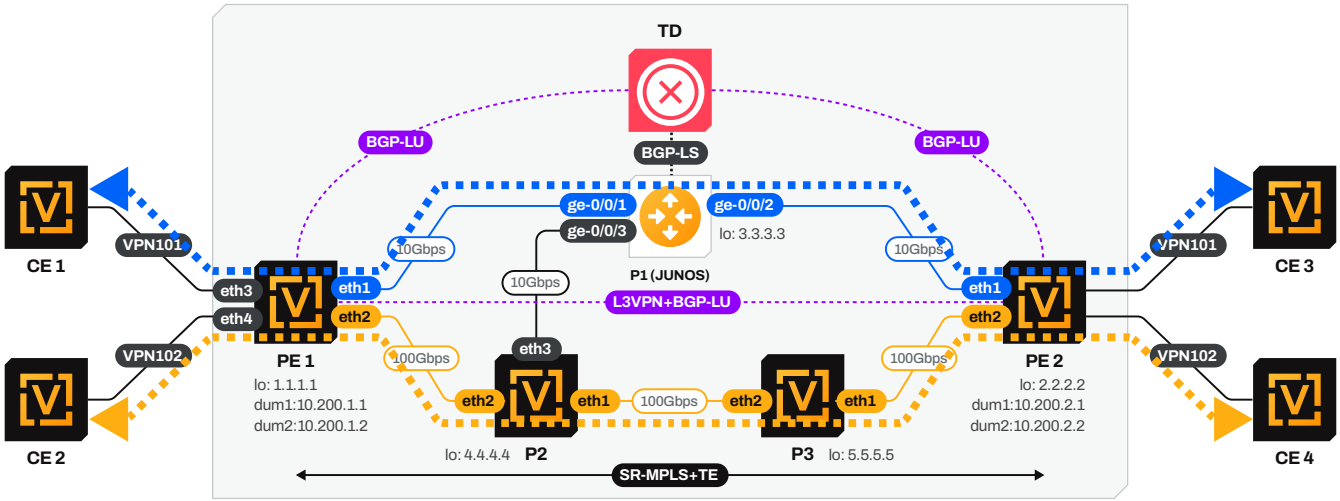
As we see in our output, VRFs are taking different paths as we defined in our SDN controller.

What happens if the Traffic Dictator goes down?

Traffic Dictator supports controller redundancy, so if the primary controller fails, the backup controller will take over and all traffic will keep using the same traffic engineering policies.

Now let's take a look at a critical failure scenario, when all controllers fail at the same time.

In regular SR-TE, color will be ignored and BGP routes will just resolve via IGP instead of the SR-TE policy, and follow the shortest path.



This scenario occurs when connectivity to the controller is lost. If the controller fails, BGP routes are resolved using the BGP-LU route, which in turn is resolved via the IGP. As a result, traffic follows the shortest path determined by the IGP

Validation:

```
vyos@PE1:~$ show bgp summary

IPv4 VPN Summary:
BGP router identifier 1.1.1.1, local AS number 65002 VRF default vrf-id 0
BGP table version 0
RIB entries 3, using 384 bytes of memory
Peers 1, using 24 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
2.2.2.2         4      65002     10050     10050        4    0    0 6d23h21m            4        4 FRRouting/10.2.4

Total number of neighbors 1

IPv4 Labeled Unicast Summary:
BGP router identifier 1.1.1.1, local AS number 65002 VRF default vrf-id 0
BGP table version 2
RIB entries 3, using 384 bytes of memory
Peers 2, using 47 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
2.2.2.2         4      65002     10050     10050        8    0    0 6d23h21m            2        2 FRRouting/10.2.4
192.168.0.1     4      65001     10387     10052        0    0    0 00:03:32        Active        0 N/A

Total number of neighbors 2
vyos@PE1:~$
```

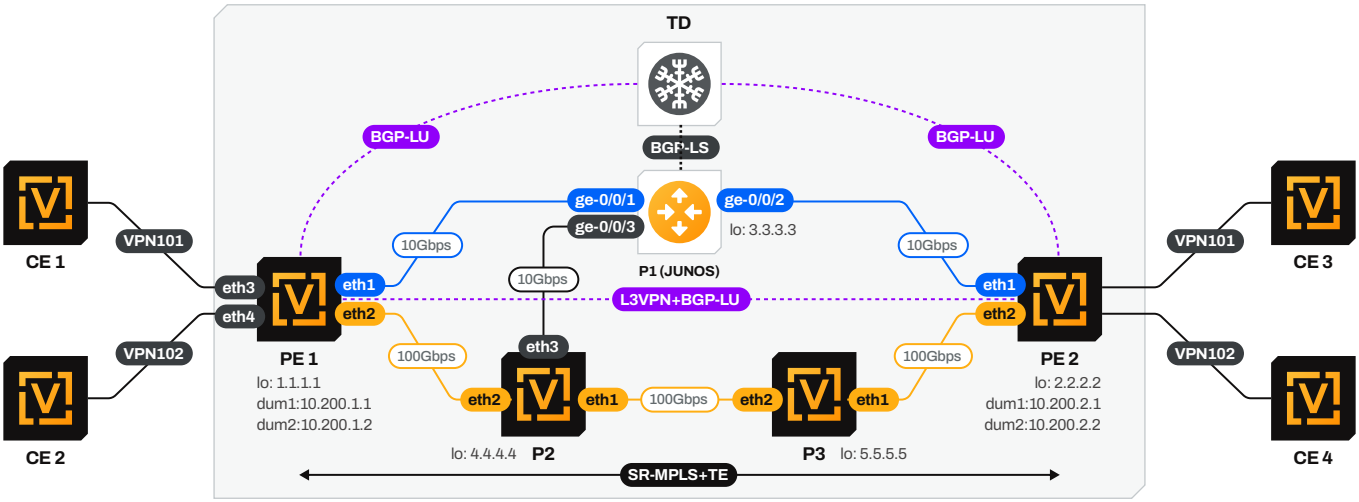
Our BGP-LU sessions established with our controller are down.

```
vyos@PE1:~$ show ip route vrf VPN101
Codes: K - kernel route, C - connected, L - local, S - static,
       R - RIP, O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric, t - Table-Direct,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

VRF VPN101:
C>* 10.100.6.0/24 is directly connected, eth3, weight 1, 01w5d21h
K * 10.100.6.0/24 [0/0] is directly connected, eth3, weight 1, 01w5d21h
L * 10.100.6.1/32 is directly connected, eth3, weight 1, 01w5d21h
L>* 10.100.6.1/32 is directly connected, eth3, weight 1, 01w5d21h
B>  10.100.8.0/24 [200/0] via 2.2.2.2 (vrf default) (recursive), label 81, weight 1, 6d23h19m
  *                       via 10.100.1.3, eth1 (vrf default), label 800002/81, weight 1, 6d23h19m
B>* 192.168.1.1/32 [20/0] via 10.100.6.6, eth3, weight 1, 6d22h32m
B>  192.168.3.3/32 [200/0] via 10.200.2.1 (vrf default) (recursive), label 81, weight 1, 00:01:49
  *                        via 10.100.1.3, eth1 (vrf default), label 800002/implicit-null/81, weight 1, 00:01:49

vyos@PE1:~$ show ip route vrf VPN102
Codes: K - kernel route, C - connected, L - local, S - static,
       R - RIP, O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric, t - Table-Direct,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

VRF VPN102:
C>* 10.100.7.0/24 is directly connected, eth4, weight 1, 01w5d21h
K * 10.100.7.0/24 [0/0] is directly connected, eth4, weight 1, 01w5d21h
L * 10.100.7.1/32 is directly connected, eth4, weight 1, 01w5d21h
L>* 10.100.7.1/32 is directly connected, eth4, weight 1, 01w5d21h
B>  10.100.9.0/24 [200/0] via 2.2.2.2 (vrf default) (recursive), label 80, weight 1, 6d23h19m
  *                       via 10.100.1.3, eth1 (vrf default), label 800002/80, weight 1, 6d23h19m
B>* 192.168.2.2/32 [20/0] via 10.100.7.7, eth4, weight 1, 6d22h22m
B>  192.168.4.4/32 [200/0] via 10.200.2.2 (vrf default) (recursive), label 80, weight 1, 00:01:55
  *                        via 10.100.1.3, eth1 (vrf default), label 800002/implicit-null/80, weight 1, 00:01:55
```

As we see in our output, both VRFs services are taking the same path when the controller goes down.

Disjointness (Disjoint Group)

Based on our previous configuration and diagram, we will use a different use case: the **Disjoint Group** in **Traffic Dictator.**



Traffic Dictator uses the disjoint policy to compute two lists of segments that steer traffic from two source nodes to two destination nodes along disjoint paths. The disjoint paths can originate from the same head-end or different head-ends. Disjoint level refers to the type of resources that should not be shared by the two computed paths. The following attribute is used for our test.

- **Link** – Specifies that links are not shared on the computed paths.

Our controllers calculate this attribute and use different paths for our services.

Let's start with our basic configuration:

```
### Add a candidate-path with more preference in both paths

traffic-eng policies
   !
   policy PE1_PE2_BLUE
      headend 1.1.1.1 topology-id 101
      endpoint 2.2.2.2 service-loopback 10.200.2.1
      install direct labeled-unicast 192.168.0.101
      !
      candidate-path preference 200
         disjoint-group 100 link

   !
   policy PE1_PE2_YELLOW
      headend 1.1.1.1 topology-id 101
      endpoint 2.2.2.2 service-loopback 10.200.2.2
      install direct labeled-unicast 192.168.0.101
      !
      candidate-path preference 200
         disjoint-group 100 link
```

Let's check how it works with our current setup:

```
## BLUE PATH

TD#show traffic-eng policy PE1_PE2_BLUE detail
Detailed traffic-eng policy information:

Traffic engineering policy "PE1_PE2_BLUE"

    Valid config, Active, Installed
    Headend 1.1.1.1, topology-id 101
    Endpoint 2.2.2.2, service-loopback 10.200.2.1
        Endpoint type: Node, Topology-id: 101, Protocol: isis, Router-id: 0002.0002.0002.00

    Setup priority: 7, Hold priority: 7
    Reserved bandwidth bps: 0
    Install direct, protocol labeled-unicast, peer 192.168.0.101
    Policy index: 0, SR-TE distinguisher: 16777216
    Route-key: [16777216][10.200.2.1/32]


    Candidate paths:
        Candidate-path preference 200
            Path config valid
            Metric: igp
            Disjoint-group: 100
              Link disjoint: True
              Node disjoint: False
              SRLG disjoint: False
            Path-option: dynamic
            This path is currently active
        Candidate-path preference 100
            Path config valid
            Metric: igp
            Path-option: dynamic
            Affinity-set: BLUE_ONLY
                Constraint: include-all
                List: ['BLUE']
                Value: 0x1
            This path has not been checked

    Calculation results:
        Aggregate metric: 30
        Topologies: ['101']
        Segment lists:
            [800005, 800002]
        BGP-LU next-hop: 10.100.2.4

    Policy statistics:
        Last config update: 2025-12-30 19:29:31,602
        Last recalculation: 2025-12-30 19:41:37.358
        Policy calculation took 0 miliseconds

TD#show traffic-eng policy PE1_PE2_BLUE extensive

Extensive traffic-eng policy information:

Traffic engineering policy "PE1_PE2_BLUE"

    Valid config, Active, Installed
    Headend 1.1.1.1, topology-id 101
    Endpoint 2.2.2.2, service-loopback 10.200.2.1
        Endpoint type: Node, Topology-id: 101, Protocol: isis, Router-id: 0002.0002.0002.00
```

```
Setup priority: 7, Hold priority: 7
Reserved bandwidth bps: 0
Install direct, protocol labeled-unicast, peer 192.168.0.101
Policy index: 0, SR-TE distinguisher: 16777216
Route-key: [16777216][10.200.2.1/32]

-----------
IOS-XR commands:
-----------
show bgp ipv4 labeled-unicast 10.200.2.1/32
show cef 10.200.2.1/32
-----------
JUNOS commands:
-----------
*JUNOS doesn't support BGP-LU policies due to nexthop resolution limitations
-----------
EOS commands:
-----------
show bgp ipv4 labeled-unicast 10.200.2.1/32
show bgp labeled-unicast tunnel | grep 10.200.2.1/32
show tunnel rib 10.200.2.1/32 brief
-----------
OcNOS commands:
-----------
show ip bgp labeled-unicast 10.200.2.1/32
-----------
FRR commands:
-----------
show ip bgp 10.200.2.1/32
show mpls table
-----------

Candidate paths:
    Candidate-path preference 200
        Path config valid
        Metric: igp
        Disjoint-group: 100
          Link disjoint: True
          Node disjoint: False
          SRLG disjoint: False
        Path-option: dynamic
        This path is currently active
    Candidate-path preference 100
        Path config valid
        Metric: igp
        Path-option: dynamic
        Affinity-set: BLUE_ONLY
            Constraint: include-all
            List: ['BLUE']
            Value: 0x1
        This path has not been checked

Calculation results:
    Aggregate metric: 30
    Topologies: ['101']
    Segment lists:
      -----------
      SID list 1:
        Segment type:   PREFIX
        Address family: ipv4
        Prefix:         5.5.5.5
```

```
            SID value:      800005

            Segment type:   PREFIX
            Address family: ipv4
            Prefix:         2.2.2.2
            SID value:      800002
        BGP-LU next-hop: 10.100.2.4

        Path details:
          Topology-id 101
            ---------------
            Nexthop list 1:
            0001.0001.0001.00
                [E][L2][I101][N[c65002][b101][s0001.0001.0001.00]][R[c65002][b101][s0004.0004.0004.00]][L[i10.100.2.1][n10.100.2.4]]
            0004.0004.0004.00
                [E][L2][I101][N[c65002][b101][s0004.0004.0004.00]][R[c65002][b101][s0005.0005.0005.00]][L[i10.100.4.4][n10.100.4.5]]
            0005.0005.0005.00
                [E][L2][I101][N[c65002][b101][s0005.0005.0005.00]][R[c65002][b101][s0002.0002.0002.00]][L[i10.100.5.5][n10.100.5.2]]
            0002.0002.0002.00

    Policy statistics:
        Last config update: 2025-12-30 19:29:31,602
        Last recalculation: 2025-12-30 19:41:37.358
        Policy calculation took 0 miliseconds

## YELLOW PATH

TD#show traffic-eng policy PE1_PE2_YELLOW  detail
Detailed traffic-eng policy information:

Traffic engineering policy "PE1_PE2_YELLOW"

    Valid config, Active, Installed
    Headend 1.1.1.1, topology-id 101
    Endpoint 2.2.2.2, service-loopback 10.200.2.2
        Endpoint type: Node, Topology-id: 101, Protocol: isis, Router-id: 0002.0002.0002.00

    Setup priority: 7, Hold priority: 7

    Reserved bandwidth bps: 0
    Install direct, protocol labeled-unicast, peer 192.168.0.101
    Policy index: 1, SR-TE distinguisher: 16777217
    Route-key: [16777217][10.200.2.2/32]

    Candidate paths:
        Candidate-path preference 200
            Path config valid
            Metric: igp
            Disjoint-group: 100
              Link disjoint: True
              Node disjoint: False
              SRLG disjoint: False
            Path-option: dynamic
            This path is currently active
        Candidate-path preference 100
            Path config valid
            Metric: igp
            Path-option: dynamic
            Affinity-set: YELLOW_ONLY
                Constraint: include-all
                List: ['YELLOW']
                Value: 0x2
            This path has not been checked
```

```
    Calculation results:
        Aggregate metric: 20
        Topologies: ['101']
        Segment lists:
            [800002]
        BGP-LU next-hop: 10.100.1.3

    Policy statistics:
        Last config update: 2025-12-30 19:34:10,103
        Last recalculation: 2025-12-30 19:41:37.357
        Policy calculation took 0 miliseconds
   !

show traffic-eng policy PE1_PE2_YELLOW  extensive

Extensive traffic-eng policy information:

Traffic engineering policy "PE1_PE2_YELLOW"

    Valid config, Active, Installed
    Headend 1.1.1.1, topology-id 101
    Endpoint 2.2.2.2, service-loopback 10.200.2.2
        Endpoint type: Node, Topology-id: 101, Protocol: isis, Router-id: 0002.0002.0002.00

    Setup priority: 7, Hold priority: 7
    Reserved bandwidth bps: 0
    Install direct, protocol labeled-unicast, peer 192.168.0.101
    Policy index: 1, SR-TE distinguisher: 16777217
    Route-key: [16777217][10.200.2.2/32]

    -----------
    IOS-XR commands:
    -----------
    show bgp ipv4 labeled-unicast 10.200.2.2/32
    show cef 10.200.2.2/32
    -----------
    JUNOS commands:
    -----------
    *JUNOS doesn't support BGP-LU policies due to nexthop resolution limitations
    -----------
    EOS commands:
    -----------
    show bgp ipv4 labeled-unicast 10.200.2.2/32
    show bgp labeled-unicast tunnel | grep 10.200.2.2/32
    show tunnel rib 10.200.2.2/32 brief
    -----------
    OcNOS commands:
    -----------
    show ip bgp labeled-unicast 10.200.2.2/32
    -----------
    FRR commands:
    -----------
    show ip bgp 10.200.2.2/32
    show mpls table
    -----------

    Candidate paths:
        Candidate-path preference 200
            Path config valid
            Metric: igp
            Disjoint-group: 100
              Link disjoint: True
              Node disjoint: False
```

```
            SRLG disjoint: False
          Path-option: dynamic
          This path is currently active
      Candidate-path preference 100
          Path config valid
          Metric: igp
          Path-option: dynamic
          Affinity-set: YELLOW_ONLY
              Constraint: include-all
              List: ['YELLOW']
              Value: 0x2
          This path has not been checked

  Calculation results:
      Aggregate metric: 20
      Topologies: ['101']
      Segment lists:
        -----------
        SID list 1:

          Segment type:   PREFIX
          Address family: ipv4
          Prefix:         2.2.2.2
          SID value:      800002
      BGP-LU next-hop: 10.100.1.3

      Path details:

        Topology-id 101
          --------------
          Nexthop list 1:

          0001.0001.0001.00
              [E][L2][I101][N[c65002][b101][s0001.0001.0001.00]][R[c65002][b101][s0003.0003.0003.00]][L[i10.100.1.1][n10.100.1.3]]
          0003.0003.0003.00
              [E][L2][I101][N[c65002][b101][s0003.0003.0003.00]][R[c65002][b101][s0002.0002.0002.00]][L[i10.100.3.3][n10.100.3.2]]
          0002.0002.0002.00

  Policy statistics:
      Last config update: 2025-12-30 19:34:10,103
      Last recalculation: 2025-12-30 19:41:37.357
      Policy calculation took 0 miliseconds
```

In our VRFs services which see these new paths:

```
### VRFs VPN101

vyos@PE1:~$ show ip route vrf VPN101
Codes: K - kernel route, C - connected, L - local, S - static,
       R - RIP, O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric, t - Table-Direct,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

VRF VPN101:
C>* 10.100.6.0/24 is directly connected, eth3, weight 1, 01w5d22h
K * 10.100.6.0/24 [0/0] is directly connected, eth3, weight 1, 01w5d22h
L * 10.100.6.1/32 is directly connected, eth3, weight 1, 01w5d22h
L>* 10.100.6.1/32 is directly connected, eth3, weight 1, 01w5d22h
B>  10.100.8.0/24 [200/0] via 2.2.2.2 (vrf default) (recursive), label 81, weight 1, 01w0d00h
```

```
  *                       via 10.100.1.3, eth1 (vrf default), label 800002/81, weight 1, 01w0d00h
B>* 192.168.1.1/32 [20/0] via 10.100.6.6, eth3, weight 1, 6d23h41m
B>  192.168.3.3/32 [200/0] via 10.200.2.1 (vrf default) (recursive), label 81, weight 1, 00:02:15
  *                        via 10.100.2.4, eth2 (vrf default), label 800005/800002/81, weight 1, 00:02:15

### VRFs VPN102

vyos@PE1:~$ show ip route vrf VPN102
Codes: K - kernel route, C - connected, L - local, S - static,
       R - RIP, O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric, t - Table-Direct,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

VRF VPN102:
C>* 10.100.7.0/24 is directly connected, eth4, weight 1, 01w5d22h
K * 10.100.7.0/24 [0/0] is directly connected, eth4, weight 1, 01w5d22h
L * 10.100.7.1/32 is directly connected, eth4, weight 1, 01w5d22h
L>* 10.100.7.1/32 is directly connected, eth4, weight 1, 01w5d22h
B>  10.100.9.0/24 [200/0] via 2.2.2.2 (vrf default) (recursive), label 80, weight 1, 01w0d00h
  *                       via 10.100.1.3, eth1 (vrf default), label 800002/80, weight 1, 01w0d00h
B>* 192.168.2.2/32 [20/0] via 10.100.7.7, eth4, weight 1, 6d23h31m
B>  192.168.4.4/32 [200/0] via 10.200.2.2 (vrf default) (recursive), label 80, weight 1, 00:02:27
  *                        via 10.100.1.3, eth1 (vrf default), label 800002/80, weight 1, 00:02:27
```

Conclusion

Traffic Dictator is a powerful SR-TE controller that lowers the entry barrier into SR-TE. It allows you to create different path calculations and enriches the VyOS network capabilities. It integrates powerfully with enterprise, cloud provider, and ISP capabilities to create more complex and robust networks.

The integration between VyOS and Traffic Dictator enables centralized, policy-based traffic control directly on the network edge. VyOS provides sr-mpls routing, firewalling, and packet-processing foundation, while Traffic Dictator adds dynamic traffic classification and decision logic. Together, they allow precise traffic steering, prioritization, and enforcement based on real-time conditions, improving network efficiency, scalability, and operational control.