Vérification de MPLS sur les commutateurs Catalyst 9000

Contenu

Introduction

Ce document décrit comment configurer et valider le réseau privé virtuel (VPN) de couche 3 MPLS (Multiprotocol Label Switching) sur les commutateurs de la gamme Catalyst 9000.

Conditions préalables

Conditions requises

Cisco vous recommande de prendre connaissance des rubriques suivantes :

- Transfert IP
- BGP (Border Gateway Protocol)
- MPLS

Components Used

Les informations contenues dans ce document sont basées sur les versions de matériel et de logiciel suivantes :

- C9500 sur Cisco IOS® XE 16.12.4
- C9300 sur Cisco IOS® XE 16.12.4
- C3850 sur Cisco IOS® XE 16.9.6

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. Si votre réseau est en ligne, assurez-vous de bien comprendre l'incidence possible des commandes.

Informations générales

Les VPN de couche 3 MPLS (L3VPN) utilisent un modèle peer-to-peer qui utilise le protocole BGP pour distribuer les informations liées au VPN. Un VPN MPLS se compose d'un ensemble de sites interconnectés au moyen d'un réseau principal du fournisseur MPLS. Sur chaque site client, un ou plusieurs périphériques de périphérie client (CE) sont reliés à un ou plusieurs périphériques de périphérie (PE).

Dans le routage de couche 3 classique, lorsqu'un paquet traverse le réseau, chaque commutateur extrait toutes les informations pertinentes pour transférer le paquet de l'en-tête de couche 3. Ces informations sont ensuite utilisées comme index pour une recherche dans la table de routage afin de déterminer le saut suivant du paquet.

Dans le cas le plus courant, le seul champ pertinent de l'en-tête est le champ d'adresse de destination, mais dans certains cas, d'autres champs d'en-tête peuvent également être pertinents. Par conséquent, l'analyse de l'en-tête doit être effectuée indépendamment sur chaque commutateur par lequel passe le paquet. En outre, une recherche de table complexe doit également être effectuée sur chaque commutateur.

Dans la commutation d'étiquettes, l'analyse de l'en-tête de couche 3 n'est effectuée qu'une seule fois. L'en-tête de couche 3 est ensuite mappé en une valeur non structurée de longueur fixe appelée **alabel**.

De nombreux en-têtes différents peuvent être mappés sur la même étiquette, à condition que ces en-têtes aient toujours le même choix de saut suivant. En effet, une étiquette représente **une classe d'équivalence de transfert** (FEC) c'est-à-dire un ensemble de paquets qui, aussi différents soient-ils, ne peuvent être distingués par la fonction de transfert.

Le choix initial d'une étiquette ne doit pas être basé exclusivement sur le contenu de l'en-tête de paquet de couche 3 ; par exemple, la décision de transférer des paquets lors de sauts ultérieurs peut également être basée sur d'autres facteurs.

Une fois qu'une étiquette est attribuée, un en-tête d'étiquette court est ajouté à l'avant du paquet

de couche 3. Cet en-tête est transporté sur le réseau dans le cadre du paquet. Lors des sauts suivants via chaque commutateur MPLS du réseau, les étiquettes sont échangées et les décisions sont prises au moyen de la recherche de table de transfert MPLS pour l'étiquette transportée dans l'en-tête de paquet. Par conséquent, l'en-tête de paquet n'a pas besoin d'être réévalué lors du transit de paquets sur le réseau. Comme l'étiquette est de longueur fixe et non structurée, le processus de recherche de table de transfert MPLS est à la fois simple et rapide.

Chaque routeur de commutation d'étiquettes (LSR) du réseau prend une décision locale indépendante quant à la valeur d'étiquette à utiliser pour représenter une classe d'équivalence de transfert. Cette association est connue sous le nom de liaison d'étiquette. Chaque LSR informe ses voisins des liaisons d'étiquette qu'il a effectuées. Ces protocoles facilitent la reconnaissance des liaisons d'étiquette par les commutateurs voisins :

- LDP (Label Distribution Protocol) : permet aux LSR homologues d'un réseau MPLS d'échanger des informations d'étiquette pour prendre en charge le transfert saut par saut dans un réseau MPLS.
- BGP (Border Gateway Protocol) : utilisé pour prendre en charge les réseaux privés virtuels MPLS (Virtual Private Networks)

Lorsqu'un paquet étiqueté est envoyé de LSR A à LSR B, la valeur d'étiquette transportée par le paquet IP est la valeur d'étiquette attribuée à LSR B pour représenter la classe d'équivalence de transmission du paquet. Ainsi, la valeur de l'étiquette change à mesure que le paquet IP traverse le réseau.

Utilisation de ce guide

Le guide est divisé en deux scénarios et une section de validation de l'échelle matérielle est présentée à la fin du document :

- contiguïté à un seul saut dans le coeur MPLS
- Les contiguïtés ECMP (Equal Cost Multi-Path) au sein du coeur MPLS
- comment vérifier l'utilisation de TCAM pour les problèmes d'évolutivité

Chaque scénario couvre la vérification des préfixes et des étiquettes pour chaque périphérique MPLS.

Terminologie

MPLS	Commutation multiprotocole par étiquette	Technologie de transfert de paquets hautes performances qui intègre les fonctionnalités de gestion des performances et du trafic de la commutation couche liaison de données (couche 2) à l'évolutivité, à la flexibilité et aux performances du routage de couche réseau (couche 3).
PE	Périphérie du fournisseur (commutateur/routeur)	Périphérique de périphérie du réseau du fournisseur qui reçoit les préfixes d'un CE client et les transmet dans le cloud MPLS.
CE	Périphérie client (commutateur/routeur)	Périphérique dans les locaux du client connecté au routeur de périphérie du fournisseur d'un réseau IP/MPLS du fournisseur de services.
LDP	Protocole de découverte	Le protocole LDP génère et échange automatiquement des étiquettes entre routeurs. Chaque routeur génère localement des étiquettes pour ses préfix

	d'étiquettes	puis les annonce à ses voisins.
LSPA	Tableau des chemins du commutateur d'étiquettes	Ensemble d'étiquettes permettant d'atteindre une destination MPLS spécifi Dans un L3VPN type, vous pouvez avoir une étiquette IGP + VPN. S'il y a tunnel TE, alors vous avez l'étiquette TE + IGP + VPN. Catalyst 9000 peut prendre en charge jusqu'à 6 étiquettes, et ce tableau d'étiquettes est appel LSPA.
ID de pile d'étiquettes	ID de pile d'étiquettes	A index unique permettant d'identifier une pile d'étiquettes (unPermet le pa LSPA).
Étiquette	Étiquette	Étiquette MPLS utilisée pour la recherche. Plusieurs étiquettes constituent pile d'étiquettes.
ID de préfixe	Identificateur de préfixe	Catalyst 9000 crée une ressource globale pour chaque préfixe (il y a autan de préfixe qu'il y a de routes dans le cas de l'allocation d'étiquette par préfix
EM	Correspondance exacte	Entrée dans la mémoire de hachage qui correspond à 1:1 (route hôte, hôte connecté directement).
LPM	Correspondance de préfixe la plus longue	Toute route qui est /31 ou plus courte (/32 routes sont de type EM).
TCAM	Mémoire Ternaire Adressable Au Contenu	Type de mémoire qui stocke et interroge les entrées avec trois entrées différentes : 0, 1 et X. Ce type de mémoire doit être utilisé dans les cas où y avoir plusieurs correspondances à la même entrée, et le hachage résulta pour chacune ne serait pas unique. **Ce tableau inclut un masque ou une va « X » qui lui permet de savoir s'il correspond ou non à cette entrée.**
CAM	Mémoire adressable au contenu	Terme général de la mémoire matérielle (Hash/TCAM).
RIB	Base d'informations de routage	La table de routage affichée dans la commande show ip route
FIB	Base d'informations de transfert	tableau simplifié avec préfixes ajoutés par les tables RIB et ARP avec un pointeur vers la table ADJ
Connexion directe	Route connectée directement	Un préfixe d'hôte connecté localement (ARP adjacent)
Indirecteme nt connecté	Route connectée indirectement	Une route qui passe par un prochain saut distant pour atteindre
ADJ	Contiguïté (tableau)	Stocke les informations de tronçon suivant utilisées pour la réécriture des paquets
EM	Correspondance exacte	Hôtes connectés, préfixes d'hôtes /32 indirects
TCAM	Mémoire Ternaire Adressable Au Contenu	Préfixes indirects /31 ou plus
FED	Pilote du moteur de transfert	La couche ASIC (matérielle)
FMAN-FP	Gestionnaire de transfert - Plan de transfert	FMAN-FP gère les objets logiciels qui ajoutent, suppriment ou modifient les informations FED
SI	Index des stations	Index des stations = informations de réécriture de paquets (RI = Index de réécriture) et informations d'interface sortante (DI = Index de destination)
RI	Index de	Informations de réécriture d'adresse MAC pour le transfert de couche 3 ver

	réécriture	contiguïté de tronçon suivant
DI	Index de destination	Index pointant vers l'interface de sortie

Configuration et vérification

Scénario 1. L3VPN avec contiguïté à un seul saut dans le coeur MPLS

Topologie de référence

Pour les besoins de cet exemple, les commutateurs Catalyst 9300 fonctionnent comme des périphériques PE, Catalyst 9500 in Stackwise Virtual comme périphérique P et Catalyst 3850 comme périphériques CE.
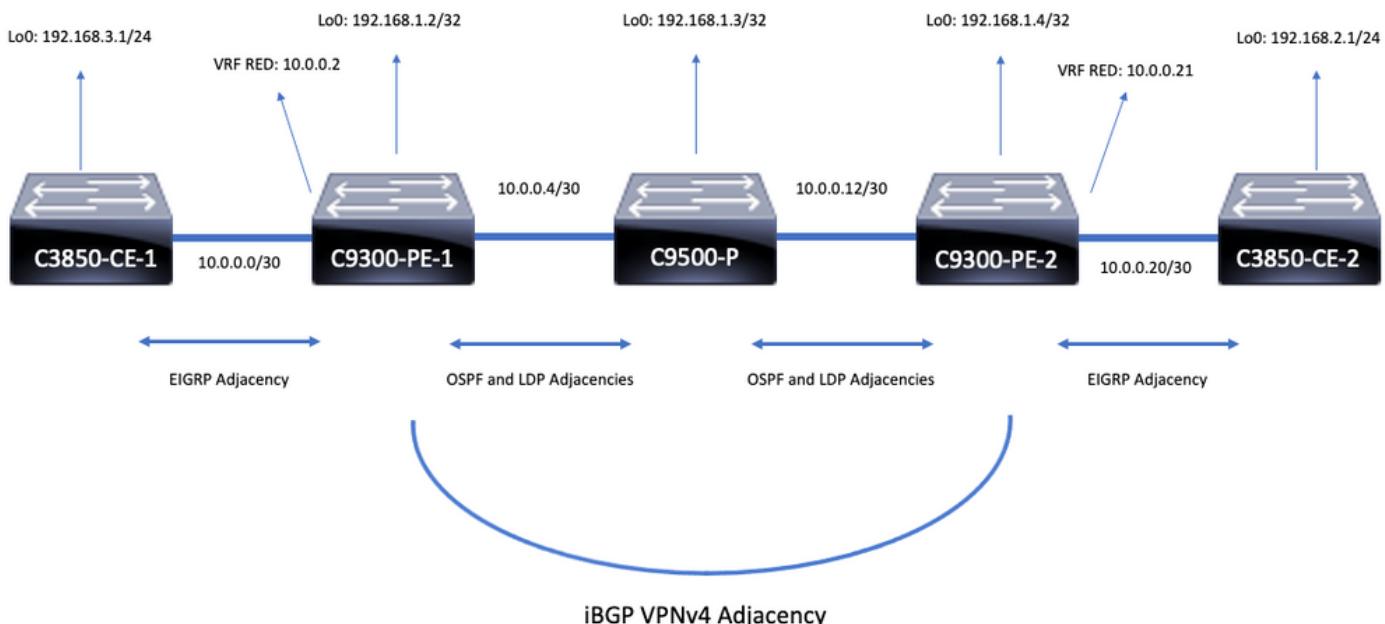
Détails de la configuration

Configuration du C3850-CE-1

```
hostname C3850-CE-1
!
interface Loopback0
ip address 192.168.3.1 255.255.255.0
!
interface TenGigabitEthernet1/0/1
no switchport
ip address 10.0.0.1 255.255.255.252
!
router eigrp 420
network 10.0.0.0 0.0.0.3
network 192.168.3.0 0.0.0.255
eigrp stub connected summary
```

```
!
ip route 0.0.0.0 0.0.0.0 10.0.0.2
```

Configuration du C9300-PE-1

```
hostname C9300-PE-1
!
ip vrf RED
rd 69:69
route-target export 69:69
route-target import 69:69
!
mpls ldp explicit-null
!
interface Loopback0
ip address 192.168.1.2 255.255.255.255
!
interface GigabitEthernet1/0/1
no switchport
ip vrf forwarding RED
ip address 10.0.0.2 255.255.255.252
!
interface GigabitEthernet1/0/2
no switchport
ip address 10.0.0.5 255.255.255.252
!
router eigrp 420
!
address-family ipv4 vrf RED
network 10.0.0.0 0.0.0.3
autonomous-system 420
exit-address-family
!
router ospf 420
network 0.0.0.0 255.255.255.255 area 0
mpls ldp autoconfig
!
router bgp 69420
bgp log-neighbor-changes
neighbor 192.168.1.4 remote-as 69420
neighbor 192.168.1.4 update-source Loopback0
!
address-family vpnv4
neighbor 192.168.1.4 activate
neighbor 192.168.1.4 send-community extended
exit-address-family
!
address-family ipv4 vrf RED
redistribute eigrp 420
exit-address-family
```

Configuration du C9500-P

```
hostname C9500-P
!
interface Loopback0
ip address 192.168.1.3 255.255.255.255
!
interface TenGigabitEthernet1/0/1
no switchport
ip address 10.0.0.6 255.255.255.252
!
```

```
interface TenGigabitEthernet1/0/2
no switchport
ip address 10.0.0.13 255.255.255.252
!
router ospf 420
network 0.0.0.0 255.255.255.255 area 0
mpls ldp autoconfig
```
Configuration du C9300-CE-2

```
hostname C9300-PE-2
!
ip vrf RED
rd 69:69
route-target export 69:69
route-target import 69:69
!
mpls ldp explicit-null
!
interface Loopback0
ip address 192.168.1.4 255.255.255.255
!
interface GigabitEthernet2/0/1
no switchport
ip vrf forwarding RED
ip address 10.0.0.21 255.255.255.252
!
interface GigabitEthernet2/0/2
no switchport
ip address 10.0.0.14 255.255.255.252
!
router eigrp 400
!
address-family ipv4 vrf RED
network 10.0.0.20 0.0.0.3
autonomous-system 400
exit-address-family
!
router ospf 420
network 0.0.0.0 255.255.255.255 area 0
mpls ldp autoconfig
!
router bgp 69420
bgp log-neighbor-changes
neighbor 192.168.1.2 remote-as 69420
neighbor192.168.1.2 update-source Loopback0
!
address-family vpnv4
neighbor 192.168.1.2 activate
neighbor 192.168.1.2 send-community extended
exit-address-family
!
address-family ipv4 vrf RED
redistribute eigrp 400
exit-address-family
```
Configuration du C3850-CE-2

```
hostname C3850-CE-2
!
interface Loopback0
ip address 192.168.2.1 255.255.255.0
```

```
!
interface TenGigabitEthernet2/0/1
no switchport
ip address 10.0.0.22 255.255.255.252
!
router eigrp 400
network 10.0.0.20 0.0.0.3
network 192.168.2.0 0.0.0.255
eigrp stub connected summary
!
ip route 0.0.0.0 0.0.0.0 10.0.0.21
```

Vérification de base

Avant la validation de la programmation MPLS, il y a des exigences de base qui doivent être validées :

- Valider la connectivité PE à PE est présente
- Valider le chemin LSP (Label Switched Path) entre les PE
- Valider la contiguïté BGPv4 entre les PE
- Valider les étiquettes VPNv4 et LDP
- Valider la table de transfert MPLS

Valider la connectivité PE à PE

Vous pouvez envoyer une requête ping au bouclage PE distant et à la source à partir du bouclage local, mais cela ne confirme pas que le chemin LSP (Label Switched Path) MPLS est correct, puisque les adresses IP de bouclage sont annoncées dans la sous-couche.

> Remarque : La contiguïté VPNv4 PE à PE MP-BGP est obtenue via leurs interfaces Loopback0 respectives.

```
C9300-PE-1#ping 192.168.1.4 source 192.168.1.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.4, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms C9300-PE-1#show ip route
192.168.1.4
Routing entry for 192.168.1.4/32
Known via "ospf 420", distance 110, metric 3, type intra area
Last update from 10.0.0.10 on GigabitEthernet1/0/3, 00:55:58 ago
Routing Descriptor Blocks:
* 10.0.0.6, from 192.168.1.4, 00:55:58 ago, via GigabitEthernet1/0/2
Route metric is 3, traffic share count is 1
```

Valider le LSP

Vous pouvez utiliser un traceroute MPLS à partir du bouclage PE vers PE pour valider le LSP et toutes les étiquettes LDP MPLS le long du chemin.

> Remarque : Cette traceroute MPLS impose une seule étiquette, l'étiquette LDP, cela ne démontre pas que le trafic en provenance de CE est réussi, car le trafic est imposé avec 2 étiquettes, l'étiquette VPNv4 (interne) et l'étiquette LDP (externe).

```
C9300-PE-1#traceroute mpls ipv4 192.168.1.4/32 source 192.168.1.2
Tracing MPLS Label Switched Path to 192.168.1.4/32, timeout is 2 seconds

Codes: '!' - success, 'Q' - request not sent, '.' - timeout,
  'L' - labeled output interface, 'B' - unlabeled output interface,
  'D' - DS Map mismatch, 'F' - no FEC mapping, 'f' - FEC mismatch,
  'M' - malformed request, 'm' - unsupported tlvs, 'N' - no label entry,
  'P' - no rx intf label prot, 'p' - premature termination of LSP,
  'R' - transit router, 'I' - unknown upstream index,
  'l' - Label switched with FEC change, 'd' - see DDMAP for return code,
  'X' - unknown return code, 'x' - return code 0

Type escape sequence to abort.
  0 10.0.0.5 MRU 1500 [Labels: 17 Exp: 0]
L 1 10.0.0.6 MRU 1500 [Labels: explicit-null Exp: 0] 8 ms
! 2 10.0.0.14 2 ms
```

Si vous n'avez pas accès au CE ou à un périphérique derrière le CE et que vous voulez démontrer qu'il y a une imposition/disposition d'étiquette VPNv4 et LDP réussie, vous pouvez tenter d'envoyer une requête ping de l'interface CE du VRF sur un PE à l'autre interface CE du VRF sur le PE distant.

```
C9300-PE-1#ping vrf RED 10.0.0.21 source 10.0.0.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.21, timeout is 2 seconds:
Packet sent with a source address of 10.0.0.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms
```

Valider la contiguïté VPNv4 BGP entre les PE

```
C9300-PE-1#show bgp vpnv4 unicast all neighbors 192.168.1.4
BGP neighbor is 192.168.1.4, remote AS 69420, internal link
BGP version 4, remote router ID 192.168.1.4
BGP state = Established, up for 00:57:37
Last read 00:00:41, last write 00:00:41, hold time is 180, keepalive interval is 60 seconds
Neighbor sessions:
1 active, is not multisession capable (disabled)
Neighbor capabilities:
Route refresh: advertised and received(new)
Four-octets ASN Capability: advertised and received
Address family IPv4 Unicast: advertised and received
Address family VPNv4 Unicast: advertised and received
Enhanced Refresh Capability: advertised and received
Multisession Capability:
Stateful switchover support enabled: NO for session 1
Message statistics:
InQ depth is 0
OutQ depth is 0

Sent Rcvd
Opens: 1 1
Notifications: 0 0
Updates: 6 6
Keepalives: 62 63
Route Refresh: 0 0
Total: 69 70
Do log neighbor state changes (via global configuration)
Default minimum time between advertisement runs is 0 seconds
```

```
<snip>

C9300-PE-2#show bgp vpnv4 unicast all neighbors 192.168.1.2
BGP neighbor is 192.168.1.2, remote AS 69420, internal link
BGP version 4, remote router ID 192.168.1.2
BGP state = Established, up for 01:01:00
Last read 00:00:13, last write 00:00:37, hold time is 180, keepalive interval is 60 seconds
Neighbor sessions:
1 active, is not multisession capable (disabled)
Neighbor capabilities:
Route refresh: advertised and received(new)
Four-octets ASN Capability: advertised and received
Address family IPv4 Unicast: advertised and received
Address family VPNv4 Unicast: advertised and received
Enhanced Refresh Capability: advertised and received
Multisession Capability:
Stateful switchover support enabled: NO for session 1
Message statistics:
InQ depth is 0
OutQ depth is 0

Sent Rcvd
Opens: 1 1
Notifications: 0 0
Updates: 6 6
Keepalives: 67 66
Route Refresh: 0 0
Total: 74 73
Do log neighbor state changes (via global configuration)
Default minimum time between advertisement runs is 0 seconds
```
La contiguïté VPNv4 de l'ordinateur de bureau distant est active et un préfixe a été reçu

```
C9300-PE-1#show bgp vpnv4 unicast all summary
BGP router identifier 192.168.1.2, local AS number 69420
BGP table version is 7, main routing table version 7
4 network entries using 1024 bytes of memory
4 path entries using 544 bytes of memory
4/4 BGP path/bestpath attribute entries using 1216 bytes of memory
4 BGP extended community entries using 1000 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3784 total bytes of memory
BGP activity 4/0 prefixes, 4/0 paths, scan interval 60 secs
4 networks peaked at 16:19:10 Jun 1 2021 UTC (01:32:00.716 ago)


Neighbor        V         AS MsgRcvd MsgSent    TblVer  InQ OutQ Up/Down  State/PfxRcd
192.168.1.4     4      69420     108        108         7    0    0 01:34:52           2

C9300-PE-2#show bgp vpnv4 unicast all summary
BGP router identifier 192.168.1.4, local AS number 69420
BGP table version is 7, main routing table version 7
4 network entries using 1024 bytes of memory
4 path entries using 544 bytes of memory
4/4 BGP path/bestpath attribute entries using 1216 bytes of memory
4 BGP extended community entries using 1000 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3784 total bytes of memory
BGP activity 4/0 prefixes, 4/0 paths, scan interval 60 secs
4 networks peaked at 16:18:31 Jun 1 2021 UTC (01:37:30.404 ago)


Neighbor        V         AS MsgRcvd MsgSent    TblVer  InQ OutQ Up/Down   State/PfxRcd
```

```
192.168.1.2    4    69420    114    114    7    0    0 01:40:22    2
```

Vérifier quels préfixes sont échangés dans le VRF particulier

```
C9300-PE-1#show ip bgp vpnv4 vrf RED
BGP table version is 10, local router ID is 192.168.1.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop          Metric LocPrf Weight Path
Route Distinguisher: 69:69 (default for vrf RED)
 *>   10.0.0.0/30      0.0.0.0                0         32768 ?
 *>i  10.0.0.20/30     192.168.1.4            0    100      0 ?
 *>   192.168.1.0      10.0.0.1          130816         32768 ?
 *>i  192.168.2.0      192.168.1.4       130816    100      0 ?

C9300-PE-2#show ip bgp vpnv4 vrf RED
BGP table version is 9, local router ID is 192.168.1.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop          Metric LocPrf Weight Path
Route Distinguisher: 69:69 (default for vrf RED)
 *>i  10.0.0.0/30      192.168.1.2            0    100      0 ?
 *>   10.0.0.20/30     0.0.0.0                0         32768 ?
 *>i  192.168.1.0      192.168.1.2       130816    100      0 ?
 *>   192.168.2.0      10.0.0.22         130816         32768 ?
```

Valider les étiquettes VPNv4 et LDP :

Vérifiez l'étiquette VPNv4 utilisée pour atteindre les préfixes dans le VRF

```
C9300-PE-1#show ip bgp vpnv4 vrf RED labels
   Network          Next Hop      In label/Out label
Route Distinguisher: 69:69 (RED)
   10.0.0.0/30      0.0.0.0          20/nolabel(RED)
   10.0.0.20/30     192.168.1.4      nolabel/20
   192.168.1.0      10.0.0.1         21/nolabel
   192.168.2.1/32   192.168.1.4      nolabel/21 <-- VPNv4 label that is imposed to reach
192.168.2.0

C9300-PE-1#show ip route vrf RED 192.168.2.1
Routing Table: RED
Routing entry for 192.168.2.0/24
Known via "bgp 69420", distance 200, metric 130816, type internal
Last update from 192.168.1.4 01:31:56 ago
Routing Descriptor Blocks:
* 192.168.1.4 (default), from 192.168.1.4, 01:31:56 ago
Route metric is 130816, traffic share count is 1
AS Hops 0
MPLS label: 21 <-- VPNv4 label that matches the previous output
```

```
MPLS Flags: MPLS Required
C9300-PE-2#show ip bgp vpnv4 vrf RED labels
   Network          Next Hop      In label/Out label
Route Distinguisher: 69:69 (RED)
   10.0.0.0/30      192.168.1.2    nolabel/20
   10.0.0.20/30     0.0.0.0        20/nolabel(RED)
   192.168.1.0      192.168.1.2    nolabel/21
   192.168.2.0.     10.0.0.22      21/nolabel <-- VPNv4 label that is advertised to reach
192.168.2.0


C9300-PE-2#show ip route vrf RED 192.168.2.1

Routing Table: RED
Routing entry for 192.168.2.0/24
  Known via "eigrp 400", distance 90, metric 130816, precedence routine (0), type internal
  Redistributing via eigrp 400, bgp 69420
  Advertised by bgp 69420
  Last update from 10.0.0.22 on GigabitEthernet2/0/1, 01:34:42 ago
  Routing Descriptor Blocks:
  * 10.0.0.22, from 10.0.0.22, 01:34:42 ago, via GigabitEthernet2/0/1 <-- CE-facing interface in
the VRF
      Route metric is 130816, traffic share count is 1
      Total delay is 5010 microseconds, minimum bandwidth is 1000000 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 1
```

Vérifier les étiquettes LDP utilisées

```
C9300-PE-1#show mpls forwarding-table 192.168.1.4
Local      Outgoing    Prefix           Bytes Label  Outgoing    Next Hop
Label      Label       or Tunnel Id     Switched     interface
19         17          192.168.1.4/32   0            Gi1/0/2     10.0.0.6 <-- 17 is the LDP label
imposed to reach PE at 192.168.1.4 through Gi1/0/2

C9300-PE-2#show mpls forwarding-table 192.168.1.2
Local      Outgoing    Prefix           Bytes Label  Outgoing    Next Hop
Label      Label       or Tunnel Id     Switched     interface
17         16          192.168.1.2/32   0            Gi2/0/2     10.0.0.13 <-- 16 is the LDP
label imposed to reach PE at 192.168.1.4 through Gi2/0/2
```

Valider la table de transfert MPLS

```
C9300-PE-1#show mpls forwarding-table
Local      Outgoing    Prefix           Bytes Label  Outgoing    Next Hop
Label      Label       or Tunnel Id     Switched     interface
16         Pop Label   192.168.1.3/32   0            Gi1/0/2     10.0.0.6
17         Pop Label   10.0.0.16/30     0            Gi1/0/2     10.0.0.6
18         Pop Label   10.0.0.12/30     0            Gi1/0/2     10.0.0.6
19         17          192.168.1.4/32   0            Gi1/0/2     10.0.0.6
20         No Label    10.0.0.0/30[V]   1982         aggregate/RED
21         No Label    192.168.3.0/24[V]  \
                                        0            Gi1/0/1     10.0.0.1


C9300-PE-2#show mpls forwarding-table
Local      Outgoing    Prefix           Bytes Label  Outgoing    Next Hop
Label      Label       or Tunnel Id     Switched     interface
16         Pop Label   192.168.1.3/32   0            Gi2/0/2     10.0.0.13
           Pop Label   192.168.1.3/32   0            Gi2/0/3     10.0.0.17
17         16          192.168.1.2/32   164          Gi2/0/2     10.0.0.13
           16          192.168.1.2/32   1224         Gi2/0/3     10.0.0.17
18         Pop Label   10.0.0.4/30      0            Gi2/0/2     10.0.0.13
```

```
                 Pop Label  10.0.0.4/30     0            Gi2/0/3    10.0.0.17
20       No Label   10.0.0.20/30[V]  0            aggregate/RED
21       No Label   192.168.2.0/24[V]  \
                                      1440         Gi2/0/1    10.0.0.22
```

Confirmer les étiquettes internes (VPNv4) et externes (LDP) utilisées pour atteindre chaque préfixe donné dans le VRF

```
C9300-PE-1#show ip cef vrf RED 192.168.2.0/24 detail
192.168.2.1/32, epoch 0, flags [rib defined all labels]
  recursive via 192.168.1.4 label 21 <-- VPNv4 label
    nexthop 10.0.0.6 GigabitEthernet1/0/2 label 17-(local:19) <-- 17 is the LDP label that is be
imposed to reach the remote PE,
19 is the local LDP label advertised to the P router

C9300-PE-2#show ip cef vrf RED 192.168.3.0/24 detail
192.168.1.1/32, epoch 0, flags [rib defined all labels]
  recursive via 192.168.1.2 label 22 <-- VPNv4 label
    nexthop 10.0.0.13 GigabitEthernet2/0/2 label 16-(local:17) <-- 16 is the LDP label that is
be imposed to reach the remote PE,
                                                17 is the local LDP label
advertised to the P router
```

Vérifier les statistiques du Gestionnaire d'objets

Dans les scénarios idéaux, il n'y a aucun objet en attente

```
C9300-PE-1#show platform software object-manager switch active f0 statistics
Forwarding Manager Asynchronous Object Manager Statistics

Object update: Pending-issue: 0, Pending-acknowledgement: 0
Batch begin:   Pending-issue: 0, Pending-acknowledgement: 0
Batch end:     Pending-issue: 0, Pending-acknowledgement: 0
Command:       Pending-acknowledgement: 0
Total-objects: 491
Stale-objects: 0
Resolve-objects: 0
Childless-delete-objects: 0
Error-objects: 0
Paused-types: 0
9500-P#show platform software object-manager switch active f0 statistics
Forwarding Manager Asynchronous Object Manager Statistics

Object update: Pending-issue: 0, Pending-acknowledgement: 0
Batch begin:   Pending-issue: 0, Pending-acknowledgement: 0
Batch end:     Pending-issue: 0, Pending-acknowledgement: 0
Command:       Pending-acknowledgement: 0
Total-objects: 491
Stale-objects: 0
Resolve-objects: 0
Childless-delete-objects: 0
Error-objects: 0
Paused-types: 0
C9300-PE-2#show platform software object-manager switch active f0 statistics
Forwarding Manager Asynchronous Object Manager Statistics

Object update: Pending-issue: 0, Pending-acknowledgement: 0
Batch begin:   Pending-issue: 0, Pending-acknowledgement: 0
Batch end:     Pending-issue: 0, Pending-acknowledgement: 0
Command:       Pending-acknowledgement: 0
```

```
Total-objects: 482
Stale-objects: 0
Resolve-objects: 0
Childless-delete-objects: 0
Error-objects: 0
Paused-types: 0
```

Programmation du préfixe

La section suivante traite de la programmation de préfixe sur les routeurs MPLS, C9300-PE-1, C9500-P et C9300-PE-2.

Programmation du préfixe C9300-PE-1

```
***Software Prefix Programming***
C9300-PE-1#show ip route vrf RED 192.168.2.1

Routing Table: RED
Routing entry for 192.168.2.0/24
  Known via "bgp 69420", distance 200, metric 130816, type internal
  Last update from 192.168.1.4 20:21:40 ago
  Routing Descriptor Blocks:
  * 192.168.1.4 (default), from 192.168.1.4, 20:21:40 ago <-- Remote PE reachable in the global
routing table
      Route metric is 130816, traffic share count is 1
      AS Hops 0
      MPLS label: 21 <-- VPNv4 label
      MPLS Flags: MPLS Required

C9300-PE-1#show ip route 192.168.1.4
Routing entry for 192.168.1.4/32
Known via "ospf 420", distance 110, metric 3, type intra area
Last update from 10.0.0.6 on GigabitEthernet1/0/2, 21:27:11 ago
Routing Descriptor Blocks:
* 10.0.0.6, from 192.168.1.4, 21:27:11 ago, via GigabitEthernet1/0/2 <-- Next-hop 10.0.0.6 via
Gi1/0/2 to reach
Route metric is 3, traffic share count is 1

***FMAN RP Prefix Programming***
C9300-PE-1#show ip vrf detail
VRF RED (VRF Id = 2); default RD 69:69; default VPNID <-- VRF ID is important in subsequent
command
  Old CLI format, supports IPv4 only
  Flags: 0xC
  Interfaces:
    Gi1/0/1
Address family ipv4 unicast (Table ID = 0x2):
  Flags: 0x0
  Export VPN route-target communities
    RT:69:69
  Import VPN route-target communities
    RT:69:69
  No import route-map
  No global export route-map
  No export route-map
  VRF label distribution protocol: not configured
  VRF label allocation mode: per-prefix
C9300-PE-1#show platform software ip switch active r0 cef table index 2 prefix 192.168.2.0/24 <-
- Index value is the VRF ID from previous command
```

```
Forwarding Table

Prefix/Len                    Next Object      Index
----------------------------------------------------------------
192.168.2.0/24                OBJ_LABEL        0x14
```

C9300-PE-1#**show platform software mpls switch active r0 label index 0x14 <-- Utilize the Index value from previous command**


```
Label OCE 0x14 -> OBJ_LABEL (0x17) <-- Utilized in next command
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x15
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x3480636fb0
```

C9300-PE-1#**show platform software mpls switch active r0 label index 0x17 <-- Utilize the OBJ_LABEL value from previous command**


```
Label OCE 0x17 -> OBJ_ADJACENCY (0x46) <-- Utilized in next command
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x11
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x348062f858
```

C9300-PE-1#**show platform software adjacency switch active r0 index 0x46 <-- Utilize the OBJ_ADJACENCY value from previous command**
```
Number of adjacency objects: 6

Adjacency id: 0x46 (70)
  Interface: GigabitEthernet1/0/2, IF index: 54, Link Type: MCP_LINK_TAG <-- Egress interface
  Encap: d4:ad:71:b5:dd:e4:a0:f8:49:11:d1:d6:88:47 <-- MAC ending in DDE4 is the DMAC, MAC
ending in D1D6 is SMAC, 8847 is MPLS ETYPE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: unknown
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 10.0.0.6 <-- Next-hop IP address
  IP FRR MCP_ADJ_IPFRR_NONE 0
  OM handle: 0x3480636280
```

FMAN FP Prefix Programming
C9300-PE-1#**show ip vrf detail**
VRF RED (**VRF Id = 2**); default RD 69:69; default VPNID **<-- VRF ID is important in subsequent command**
```
  Old CLI format, supports IPv4 only
  Flags: 0xC
  Interfaces:
    Gi1/0/1
Address family ipv4 unicast (Table ID = 0x2):
  Flags: 0x0
  Export VPN route-target communities
    RT:69:69
  Import VPN route-target communities
    RT:69:69
  No import route-map
  No global export route-map
  No export route-map
  VRF label distribution protocol: not configured
  VRF label allocation mode: per-prefix
```

C9300-PE-1#**show platform software ip switch active f0 cef table index 2 prefix 192.168.2.0/24**

detail <-- Index value is the VRF ID from previous command
Forwarding Table

192.168.2.0/24 -> OBJ_LABEL (**0x14**), urpf: 15 **<-- Utilized in next command**
Prefix Flags: unknown
aom id: 648, HW handle: (nil) (created)

C9300-PE-1#**show platform software mpls switch active f0 label index 0x14 <-- Utilize the**
OBJ_LABEL value from the previous command

Label OCE 0x14 -> OBJ_LABEL (**0x17**) **<-- Utilized in next command**
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x15
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 647, CPP handle: 0xdeadbeef (created)

C9300-PE-1#**show platform software mpls switch active f0 label index 0x17 <-- Utilize the**
OBJ_LABEL value from the previous command

Label OCE 0x17 -> OBJ_ADJACENCY (**0x46**) **<-- Utilized in next command**
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x11
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 664, CPP handle: 0xdeadbeef (created)

C9300-PE-1#**show platform software adjacency switch active f0 index 0x46 <-- Utilize the**
OBJ_ADJACENCY value from the previous command
Number of adjacency objects: 6

Adjacency id: 0x46 (70)
  Interface: **GigabitEthernet1/0/2**, IF index: 54, Link Type: MCP_LINK_TAG **<-- Egress interface**
  Encap: **d4:ad:71:b5:dd:e4:a0:f8:49:11:d1:d6:88:47 <-- MAC ending in DDE4 is the DMAC, MAC**
ending in D1D6 is SMAC, 8847 is MPLS ETYPE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: unknown
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: **10.0.0.6 <-- Next-hop IP address**
  IP FRR MCP_ADJ_IPFRR_NONE 0
  aom id: 522, HW handle: (nil) (created)

FED Prefix Programming
C9300-PE-1#**show platform software fed switch active ip route vrf-name RED 192.168.2.0/24**
vrf   dest   htm   flags SGT   DGID MPLS Last-
modified
---   ----   ---   ----- ---   ---- ---- -----
----
2   192.168.2.0/24   **0x7feeeca12bb8** 0x0   0   0   lspa0x2
2021/06/14 17:13:59.644 **<-- HTM value significant for next command**
  FIB: prefix_hdl:0x5000002a, mpls_ecr_prefix_hdl:0
  ========== OCE chain =====
  LABEL:objid:20 link_type:MPLS local_label:1048577 outlabel:(**21**, 0) **<-- VPNv4 Label**
      flags:0x1:(REAL,) pdflags:0x80:(INSTALL_HW_OK,RECIR_ADJ,) **adj_handle:0x5100003d <--**
adj_handle and local_adj_hdl values must match
      unsupported recursion:0 olbl_changed 0 local_adj:1 modify_cnt:1
      bwalk_cnt:0 subwalk_cnt:1 collapsed_oce:0
      AAL: id:1358954557 **lbl:19** smac:0000.0000.0000 dmac:0000.0000.0000 **<-- Label 19 matches the**
local transport label
        sub_type:0 link_type:0 adj_flags:0x10 label_type:0 rewrite_type:PSH2(121)
        vlan_id:0 vrf_id:0 ri:0x7feeeca9acf8, **ri_id:0x46** phdl:0, ref_cnt:2 **<-- ri_id and**

ri_idx values must match
              si:0x7feeeca6ab98, si_id:0xb6, di_id:0x5013
    LABEL:objid:23 link_type:MPLS local_label:**19** outlabel:(**17**, 0) **<-- Label 19 is the local**
transport label, Label 17 is the LDP label
        flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0x50000034
        unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
        bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
        AAL: id:1342177332 lbl:0 **smac:a0f8.4911.d1d6 dmac:d4ad.71b5.dde4 <-- Matches the next-hop**
information to reach 192.168.2.0/24
              sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
              vlan_id:0 vrf_id:0 ri:0x7feeecd6d238, ri_id:0x3e phdl:0x9f00004b, ref_cnt:1
              si:0x7feeecd706d8, si_id:0x4013, **di_id:0x535f <-- di_id utilized in subsequent**
commands
    ADJ:objid:70 {link_type:MPLS ifnum:0x36, si:0x94000021, }
    ==============
    MPLS info: mpls_ecr_scale_prefix_adj:0, mpls_lspa_hdl:0xab000003
      AAL:LSPA: id:2868903939 num_path:1 prefix_id:0x2 delete_hw_hdl_cnt:0
          cookie[64]:
15000000000000000000000000000000000000000000000000000000000460000000000000000000000000000000
00000000000000000000000000000000 status:ok
          vpn_lbl:21 local_adj_hdl:0x5100003d hw_hdl:0x7feeecab2d48 **ri_idx:0x46 <-- vpn_lbl**
matches the VPNv4 label,adj_handle and local_adj_hdl values must match,ri_id and ri_idx values
must match
    ==============

C9300-PE-1#**show platform hardware fed switch active fwd-asic abstraction print-resource-handle**
0x7feeeca12bb8 1 <-- Utilize HTM value from previous command
Handle:0x7feeeca12bb8 Res-Type:ASIC_RSC_HASH_TCAM Res-Switch-Num:0 Asic-Num:255 Feature-
ID:AL_FID_L3_UNICAST_IPV4 Lkp-ftr-id:LKP_FEAT_IPV4_L3_UNICAST ref_count:1
priv_ri/priv_si Handle: (nil)Hardware Indices/Handles: handle [ASIC: 0]: 0x7feeeca2af28
Features sharing this resource:Cookie length: 12
01 02 a8 c0 00 00 02 d0 07 00 00 00

Detailed Resource Information (ASIC# 0)

Number of HTM Entries: 1

Entry 0: (handle 0x7feeeca2af28)

Absolute Index: 66036
Time Stamp: 160003
KEY - vrf:2 mtr:0 **prefix:192.168.2.0** rcp_redirect_index:0x0
MASK - vrf:0 mtr:0 **prefix:0.0.0.255** rcp_redirect_index:0x0
FWD-AD = afd_label_flag:0 icmp_redir_enable:1 lvx_smr_enabled:0, dstNatType:0 priority:5
afdLabelOrDestClientId:0 SI:182 destined_to_us:0 hw_stats_idx:0 stats_id:0
redirectSetRouterMac:0 dgtIdx:0 destModIndex:0 dstNatTypeOrVpnPrefixPtrMsb:0 vpnPrefixPtr:0x2
SRC-AD = learning_violation:0 need_to_learn:0 locally_connected:0 staticentryViolation:0
rpfValid:1 rpfLe:0 rpfLePointer:0 rpfForcePass:0 rpfForceFail:0 reachableviaSome:0
rpfCheckIncomplete:0 defaultRoute:0 ChainPtrValid:0 ChainPtrOrPortLeIndex:72 UseRpfmatchTable:0
rpfIncomplete:0 is_src_ce:0 sgtValid:0 sgt:0 src_rloc_trusted:0,sgtCacheControl1 = 0,
sgtCacheControl0 = 0
port_label:0x0 port_mask:0x0 vlan_label:0x0 vlan_mask:0x0 l3if_label:0x0 l3if_mask:0x0
group_label:0x0 group_mask:0x0

===

C9300-PE-1#**show platform hardware fed switch active fwd-asic resource asic all destination-index**
range 0x535f 0x535f <-- Utilize the di_id from the previous command
ASIC#0:

index = 0x535f
pmap = 0x00000000 0x00000000
cmi = 0x0

```
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0
ASIC#1:

index = 0x535f
pmap = 0x00000000 0x00000002 <-- Looking at 0x00000002, in binary that is 0000 0000 0000 0000
0000 0000 0000 0010 = Port 1 (Zero based, count right to left)
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0


C9300-PE-1#show plat soft fed switch active ifm mappings
Interface              IF_ID    Inst Asic Core Port SubPort Mac  Cntx LPN  GPN  Type Active
GigabitEthernet1/0/2   0x36      1    0    1    1     0       6    7    2    2   NIF  Y    <-
- Port 1 is the egress port, Gi1/0/2
```

Programmation du préfixe C9500-P


```
***Software Prefix Programming***
C9500-P#show ip route 192.168.1.4
Routing entry for 192.168.1.4/32
  Known via "ospf 420", distance 110, metric 2, type intra area
  Last update from 10.0.0.14 on TenGigabitEthernet1/0/2, 1d21h ago
  Routing Descriptor Blocks:
  * 10.0.0.14, from 192.168.1.4, 1d21h ago, via TenGigabitEthernet1/0/2 <-- Next-hop to reach
192.168.1.4
      Route metric is 2, traffic share count is 1

C9500-P#show ip cef 192.168.1.4 detail
192.168.1.4/32, epoch 4
  dflt local label info: global/17 [0x3]
  nexthop 10.0.0.14 TenGigabitEthernet1/0/2 label explicit-null-(local:17)

***FMAN RP Prefix Programming***
C9500-P#show platform software ip switch active r0 cef prefix 192.168.1.4/32
Forwarding Table

Prefix/Len                   Next Object      Index
-------------------------------------------------------------------
192.168.1.4/32               OBJ_LABEL        0x16 <-- Value used in next command


C9500-P#show platform software mpls switch active r0 label index 0x16 <-- Utilize the OBJ_LABEL
```

value from previous command

```
Label OCE 0x16 -> OBJ_ADJACENCY (0x49) <-- Value used in next command
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x34806492f0
```

C9500-P#**show platform software adjacency switch active r0 index 0x49 <-- Utilize OBJ_ADJACENCY**
value from previous command
```
Number of adjacency objects: 8

Adjacency id: 0x49 (73)
  Interface: TenGigabitEthernet1/0/2, IF index: 66, Link Type: MCP_LINK_TAG
  Encap: 70:d3:79:be:ae:71:d4:ad:71:b5:dd:d6:88:47 <-- MAC ending in AE71 is the DMAC, MAC
ending in DDD6 is the SMAC, 8847 is MPLS ETYPE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: unknown
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 10.0.0.14 <-- Next-hop IP
  IP FRR MCP_ADJ_IPFRR_NONE 0
  OM handle: 0x3480647760
```

FMAN FP Prefix Programming
C9500-P#**show platform software ip switch active f0 cef prefix 192.168.1.4/32 detail**
```
Forwarding Table

192.168.1.4/32 -> OBJ_LABEL (0x16), urpf: 21 <-- Used in subsequent command
Prefix Flags: unknown
aom id: 567, HW handle: (nil) (created)
```

C9500-P#**show platform software mpls switch active f0 label index 0x16 <-- Utilize the OBJ_LABEL**
value from previous command

```
Label OCE 0x16 -> OBJ_ADJACENCY (0x49) <-- Used in subsequent command
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 589, CPP handle: 0xdeadbeef (created)
```

C9500-P#**show platform software adjacency switch active f0 index 0x49 <-- Utilize the**
OBJ_ADJACENCY from previous command
```
Number of adjacency objects: 8

Adjacency id: 0x49 (73)
  Interface: TenGigabitEthernet1/0/2, IF index: 66, Link Type: MCP_LINK_TAG
  Encap: 70:d3:79:be:ae:71:d4:ad:71:b5:dd:d6:88:47 <-- MAC ending in AE71 is the DMAC, MAC
ending in DDD6 is the SMAC, 8847 is MPLS ETYPE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: unknown
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 10.0.0.14 <-- Next-hop IP
  IP FRR MCP_ADJ_IPFRR_NONE 0
  aom id: 535, HW handle: (nil) (created)
```

*** FED Prefix Programming***
C9500-P#**show platform software fed switch active ip route 192.168.1.4/32**
```
vrf   dest                                     htm           flags   SGT   DGID MPLS Last-
```

```
modified
---   ----                                   ---        -----   ---   ---- ---- -----
------------------
0     192.168.1.4/32                         0x7f790c4cf0e8 0x0     0     0
2021/06/14 22:10:54.150 <-- HTM value significant for next command
  FIB: prefix_hdl:0x6a000020, mpls_ecr_prefix_hdl:0
  ========= OCE chain =====
  LABEL:objid:22 link_type:MPLS local_label:17 outlabel:(0, 0) <-- Label 17 is the local
transport label
       flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0xb9000037
       unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
       bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
       AAL: id:3103785015 lbl:0 smac:d4ad.71b5.ddd6 dmac:70d3.79be.ae71 <-- Matches the next-hop
information to reach 192.168.1.4/32
            sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
            vlan_id:0 vrf_id:0 ri:0x7f790c4cdfd8, ri_id:0x38 phdl:0x76000058, ref_cnt:1
            si:0x7f790c4c22f8, si_id:0x400b, di_id:0x2 <-- di_id utilized in subsequent commands
  ADJ:objid:73 {link_type:MPLS ifnum:0x42, si:0x2d000027, }
  ==============
  MPLS info: mpls_ecr_scale_prefix_adj:0, mpls_lspa_hdl:0
  ==============


C9500-P#show platform hardware fwd-asic abstraction print-resource-handle 0x7f790c4cf0e8 1 <--
Utilize the HTM value from previous command
Handle:0x7f790c4cf0e8 Res-Type:ASIC_RSC_HASH_TCAM Res-Switch-Num:0 Asic-Num:255 Feature-
ID:AL_FID_L3_UNICAST_IPV4 Lkp-ftr-id:LKP_FEAT_IPV4_L3_UNICAST ref_count:1
priv_ri/priv_si Handle: (nil)Hardware Indices/Handles: handle [ASIC: 0]: 0x7f790c4cf2f8
Features sharing this resource:Cookie length: 12
04 01 a8 c0 00 00 00 d0 07 00 00 00

Detailed Resource Information (ASIC# 0)
----------------------------------------
Number of HTM Entries: 1

Entry 0: (handle 0x7f790c4cf2f8)

Absolute Index: 126650
Time Stamp: 40
KEY - vrf:0 mtr:0 prefix:192.168.1.4 rcp_redirect_index:0x0
MASK - vrf:0 mtr:0 prefix:0.0.0.0 rcp_redirect_index:0x0
FWD-AD = afd_label_flag:0 icmp_redir_enable:1 lvx_smr_enabled:0, dstNatType:0 priority:5
afdLabelOrDestClientId:0 SI:16395 destined_to_us:0 hw_stats_idx:1 stats_id:0
redirectSetRouterMac:0 dgtIdx:0 destModIndex:0 dstNatTypeOrVpnPrefixPtrMsb:0 vpnPrefixPtr:0
SRC-AD = learning_violation:0 need_to_learn:0  locally_connected:0 staticentryViolation:0
rpfValid:1 rpfLe:38 rpfLePointer:0 rpfForcePass:0 rpfForceFail:0 reachableviaSome:1
rpfCheckIncomplete:0 defaultRoute:0 ChainPtrValid:0 ChainPtrOrPortLeIndex:72 UseRpfmatchTable:0
rpfIncomplete:0 is_src_ce:0 sgtValid:0 sgt:0 src_rloc_trusted:0,sgtCacheControl1 = 0,
sgtCacheControl0 = 0
port_label:0x0 port_mask:0x0 vlan_label:0x0 vlan_mask:0x0 l3if_label:0x0 l3if_mask:0x0
group_label:0x0 group_mask:0x0


================================================================

C9500-P#show platform hardware fed switch active fwd-asic resource asic all destination-index
range 0x2 0x2 <-- Utilize the di_id value from the previous command
ASIC#0:

index = 0x2
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
```

```
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0
ASIC#1:

index = 0x2
pmap = 0x00000000 0x00000002 <-- 0x00000002 in binary is 0000 0000 0000 0000 0000 0000 0000 =
Port 1 (Zero based, count right to left)
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0


C9500-P#show platform software fed switch active ifm mappings
Interface              IF_ID   Inst Asic Core Port SubPort Mac  Cntx LPN  GPN  Type Active
TenGigabitEthernet1/0/2 0x42     1   0    1    1     0      10   1    2    2    NIF  Y    <-
- Port 1 is the egress port, TenGig1/0/2
```

Programmation du préfixe C9300-PE-2

```
***Software Prefix Programming***
C9300-PE-2#show ip route vrf RED 192.168.2.1

Routing Table: RED
Routing entry for 192.168.2.0/24
  Known via "eigrp 400", distance 90, metric 130816, precedence routine (0), type internal
  Redistributing via eigrp 400, bgp 69420
  Advertised by bgp 69420
  Last update from 10.0.0.22 on GigabitEthernet2/0/1, 1d21h ago
  Routing Descriptor Blocks:
  * 10.0.0.22, from 10.0.0.22, 1d21h ago, via GigabitEthernet2/0/1 <-- Next-hop reachable in the
VRF
      Route metric is 130816, traffic share count is 1
      Total delay is 5010 microseconds, minimum bandwidth is 1000000 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 1

C9300-PE-2#show ip route vrf RED 10.0.0.22

Routing Table: RED
Routing entry for 10.0.0.20/30
  Known via "connected", distance 0, metric 0 (connected, via interface)
  Redistributing via eigrp 400, bgp 69420
  Advertised by bgp 69420
  Routing Descriptor Blocks:
  * directly connected, via GigabitEthernet2/0/1 <-- Next-hop directly connected
      Route metric is 0, traffic share count is 1
```

```
C9300-PE-2#show ip cef vrf RED 192.168.2.0/24 detail
192.168.2.0/24, epoch 0
  QOS: Precedence routine (0)
  dflt local label info: other/21 [0x2]
  nexthop 10.0.0.22 GigabitEthernet2/0/1


***FMAN RP Prefix Programming***
C9300-PE-2#show ip vrf detail
VRF RED (VRF Id = 2); default RD 69:69; default VPNID <-- VRF ID is important in subsequent
command
  Old CLI format, supports IPv4 only
  Flags: 0xC
  Interfaces:
    Gi2/0/1
Address family ipv4 unicast (Table ID = 0x2):
  Flags: 0x0
  Export VPN route-target communities
    RT:69:69
  Import VPN route-target communities
    RT:69:69
  No import route-map
  No global export route-map
  No export route-map
  VRF label distribution protocol: not configured
  VRF label allocation mode: per-prefix


C9300-PE-2#show platform software ip switch active r0 cef table index 2 prefix 192.168.2.0/24
Forwarding Table


Prefix/Len                    Next Object      Index
------------------------------------------------------------------
192.168.2.0/24                OBJ_ADJACENCY    0x19


C9300-PE-2#show platform software adjacency switch active r0 index 0x19 <-- Utilize the Index
value from previous command
Number of adjacency objects: 6


Adjacency id: 0x19 (25)
  Interface: GigabitEthernet2/0/1, IF index: 53, Link Type: MCP_LINK_IP
  Encap: 0:72:78:c8:c9:c2:70:d3:79:be:ae:42:8:0 <-- MAC ending in C9C2 is DMAC, MAC ending in
AE42 is SMAC, 0x800 is the IP ETYPE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: no-l3-inject
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 10.0.0.22
  IP FRR MCP_ADJ_IPFRR_NONE 0
  OM handle: 0x348062f118


***FMAN FP Prefix Programming***
C9300-PE-2#show platform software ip switch active f0 cef table index 2 prefix 192.168.2.0/24
detail
Forwarding Table


192.168.2.0/24 -> OBJ_ADJACENCY (0x19), urpf: 30 <-- Utilized in next command
Prefix Flags: unknown
aom id: 665, HW handle: (nil) (created)
QPPB precedence: 0


C9300-PE-2#show platform software adjacency switch active f0 index 0x19 <-- Utilize the
OBJ_ADJACENCY from previous command
Number of adjacency objects: 6
```

```
Adjacency id: 0x19 (25)
  Interface: GigabitEthernet2/0/1, IF index: 53, Link Type: MCP_LINK_IP
  Encap: 0:72:78:c8:c9:c2:70:d3:79:be:ae:42:8:0
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: no-l3-inject
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 10.0.0.22
  IP FRR MCP_ADJ_IPFRR_NONE 0
  aom id: 659, HW handle: (nil) (created)
```

FED Prefix Programming
```
C9300-PE-2#show platform software fed switch active ip route vrf-name RED 192.168.2.0/24
vrf   dest                                     htm           flags  SGT   DGID MPLS Last-
modified
---   ----                                     ---           -----  ---   ---- ---- -----
------------------
2     192.168.2.0/24                           0x7f7fb4a25648 0x0     0     0
2021/06/14 17:04:13.460 <-- HTM value significant for next command
  FIB: prefix_hdl:0x6e00002a, mpls_ecr_prefix_hdl:0
  ========= OCE chain =====
  ADJ:objid:25 {link_type:IP ifnum:0x35, si:0x3300003e, IPv4:      10.0.0.22 }
  ==============
  MPLS info: mpls_ecr_scale_prefix_adj:0, mpls_lspa_hdl:0


  ==============

C9300-PE-2#show platform hardware fed switch active fwd-asic abstraction print-resource-handle
0x7f7fb4a25648 1 <-- Utilize HTM value from previous command
Handle:0x7f7fb4a25648 Res-Type:ASIC_RSC_HASH_TCAM Res-Switch-Num:0 Asic-Num:255 Feature-
ID:AL_FID_L3_UNICAST_IPV4 Lkp-ftr-id:LKP_FEAT_IPV4_L3_UNICAST ref_count:1
priv_ri/priv_si Handle: (nil)Hardware Indices/Handles: handle [ASIC: 0]: 0x7f7fb4a10e58
Features sharing this resource:Cookie length: 12
01 02 a8 c0 00 00 02 d0 07 00 00 00

Detailed Resource Information (ASIC# 0)
----------------------------------------
Number of HTM Entries: 1

Entry 0: (handle 0x7f7fb4a10e58)

Absolute Index: 66036
Time Stamp: 164911
KEY - vrf:2 mtr:0 prefix:192.168.2.0 rcp_redirect_index:0x0
MASK - vrf:0 mtr:0 prefix:0.0.0.255 rcp_redirect_index:0x0
FWD-AD = afd_label_flag:0 icmp_redir_enable:1 lvx_smr_enabled:0, dstNatType:0 priority:5
afdLabelOrDestClientId:0 SI:182 destined_to_us:0 hw_stats_idx:1 stats_id:0
redirectSetRouterMac:0 dgtIdx:0 destModIndex:0 dstNatTypeOrVpnPrefixPtrMsb:0 vpnPrefixPtr:0
SRC-AD = learning_violation:0 need_to_learn:0  locally_connected:0 staticentryViolation:0
rpfValid:1 rpfLe:37 rpfLePointer:0 rpfForcePass:0 rpfForceFail:0 reachableviaSome:1
rpfCheckIncomplete:0 defaultRoute:0 ChainPtrValid:0 ChainPtrOrPortLeIndex:72 UseRpfmatchTable:0
rpfIncomplete:0 is_src_ce:0 sgtValid:0 sgt:0 src_rloc_trusted:0,sgtCacheControl1 = 0,
sgtCacheControl0 = 0
port_label:0x0 port_mask:0x0 vlan_label:0x0 vlan_mask:0x0 l3if_label:0x0 l3if_mask:0x0
group_label:0x0 group_mask:0x0


==================================================================

C9300-PE-2#show platform software fed switch active ip adj
IPV4 Adj entries
```

```
dest            if_name              dst_mac          si_hdl          ri_hdl          pd_flags
adj_id  Last-modified
----            -------              -------          ------          ------          --------
-----   -----------------------
10.0.0.22       GigabitEthernet2/0/1    0072.78c8.c9c2   0x7f7fb4a44048 0x7f7fb4b089d8 0x0
0x19        2021/06/14 16:59:43.447 <-- si_hdl used in next command

C9300-PE-2#show platform hardware fed switch active fwd-asic abstraction print-resource-handle
0x7f7fb4a44048 1 <-- Utilize the si_hdl value from previous command
Handle:0x7f7fb4a44048 Res-Type:ASIC_RSC_SI Res-Switch-Num:255 Asic-Num:255 Feature-
ID:AL_FID_L3_UNICAST_IPV4 Lkp-ftr-id:LKP_FEAT_INVALID ref_count:1
priv_ri/priv_si Handle: 0x7f7fb4b089d8Hardware Indices/Handles: index0:0xb6
mtu_index/l3u_ri_index0:0x0  index1:0xb6  mtu_index/l3u_ri_index1:0x0
Features sharing this resource:66 (1)]
Cookie length: 56
00 00 00 00 00 00 00 00 25 00 00 00 00 00 00 00 00 00 00 00 08 00 00 72 78 c8 c9 c2 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00


Detailed Resource Information (ASIC# 0)
----------------------------------------


Station Index (SI) [0xb6]
RI = 0x2b
DI = 0x5338
stationTableGenericLabel = 0
stationFdConstructionLabel = 0x7
lookupSkipIdIndex = 0
rcpServiceId = 0
dejaVuPreCheckEn = 0
Replication Bitmap: CD


Detailed Resource Information (ASIC# 1)
----------------------------------------


Station Index (SI) [0xb6]
RI = 0x2b
DI = 0x5338
stationTableGenericLabel = 0
stationFdConstructionLabel = 0x7
lookupSkipIdIndex = 0
rcpServiceId = 0
dejaVuPreCheckEn = 0
Replication Bitmap: LD


===============================================================

C9300-PE-2#show platform hardware fed switch active fwd-asic resource asic all destination-index
range 0x5338 0x5338 <-- Utilize the DI value from previous command
ASIC#0:

index = 0x5338
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
```

```
npuIndex = 0
stripSeg = 0
copySeg = 0
ASIC#1:

index = 0x5338
pmap = 0x00000000 0x00000001 <-- 0x00000001 in binary is 0000 0000 0000 0000 0000 0000 0000 0001
= Port 0 (Zero based, count right to left)
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0
```

```
C9300-PE-2#show platform software fed switch active ifm map
Interface               IF_ID   Inst Asic Core Port SubPort Mac  Cntx LPN  GPN  Type Active
GigabitEthernet2/0/1    0x35      1    0    1    0     0      26   6    1   97   NIF  Y    <-
- Port 0 is the egress port, Gi2/0/1
```

Programmation des étiquettes VPNv4

La section suivante traite de la programmation d'étiquettes VPNv4 sur les routeurs PE MPLS, C9300-PE-1 et C9300-PE-2. Le C9500 ne transfère pas sur l'étiquette VPNv4, il n'y a donc aucune sortie du C9500.

C9300-PE-1 VPNv4 Étiquette Programmation :

Vérifiez le préfixe local sur le PE, et non le préfixe distant.

```
***Software VPNv4 Label Programming***
C9300-PE-1#show ip cef vrf RED 192.168.3.0/24 detail
192.168.3.0/24, epoch 0
  QOS: Precedence routine (0)
  dflt local label info: other/22 [0x2] <-- VPNv4 label associated with the local prefix
  nexthop 10.0.0.1 GigabitEthernet1/0/1

*** FMAN RP VPNv4 Label Programming***
C9300-PE-1#show platform software mpls switch active r0 eos index 24 <-- Utilize the objid from
the FED command


EOS Choice 0x18, Number of paths: 2
  Next Object Type: OBJ_ADJ_DROP,OBJ_LABEL
  Next Object Index: 0,0x17
  OM handle: 0x3480631760

***FMAN FP VPNv4 Label Programming***
C9300-PE-1#show platform software mpls switch active f0 eos index 24 <-- Utilize the objid from
the FED command
```

```
EOS Choice 0x18, Number of paths: 2
  Next Object Type: OBJ_ADJ_DROP,OBJ_LABEL
  Next Object Index: 0,0x17
  aom id: 5748, CPP handle: 0xdeadbeef (created), flags: 0 <-- Utilized in subsequent command

C9300-PE-1#show platform software object-manager switch active f0 object 5748 <-- Utilize the
aom id from previous command
Object identifier: 5748
  Description: EOS Choice 0x18
  Status: Done, Epoch: 0, Client data: 0x63150908

C9300-PE-1#show platform software object-manager switch active f0 object 5748 parents <--
Utilize the aom id
Object identifier: 7
  Description: Special Object adj_drop
  Status: Done

Object identifier: 5746
  Description: label 0x17
  Status: Done

***FED VPNv4 Label Programming***
C9300-PE-1#show platform software fed switch active mpls forwarding label 22 detail
 LENTRY:label:22 nobj:(EOS, 24) lentry_hdl:0x800000a
   modify_cnt:1 backwalk_cnt:0
   lspa_handle:0
   AAL: id:134217738 lbl:22
        eos0:[adj_hdl:0, hw_hdl:0x7fa4c4d72e08]
        eos1:[adj_hdl:0x6e00003e, hw_hdl:0x7fa4c4d72c58]
        deagg_vrf_id = 0 lspa_handle:0
   EOS:objid:24 local_label:0 flags:0:() pdflags:0 <-- Utilized in previous commands
     nobj0:(ADJ SPECIAL,DROP 0), nobj1:(LABEL, 23) modify:0 bwalk:0
     LABEL:objid:23 link_type:IP local_label:22 outlabel:(1048577, 0)
        flags:0xc:(UHP,POP,) pdflags:0x2:(INSTALL_HW_OK,) adj_handle:0x6e00003e
        unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
        bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
        AAL: id:1845493822 lbl:0 smac:a0f8.4911.d1e4 dmac:0072.78c8.06e4
           sub_type:0 link_type:0 adj_flags:0x2 label_type:1 rewrite_type:POP2IP(135)
           vlan_id:0 vrf_id:0 ri:0x7fa4c4a81af8, ri_id:0x44 phdl:0xf1000024, ref_cnt:1
           si:0x7fa4c4d83da8, si_id:0x4012, di_id:0x5338
     ADJ:objid:113 {link_type:IP ifnum:0x35, si:0x2000003a, IPv4:          10.0.0.1 }
```

Vérifiez Étiquette VPNv4 C9300-PE-2 :

Vérifiez le préfixe local sur le PE, et non le préfixe distant

```
***Software VPNv4 Label Programming***
C9300-PE-2#show ip cef vrf RED 192.168.2.0/24 detail
192.168.2.0/24, epoch 0
  QOS: Precedence routine (0)
  dflt local label info: other/21 [0x2] <-- VPNv4 label associated with local prefix
  nexthop 10.0.0.22 GigabitEthernet2/0/1

*** FMAN RP VPNv4 Label Programming***
C9300-PE-2#show platform software mpls switch active r0 eos index 61 <-- Use the objid from the
FED command

EOS Choice 0x3d, Number of paths: 2
  Next Object Type: OBJ_ADJ_DROP,OBJ_LABEL
  Next Object Index: 0,0x3b
```

```
    OM handle: 0x348063f2f8


*** FMAN FP VPNv4 Label Programming***
C9300-PE-2#show platform software mpls switch active f0 eos index 61 <-- Use the objid from the
FED command


EOS Choice 0x3d, Number of paths: 2
  Next Object Type: OBJ_ADJ_DROP,OBJ_LABEL
  Next Object Index: 0,0x3b
  aom id: 3541, CPP handle: 0xdeadbeef (created), flags: 0 <-- Utilized in subsequent command

C9300-PE-2#show platform software object-manager switch active f0 object 3541 <-- Use the aom id
from previous command
Object identifier: 3541
  Description: EOS Choice 0x3d
  Status: Done, Epoch: 0, Client data: 0x11079188


C9300-PE-2#show platform software object-manager switch active f0 object 3541 parents <-- Use
the aom id from previous command
Object identifier: 7
  Description: Special Object adj_drop
  Status: Done

Object identifier: 3540
  Description: label 0x3b
  Status: Done


*** FED VPNv4 Label Programming***
C9300-PE-2#show platform software fed switch active mpls forwarding label 21 detail
 LENTRY:label:21 nobj:(EOS, 61) lentry_hdl:0x69000009
   modify_cnt:3 backwalk_cnt:0
   lspa_handle:0
   AAL: id:1761607689 lbl:21
        eos0:[adj_hdl:0, hw_hdl:0x7fe8f8a71bd8]
        eos1:[adj_hdl:0x49000040, hw_hdl:0x7fe8f8a72458]
        deagg_vrf_id = 0 lspa_handle:0
   EOS:objid:61 local_label:0 flags:0:() pdflags:0 <-- Utilized in previous commands
      nobj0:(ADJ SPECIAL,DROP 0), nobj1:(LABEL, 59) modify:0 bwalk:0
      LABEL:objid:59 link_type:IP local_label:21 outlabel:(1048577, 0)
          flags:0xc:(UHP,POP,) pdflags:0x2:(INSTALL_HW_OK,) adj_handle:0x49000040
          unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
          bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
          AAL: id:1224736832 lbl:0 smac:70d3.79be.ae42 dmac:0072.78c8.c9c2
              sub_type:0 link_type:0 adj_flags:0x2 label_type:1 rewrite_type:POP2IP(135)
              vlan_id:0 vrf_id:0 ri:0x7fe8f8a8ab98, ri_id:0x44 phdl:0xf1000024, ref_cnt:1
              si:0x7fe8f8a6ae08, si_id:0x4006, di_id:0x5338
        ADJ:objid:25 {link_type:IP ifnum:0x35, si:0x800003e, IPv4:        10.0.0.22 }
```

Programmation des étiquettes LDP

La section suivante traite de la programmation d'étiquettes LDP sur les routeurs MPLS, C9300-PE-1, C9500-P et C9300-PE-2.

L'étiquette LDP (externe) correspond à l'étiquette réseau MPLS sur laquelle bascule les paquets. Validez l'étiquette LDP locale qui est annoncée au périphérique PE distant, ne validez pas l'étiquette LDP distante.

C9300-PE-1 LDP Label Programming :

Validez l'étiquette LDP locale qui est annoncée au périphérique PE distant, ne validez pas l'étiquette LDP distante. Vérifiez l'étiquette d'un point de vue FED, puis revenez à FMAN RP et FMAN FP.

```
***Software LDP Label Programming***
C9300-PE-1#show mpls forwarding-table
Local     Outgoing   Prefix          Bytes Label   Outgoing    Next Hop
Label     Label      or Tunnel Id    Switched      interface
16        Pop Label  192.168.1.3/32  0             Gi1/0/2     10.0.0.6
18        Pop Label  10.0.0.12/30    0             Gi1/0/2     10.0.0.6
19        17         192.168.1.4/32  0             Gi1/0/2     10.0.0.6  <-- LDP Label 19 is
advertised to Remote PE 192.168.1.4, validate LDP label 19
20        No Label   10.0.0.0/30[V]  1890                      aggregate/RED
22        No Label   192.168.3.0/24[V]  \
                                     1982          Gi1/0/1     10.0.0.1

***FMAN RP LDP Label Programming***
C9300-PE-1#show platform software mpls switch active r0 label index 59


Label OCE 0x3b -> OBJ_ADJACENCY (0x46)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x11
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x34805f3dc8


***FMAN FP LDP Label Programming***
C9300-PE-1#show platform software mpls switch active f0 label index 59


Label OCE 0x3b -> OBJ_ADJACENCY (0x46)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x11
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 7065, CPP handle: 0xdeadbeef (created)

C9300-PE-1#show platform software object-manager switch active f0 object 7065
Object identifier: 7065
  Description: label 0x3b
  Status: Done, Epoch: 0, Client data: 0x63152218


C9300-PE-1#show platform software object-manager switch active f0 object 7065 parents
Object identifier: 511
  Description: adj 0x46, Flags None
  Status: Done

***FED LDP Label Programming***
C9300-PE-1#show platform software fed switch active mpls forwarding label 19 detail
 LENTRY:label:19 nobj:(LABEL, 59) lentry_hdl:0xef000007
   modify_cnt:7 backwalk_cnt:0
   lspa_handle:0
   AAL: id:4009754631 lbl:19
        eos0:[adj_hdl:0x91000056, hw_hdl:0x7fa4c4d6cae8]
        eos1:[adj_hdl:0x91000056, hw_hdl:0x7fa4c4d6c8e8]
        deagg_vrf_id = 0 lspa_handle:0
   LABEL:objid:59 link_type:MPLS local_label:19 outlabel:(17, 0)
        flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0x91000056
        unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
        bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
        AAL: id:2432696406 lbl:0 smac:a0f8.4911.d1d6 dmac:d4ad.71b5.dde4
             sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
```

```
              vlan_id:0 vrf_id:0 ri:0x7fa4c4d75fa8, ri_id:0x26 phdl:0x9f00004b, ref_cnt:1
              si:0x7fa4c4d5f6c8, si_id:0x4013, di_id:0x535f
      ADJ:objid:70 {link_type:MPLS ifnum:0x36, si:0x25000021, }
```

Programmation LDP du C9500 :

Validez l'étiquette LDP locale qui est annoncée au périphérique PE distant, ne validez pas
l'étiquette LDP distante. Vérifiez l'étiquette d'un point de vue FED, puis revenez à FMAN RP et
FMAN FP.

```
***Software LDP Label Programming***
C9500-P#show mpls forwarding-table
Local       Outgoing    Prefix          Bytes Label   Outgoing   Next Hop
Label       Label       or Tunnel Id    Switched      interface
16          explicit-n  192.168.1.2/32  23409         Te1/0/1    10.0.0.5  <-- LDP label 16 is
advertised to reach PE 192.168.1.2
17          explicit-n  192.168.1.4/32  23345         Te1/0/2    10.0.0.14 <-- LDP label 17 is
advertised to reach PE 192.168.1.4

***FMAN RP LDP Label Programming***
C9500-P#show platform software mpls switch active r0 label index 23 <-- Use the obj id from the
FED command


Label OCE 0x17 -> OBJ_ADJACENCY (0x3f)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x3480645150

***FMAN FP LDP Label Programming***
C9500-P#show platform software mpls switch active f0 label index 23 <-- Use the obj id from the
FED command


Label OCE 0x17 -> OBJ_ADJACENCY (0x3f)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 654, CPP handle: 0xdeadbeef (created)

C9500-P#show platform software object-manager switch active f0 object 654 <-- Use the aom id
from the previous command
Object identifier: 654
  Description: label 0x17
  Status: Done, Epoch: 0, Client data: 0x4b41c08

C9500-P#show platform software object-manager switch active f0 object 654 parents <-- Use the
aom id from the previous command
Object identifier: 515
  Description: adj 0x3f, Flags None
  Status: Done

***FED LDP Label Programming***
C9500-P#show platform software fed switch active mpls forwarding label 16 detail
 LENTRY:label:16 nobj:(LABEL, 23) lentry_hdl:0xec000004
   modify_cnt:6 backwalk_cnt:0
   lspa_handle:0
   AAL: id:3959422980 lbl:16
       eos0:[adj_hdl:0xc3000055, hw_hdl:0x7f28944be3c8]
       eos1:[adj_hdl:0xc3000055, hw_hdl:0x7f28944be1b8]
```

```
          deagg_vrf_id = 0 lspa_handle:0
     LABEL:objid:23 link_type:MPLS local_label:16 outlabel:(0, 0) <-- Utilized in previous
commands
          flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0xc3000055
          unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
          bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
          AAL: id:3271557205 lbl:0 smac:d4ad.71b5.dde4 dmac:a0f8.4911.d1d6
               sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
               vlan_id:0 vrf_id:0 ri:0x7f289449bf88, ri_id:0x44 phdl:0xe9000057, ref_cnt:1
               si:0x7f2894489b58, si_id:0x4009, di_id:0x1
     ADJ:objid:63 {link_type:MPLS ifnum:0x41, si:0x57000023, }


***Software LDP Label Programming***
C9500-P#show mpls forwarding-table
Local      Outgoing   Prefix          Bytes Label   Outgoing   Next Hop
Label      Label      or Tunnel Id    Switched      interface
16         explicit-n 192.168.1.2/32  23409         Te1/0/1    10.0.0.5
17         explicit-n 192.168.1.4/32  23345         Te1/0/2    10.0.0.14

***FMAN RP LDP Label Programming***
C9500-P#show platform software mpls switch active r0 label index 64 <-- Use the obj id from the
FED command


Label OCE 0x40 -> OBJ_ADJACENCY (0x49)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x3480641d08


***FMAN FP LDP Label Programming***
C9500-P#show platform software mpls switch active f0 label index 64 <-- Use the obj id from the
FED command


Label OCE 0x40 -> OBJ_ADJACENCY (0x49)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 657, CPP handle: 0xdeadbeef (created)

C9500-P#show platform software object-manager switch active f0 object 657 <-- Use the aom id
value from previous command
Object identifier: 657
  Description: label 0x40
  Status: Done, Epoch: 0, Client data: 0x4b523f8



C9500-P#show platform software object-manager switch active f0 object 657 parents<-- Use the aom
id value from previous command
Object identifier: 535
  Description: adj 0x49, Flags None
  Status: Done


***FED LDP Label Programming***
C9500-P#show platform software fed switch active mpls forwarding label 17 detail
 LENTRY:label:17 nobj:(LABEL, 64) lentry_hdl:0x8d000005
   modify_cnt:6 backwalk_cnt:0
   lspa_handle:0
   AAL: id:2365587461 lbl:17
        eos0:[adj_hdl:0xcc000037, hw_hdl:0x7f2894480438]
        eos1:[adj_hdl:0xcc000037, hw_hdl:0x7f2894480228]
        deagg_vrf_id = 0 lspa_handle:0
     LABEL:objid:64 link_type:MPLS local_label:17 outlabel:(0, 0) <-- Utilized in previous
```

```
commands
        flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0xcc000037
        unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
        bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
        AAL: id:3422552119 lbl:0 smac:d4ad.71b5.ddd6 dmac:70d3.79be.ae71
             sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
             vlan_id:0 vrf_id:0 ri:0x7f2894498008, ri_id:0x38 phdl:0x76000058, ref_cnt:1
             si:0x7f2894498478, si_id:0x400b, di_id:0x2
    ADJ:objid:73 {link_type:MPLS ifnum:0x42, si:0x3d000027, }
```

C9300-PE-2 LDP Label Programming :

Validez l'étiquette LDP locale qui est annoncée au périphérique PE distant, ne validez pas
l'étiquette LDP distante. Vérifiez l'étiquette d'un point de vue FED, puis revenez à FMAN RP et
FMAN FP.

```
***Software LDP Label Programming***
C9300-PE-2#show mpls forwarding-table
Local      Outgoing   Prefix          Bytes Label    Outgoing    Next Hop
Label      Label      or Tunnel Id    Switched       interface
16         Pop Label  192.168.1.3/32  0              Gi2/0/2     10.0.0.13
17         16         192.168.1.2/32  630            Gi2/0/2     10.0.0.13 <-- LDP label 17 is
advertised to Remote PE 192.168.1.2
18         Pop Label  10.0.0.4/30     0              Gi2/0/2     10.0.0.13
20         No Label   10.0.0.20/30[V] 1260           aggregate/RED
21         No Label   192.168.2.0/24[V]  \
                                      2070           Gi2/0/1     10.0.0.22

C9300-PE-2#show platform software mpls switch active r0 label index 82 <-- Utilize the obj id
value from the FED Command


Label OCE 0x52 -> OBJ_ADJACENCY (0x46)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x10
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x348063ad00


C9300-PE-2#show platform software mpls switch active f0 label index 82 <-- Utilize the obj id
value from the FED Command


Label OCE 0x52 -> OBJ_ADJACENCY (0x46)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x10
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 3624, CPP handle: 0xdeadbeef (created) <-- Used in next commands

C9300-PE-2#show platform software object-manager switch active f0 object 3624 <-- Utilize the
aom id value
Object identifier: 3624
  Description: label 0x52
  Status: Done, Epoch: 0, Client data: 0x11071668


C9300-PE-2#show platform software object-manager switch active f0 object 3624 parents <--
Utilize the aom id value
Object identifier: 496
  Description: adj 0x46, Flags None
```

```
   Status: Done

C9300-PE-2#show platform software fed switch active mpls forwarding label 17 detail
 LENTRY:label:17 nobj:(LABEL, 82) lentry_hdl:0x44000005
   modify_cnt:6 backwalk_cnt:0
   lspa_handle:0
   AAL: id:1140850693 lbl:17
        eos0:[adj_hdl:0x5f000032, hw_hdl:0x7fe8f8a52798]
        eos1:[adj_hdl:0x5f000032, hw_hdl:0x7fe8f8a52588]
        deagg_vrf_id = 0 lspa_handle:0
   LABEL:objid:82 link_type:MPLS local_label:17 outlabel:(16, 0) <-- Used in previous commands
        flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0x5f000032
        unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
        bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
        AAL: id:1593835570 lbl:0 smac:70d3.79be.ae71 dmac:d4ad.71b5.ddd6
             sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
             vlan_id:0 vrf_id:0 ri:0x7fe8f8a93c78, ri_id:0x3a phdl:0x9f00004b, ref_cnt:1
             si:0x7fe8f8a91188, si_id:0x4011, di_id:0x535f
   ADJ:objid:70 {link_type:MPLS ifnum:0x36, si:0xaa000021, }
```

Scénario 2. L3VPN avec ECMP entre les PE et les routeurs P

Topologie de référence

Pour les besoins de cet exemple, les commutateurs Catalyst 3850 fonctionnent comme des
périphériques CE, les commutateurs Catalyst 9300 fonctionnent comme des périphériques PE, et
Catalyst 9500, dans Stackwise Virtual, comme périphérique P. EIGRP s'exécute entre les
périphériques CE et PE, les contiguïtés OSPF et LDP dans le coeur MPLS, avec une contiguïté
VPNv4 iBGP entre les périphériques PE. Au sein du coeur MPLS, il y a ECMP entre les
périphériques PE et P.
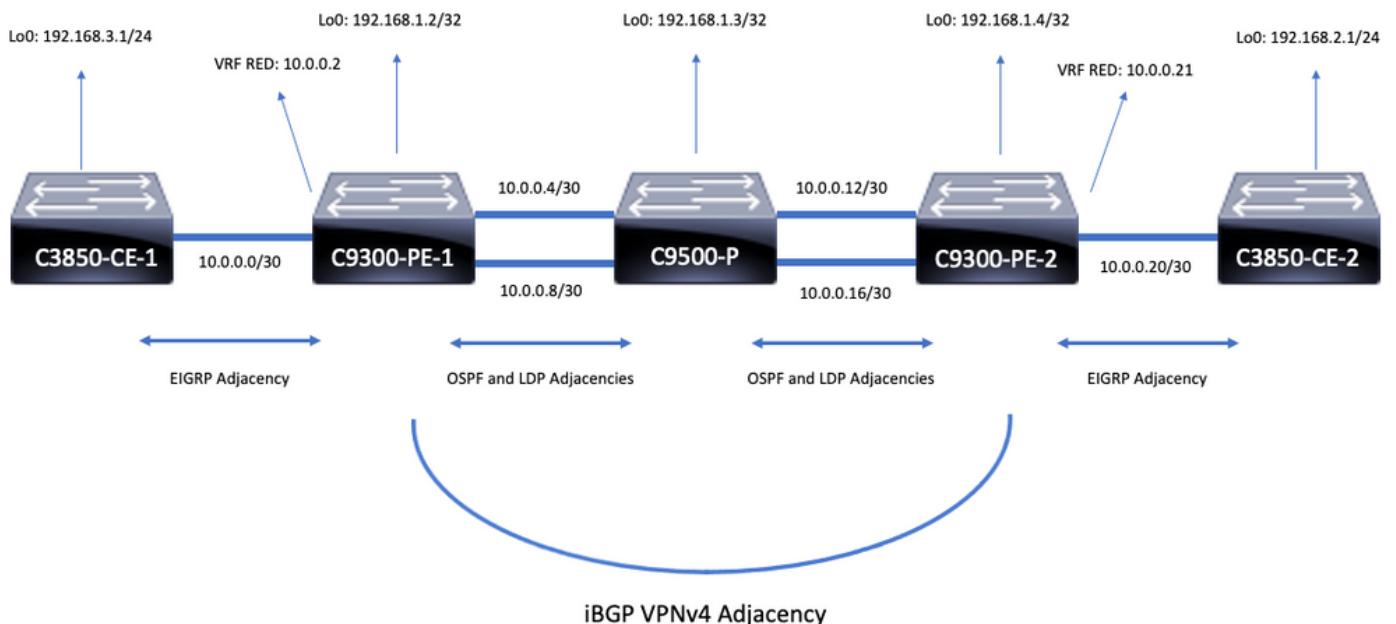
Détails de la configuration

Configuration du C3850-CE-1

```
hostname C3850-CE-1
```

```
!
interface Loopback0
ip address 192.168.3.1 255.255.255.0
!
interface TenGigabitEthernet1/0/1
no switchport
ip address 10.0.0.1 255.255.255.252
!
router eigrp 420
network 10.0.0.0 0.0.0.3
network 192.168.3.0
eigrp stub connected summary
!
ip route 0.0.0.0 0.0.0.0 10.0.0.2
```

Configuration du C9300-PE-1

```
hostname C9300-PE-1
!
ip vrf RED
rd 69:69
route-target export 69:69
route-target import 69:69
!
mpls ldp explicit-null
!
interface Loopback0
ip address 192.168.1.2 255.255.255.255
!
interface GigabitEthernet1/0/1
no switchport
ip vrf forwarding RED
ip address 10.0.0.2 255.255.255.252
!
interface GigabitEthernet1/0/2
no switchport
ip address 10.0.0.5 255.255.255.252
!
interface GigabitEthernet1/0/3
no switchport
ip address 10.0.0.9 255.255.255.252
!
router eigrp 420
!
address-family ipv4 vrf RED
network 10.0.0.0 0.0.0.3
autonomous-system 420
exit-address-family
!
router ospf 420
network 0.0.0.0 255.255.255.255 area 0
mpls ldp autoconfig
!
router bgp 69420
bgp log-neighbor-changes
neighbor 192.168.1.4 remote-as 69420
neighbor 192.168.1.4 update-source Loopback0
!
address-family vpnv4
neighbor 192.168.1.4 activate
neighbor 192.168.1.4 send-community extended
exit-address-family
!
```

```
address-family ipv4 vrf RED
redistribute eigrp 420
exit-address-family
```

Configuration du C9500-P

```
hostname C9500-P
!
interface Loopback0
ip address 192.168.1.3 255.255.255.255
!
interface TenGigabitEthernet1/0/1
no switchport
ip address 10.0.0.6 255.255.255.252
!
interface TenGigabitEthernet1/0/2
no switchport
ip address 10.0.0.13 255.255.255.252
!
interface TenGigabitEthernet2/0/1
no switchport
ip address 10.0.0.10 255.255.255.252
!
interface TenGigabitEthernet2/0/2
no switchport
ip address 10.0.0.17 255.255.255.252
!
router ospf 420
network 0.0.0.0 255.255.255.255 area 0
mpls ldp autoconfig
```

Configuration du C9300-PE-2

```
hostname C9300-PE-2
!
ip vrf RED
rd 69:69
route-target export 69:69
route-target import 69:69
!
mpls ldp explicit-null
!
interface Loopback0
ip address 192.168.1.4 255.255.255.255
!
interface GigabitEthernet2/0/1
no switchport
ip vrf forwarding RED
ip address 10.0.0.21 255.255.255.252
!
interface GigabitEthernet2/0/2
no switchport
ip address 10.0.0.14 255.255.255.252
!
interface GigabitEthernet2/0/3
no switchport
ip address 10.0.0.18 255.255.255.252
!
router eigrp 400
!
address-family ipv4 vrf RED
network 10.0.0.20 0.0.0.3
```

```
autonomous-system 400
exit-address-family
!
router ospf 420
passive-interface GigabitEthernet2/0/24
network 0.0.0.0 255.255.255.255 area 0
mpls ldp autoconfig
!
router bgp 69420
bgp log-neighbor-changes
neighbor 192.168.1.2 remote-as 69420
neighbor 192.168.1.2 update-source Loopback0
!
address-family vpnv4
neighbor 192.168.1.2 activate
neighbor 192.168.1.2 send-community extended
exit-address-family
!
address-family ipv4 vrf RED
redistribute eigrp 400
exit-address-family
```

Configuration du C3850-CE-2

```
hostname C3850-CE-2
!
interface Loopback0
ip address 192.168.2.1 255.255.255.0
!
interface TenGigabitEthernet2/0/1
no switchport
ip address 10.0.0.22 255.255.255.252
!
router eigrp 400
network 10.0.0.20 0.0.0.3
network 192.168.2.0
eigrp stub connected summary
!
ip route 0.0.0.0 0.0.0.0 10.0.0.21
```

Validation de base

Avant la validation de la programmation MPLS, il y a des exigences de base qui doivent être validées :

- Valider la connectivité PE à PE est présente
- Valider le chemin LSP (Label Switched Path) entre les PE
- Valider la contiguïté BGPv4 entre les PE
- Valider les étiquettes VPNv4 et LDP
- Valider la table de transfert MPLS

Valider la connectivité PE à PE

Vous pouvez envoyer une requête ping au bouclage PE distant et à la source à partir du bouclage local, mais cela ne confirme pas que le chemin LSP (Label Switched Path) MPLS est correct, puisque les adresses IP de bouclage sont annoncées dans la sous-couche.

> **Remarque** : La contiguïté VPNv4 PE à PE MP-BGP est obtenue via leurs interfaces Loopback0 respectives.

```
C9300-PE-1#ping 192.168.1.4 source 192.168.1.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.4, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

C9300-PE-1#show ip route 192.168.1.4
Routing entry for 192.168.1.4/32
  Known via "ospf 420", distance 110, metric 3, type intra area
  Last update from 10.0.0.10 on GigabitEthernet1/0/3, 18:39:30 ago
  Routing Descriptor Blocks:
    10.0.0.10, from 192.168.1.4, 18:39:30 ago, via GigabitEthernet1/0/3
      Route metric is 3, traffic share count is 1
  * 10.0.0.6, from 192.168.1.4, 18:39:30 ago, via GigabitEthernet1/0/2
      Route metric is 3, traffic share count is 1
```

Valider le LSP

Vous pouvez utiliser un traceroute MPLS à partir du bouclage PE vers PE pour valider le LSP et toutes les étiquettes LDP MPLS le long du chemin.

> **Remarque** : Cette traceroute MPLS impose une seule étiquette, l'étiquette LDP, cela ne démontre pas que le trafic en provenance de CE est réussi, car le trafic est imposé avec 2 étiquettes, l'étiquette VPNv4 (interne) et l'étiquette LDP (externe).

```
C9300-PE-1#traceroute mpls ipv4 192.168.1.4/32 source 192.168.1.2
Tracing MPLS Label Switched Path to 192.168.1.4/32, timeout is 2 seconds

Codes: '!' - success, 'Q' - request not sent, '.' - timeout,
  'L' - labeled output interface, 'B' - unlabeled output interface,
  'D' - DS Map mismatch, 'F' - no FEC mapping, 'f' - FEC mismatch,
  'M' - malformed request, 'm' - unsupported tlvs, 'N' - no label entry,
  'P' - no rx intf label prot, 'p' - premature termination of LSP,
  'R' - transit router, 'I' - unknown upstream index,
  'l' - Label switched with FEC change, 'd' - see DDMAP for return code,
  'X' - unknown return code, 'x' - return code 0

Type escape sequence to abort.
  0 10.0.0.5 MRU 1500 [Labels: 17 Exp: 0]
L 1 10.0.0.6 MRU 1500 [Labels: explicit-null Exp: 0] 7 ms
! 2 10.0.0.18 1 ms
```

Si vous n'avez pas accès au CE ou à un périphérique derrière le CE et que vous voulez démontrer qu'il y a une imposition/disposition d'étiquette VPNv4 et LDP réussie, vous pouvez tenter d'envoyer une requête ping de l'interface CE du VRF sur un PE à l'autre interface CE du VRF sur le PE distant.

```
C9300-PE-1#ping vrf RED 10.0.0.21 source 10.0.0.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.21, timeout is 2 seconds:
Packet sent with a source address of 10.0.0.2
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Valider la contiguïté VPNv4 BGP entre les PE

```
C9300-PE-1#show bgp vpnv4 unicast all neighbors 192.168.1.4
BGP neighbör is 192.168.1.4,  remote AS 69420, internal link
  BGP version 4, remote router ID 192.168.1.4
  BGP state = Established, up for 18:40:49
  Last read 00:00:40, last write 00:00:47, hold time is 180, keepalive interval is 60 seconds
  Neighbor sessions:
    1 active, is not multisession capable (disabled)
  Neighbor capabilities:
    Route refresh: advertised and received(new)
    Four-octets ASN Capability: advertised and received
    Address family IPv4 Unicast: advertised and received
    Address family VPNv4 Unicast: advertised and received
    Enhanced Refresh Capability: advertised and received
    Multisession Capability:
    Stateful switchover support enabled: NO for session 1
  Message statistics:
    InQ depth is 0
    OutQ depth is 0

                      Sent       Rcvd
    Opens:               1          1
    Notifications:       0          0
    Updates:             4          4
    Keepalives:       1237       1233
    Route Refresh:       0          0
    Total:            1242       1238
  Do log neighbor state changes (via global configuration)
  Default minimum time between advertisement runs is 0 seconds
<snip>
C9300-PE-2#show bgp vpnv4 unicast all neighbors 192.168.1.2
BGP neighbor is 192.168.1.2,  remote AS 69420, internal link
  BGP version 4, remote router ID 192.168.1.2
  BGP state = Established, up for 18:41:36
  Last read 00:00:42, last write 00:00:32, hold time is 180, keepalive interval is 60 seconds
  Neighbor sessions:
    1 active, is not multisession capable (disabled)
  Neighbor capabilities:
    Route refresh: advertised and received(new)
    Four-octets ASN Capability: advertised and received
    Address family IPv4 Unicast: advertised and received
    Address family VPNv4 Unicast: advertised and received
    Enhanced Refresh Capability: advertised and received
    Multisession Capability:
    Stateful switchover support enabled: NO for session 1
  Message statistics:
    InQ depth is 0
    OutQ depth is 0

                      Sent       Rcvd
    Opens:               1          1
    Notifications:       0          0
    Updates:             4          4
    Keepalives:       1234       1238
    Route Refresh:       0          0
    Total:            1239       1243
  Do log neighbor state changes (via global configuration)
  Default minimum time between advertisement runs is 0 seconds
```

La contiguïté VPNv4 de l'ordinateur de bureau distant est active et un préfixe a été reçu

```
C9300-PE-1#show bgp vpnv4 unicast all summary
BGP router identifier 192.168.1.2, local AS number 69420
BGP table version is 7, main routing table version 7
4 network entries using 1024 bytes of memory
4 path entries using 544 bytes of memory
4/4 BGP path/bestpath attribute entries using 1216 bytes of memory
4 BGP extended community entries using 1000 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3784 total bytes of memory
BGP activity 4/0 prefixes, 4/0 paths, scan interval 60 secs
4 networks peaked at 18:49:56 Jun 23 2021 UTC (18:41:06.070 ago)


Neighbor        V         AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
192.168.1.4     4      69420    1240    1244        7    0    0 18:41:59         2

C9300-PE-2#show bgp vpnv4 unicast all summary
BGP router identifier 192.168.1.4, local AS number 69420
BGP table version is 7, main routing table version 7
4 network entries using 1024 bytes of memory
4 path entries using 544 bytes of memory
4/4 BGP path/bestpath attribute entries using 1216 bytes of memory
4 BGP extended community entries using 1000 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 3784 total bytes of memory
BGP activity 4/0 prefixes, 4/0 paths, scan interval 60 secs
4 networks peaked at 18:49:37 Jun 23 2021 UTC (18:41:06.851 ago)


Neighbor        V         AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
192.168.1.2     4      69420    1244    1240        7    0    0 18:42:17         2
```

Vérifier les préfixes échangés dans le VRF particulier

```
C9300-PE-1#show ip bgp vpnv4 vrf RED
BGP table version is 7, local router ID is 192.168.1.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 69:69 (default for vrf RED)
 *>   10.0.0.0/30      0.0.0.0                  0         32768 ?
 *>i  10.0.0.20/30     192.168.1.4              0    100      0 ?
 *>i  192.168.2.0      192.168.1.4         130816    100      0 ?
 *>   192.168.3.0      10.0.0.1            130816         32768 ?

C9300-PE-2#show ip bgp vpnv4 vrf RED
BGP table version is 7, local router ID is 192.168.1.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 69:69 (default for vrf RED)
 *>i  10.0.0.0/30      192.168.1.2              0    100      0 ?
```

```
 *>   10.0.0.20/30      0.0.0.0                      0        32768 ?
 *>   192.168.2.0       10.0.0.22             130816        32768 ?
 *>i  192.168.3.0       192.168.1.2           130816   100      0 ?
```

Valider les étiquettes VPNv4 et LDP

```
C9300-PE-1#show ip bgp vpnv4 vrf RED labels
   Network          Next Hop       In label/Out label
Route Distinguisher: 69:69 (RED)
   10.0.0.0/30      0.0.0.0            20/nolabel(RED)
   10.0.0.20/30     192.168.1.4        nolabel/20
   192.168.2.0      192.168.1.4        nolabel/21 <-- VPNv4 label that is be imposed to reach
192.168.20
   192.168.3.0      10.0.0.1           21/nolabel

C9300-PE-1#show ip route vrf RED 192.168.2.1

Routing Table: RED
Routing entry for 192.168.2.0/24
  Known via "bgp 69420", distance 200, metric 130816, type internal
  Last update from 192.168.1.4 18:41:56 ago
  Routing Descriptor Blocks:
  * 192.168.1.4 (default), from 192.168.1.4, 18:41:56 ago
      Route metric is 130816, traffic share count is 1
      AS Hops 0
      MPLS label: 21 <-- VPNv4 label that matches the previous output
      MPLS Flags: MPLS Required

C9300-PE-2#show ip bgp vpnv4 vrf RED labels
   Network          Next Hop       In label/Out label
Route Distinguisher: 69:69 (RED)
   10.0.0.0/30      192.168.1.2        nolabel/20
   10.0.0.20/30     0.0.0.0            20/nolabel(RED)
   192.168.2.0      10.0.0.22          21/nolabel <-- VPNv4 label that is advertised to reach
192.168.2.0
   192.168.3.0      192.168.1.2        nolabel/21


C9300-PE-2#show ip route vrf RED 192.168.2.1

Routing Table: RED
Routing entry for 192.168.2.0/24
  Known via "eigrp 400", distance 90, metric 130816, precedence routine (0), type internal
  Redistributing via eigrp 400, bgp 69420
  Advertised by bgp 69420
  Last update from 10.0.0.22 on GigabitEthernet2/0/1, 18:45:04 ago
  Routing Descriptor Blocks:
  * 10.0.0.22, from 10.0.0.22, 18:45:04 ago, via GigabitEthernet2/0/1 <-- CE-facing interface in
the VRF
      Route metric is 130816, traffic share count is 1
      Total delay is 5010 microseconds, minimum bandwidth is 1000000 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 1
```

Vérifier les étiquettes LDP utilisées

```
C9300-PE-1#show mpls forwarding-table 192.168.1.4
Local      Outgoing    Prefix             Bytes Label   Outgoing   Next Hop
```

```
Label        Label       or Tunnel Id    Switched       interface
19           17          192.168.1.4/32  0              Gi1/0/2    10.0.0.6  <-- 17 is the LDP
label imposed to reach PE at 192.168.1.4 through Gi1/0/2
             17          192.168.1.4/32  0              Gi1/0/3    10.0.0.10 <-- 17 is the LDP
label imposed to reach PE at 192.168.1.4 through Gi1/0/3

C9300-PE-2#show mpls forwarding-table 192.168.1.2
Local        Outgoing    Prefix          Bytes Label    Outgoing   Next Hop
Label        Label       or Tunnel Id    Switched       interface
17           16          192.168.1.2/32  0              Gi2/0/2    10.0.0.13 <-- 16 is the LDP
label imposed to reach PE at 192.168.1.2 through Gi2/0/2
             16          192.168.1.2/32  0              Gi2/0/3    10.0.0.17 <-- 16 is the LDP
label imposed to reach PE at 192.168.1.2 through Gi2/0/3
```

Valider la table de transfert MPLS

```
C9300-PE-1#show mpls forwarding-table
Local        Outgoing    Prefix          Bytes Label    Outgoing   Next Hop
Label        Label       or Tunnel Id    Switched       interface
16           Pop Label   192.168.1.3/32  0              Gi1/0/2    10.0.0.6
             Pop Label   192.168.1.3/32  0              Gi1/0/3    10.0.0.10
17           Pop Label   10.0.0.16/30    0              Gi1/0/2    10.0.0.6
             Pop Label   10.0.0.16/30    0              Gi1/0/3    10.0.0.10
18           Pop Label   10.0.0.12/30    0              Gi1/0/2    10.0.0.6
             Pop Label   10.0.0.12/30    0              Gi1/0/3    10.0.0.10
19           17          192.168.1.4/32  0              Gi1/0/2    10.0.0.6
             17          192.168.1.4/32  0              Gi1/0/3    10.0.0.10
20           No Label    10.0.0.0/30[V]  630            aggregate/RED
21           No Label    192.168.3.0/24[V]  \
                                         0              Gi1/0/1    10.0.0.1

C9300-PE-2#show mpls forwarding-table
Local        Outgoing    Prefix          Bytes Label    Outgoing   Next Hop
Label        Label       or Tunnel Id    Switched       interface
16           Pop Label   192.168.1.3/32  0              Gi2/0/2    10.0.0.13
             Pop Label   192.168.1.3/32  0              Gi2/0/3    10.0.0.17
17           16          192.168.1.2/32  0              Gi2/0/2    10.0.0.13
             16          192.168.1.2/32  0              Gi2/0/3    10.0.0.17
18           Pop Label   10.0.0.4/30     0              Gi2/0/2    10.0.0.13
             Pop Label   10.0.0.4/30     0              Gi2/0/3    10.0.0.17
19           Pop Label   10.0.0.8/30     0              Gi2/0/2    10.0.0.13
             Pop Label   10.0.0.8/30     0              Gi2/0/3    10.0.0.17
20           No Label    10.0.0.20/30[V] 630            aggregate/RED
21           No Label    192.168.2.0/24[V]  \
                                         0              Gi2/0/1    10.0.0.22
```

Confirmer les étiquettes internes (VPNv4) et externes (LDP) utilisées pour atteindre chaque préfixe donné dans le VRF

```
C9300-PE-1#show ip cef vrf RED 192.168.2.0/24 detail
192.168.2.0/24, epoch 0, flags [rib defined all labels]
  recursive via 192.168.1.4 label 21 <-- VPNv4 label
    nexthop 10.0.0.6 GigabitEthernet1/0/2 label 17-(local:19) <-- 17 is the LDP label that is
imposed to reach the remote PE, 19 is the local LDP label advertised to the P router
    nexthop 10.0.0.10 GigabitEthernet1/0/3 label 17-(local:19)<-- 17 is the LDP label that is
imposed to reach the remote PE, 19 is the local LDP label advertised to the P router

C9300-PE-2#show ip cef vrf RED 192.168.3.0/24 detail
192.168.3.0/24, epoch 0, flags [rib defined all labels]
```

```
    recursive via 192.168.1.2 label 21 <-- VPNv4 label
      nexthop 10.0.0.13 GigabitEthernet2/0/2 label 16-(local:17) <-- 16 is the LDP label that is
imposed to reach the remote PE, 17 is the local LDP label advertised to the P router
      nexthop 10.0.0.17 GigabitEthernet2/0/3 label 16-(local:17) <-- 16 is the LDP label that is
imposed to reach the remote PE, 17 is the local LDP label advertised to the P router
```

Vérifier les statistiques du Gestionnaire d'objets :

Dans les scénarios idéaux, il n'y a aucun objet en attente

```
C9300-PE-1#show platform software object-manager switch active f0 statistics
Forwarding Manager Asynchronous Object Manager Statistics

Object update: Pending-issue: 0, Pending-acknowledgement: 0
Batch begin:   Pending-issue: 0, Pending-acknowledgement: 0
Batch end:     Pending-issue: 0, Pending-acknowledgement: 0
Command:       Pending-acknowledgement: 0
Total-objects: 491
Stale-objects: 0
Resolve-objects: 0
Childless-delete-objects: 0
Error-objects: 0
Paused-types: 0
9500-P#show platform software object-manager switch active f0 statistics
Forwarding Manager Asynchronous Object Manager Statistics

Object update: Pending-issue: 0, Pending-acknowledgement: 0
Batch begin:   Pending-issue: 0, Pending-acknowledgement: 0
Batch end:     Pending-issue: 0, Pending-acknowledgement: 0
Command:       Pending-acknowledgement: 0
Total-objects: 491
Stale-objects: 0
Resolve-objects: 0
Childless-delete-objects: 0
Error-objects: 0
Paused-types: 0
C9300-PE-2#show platform software object-manager switch active f0 statistics
Forwarding Manager Asynchronous Object Manager Statistics

Object update: Pending-issue: 0, Pending-acknowledgement: 0
Batch begin:   Pending-issue: 0, Pending-acknowledgement: 0
Batch end:     Pending-issue: 0, Pending-acknowledgement: 0
Command:       Pending-acknowledgement: 0
Total-objects: 482
Stale-objects: 0
Resolve-objects: 0
Childless-delete-objects: 0
Error-objects: 0
Paused-types: 0
```

Programmation du préfixe

La section suivante traite de la programmation de préfixe sur les routeurs MPLS, C9300-PE-1,
C9500-P et C9300-PE-2.

Programmation du préfixe C9300-PE-1

```
***Software Prefix Programming***
C9300-PE-1#show ip route vrf RED 192.168.2.1
```

```
Routing Table: RED
Routing entry for 192.168.2.0/24
  Known via "bgp 69420", distance 200, metric 130816, type internal
  Last update from 192.168.1.4 19:21:45 ago
  Routing Descriptor Blocks:
  * 192.168.1.4 (default), from 192.168.1.4, 19:21:45 ago <-- Remote PE reachable in the global
routing table
      Route metric is 130816, traffic share count is 1
      AS Hops 0
      MPLS label: 21 <-- VPNv4 label
      MPLS Flags: MPLS Required


C9300-PE-1#show ip route 192.168.1.4
Routing entry for 192.168.1.4/32
  Known via "ospf 420", distance 110, metric 3, type intra area
  Last update from 10.0.0.10 on GigabitEthernet1/0/3, 19:23:17 ago
  Routing Descriptor Blocks:
    10.0.0.10, from 192.168.1.4, 19:23:17 ago, via GigabitEthernet1/0/3 <-- Next-hop to reach
192.168.1.4
      Route metric is 3, traffic share count is 1
  * 10.0.0.6, from 192.168.1.4, 19:23:17 ago, via GigabitEthernet1/0/2  <-- Next-hop to reach
192.168.1.4
      Route metric is 3, traffic share count is 1


***FMAN RP Prefix Programming***
C9300-PE-1#show ip vrf detail
VRF RED (VRF Id = 2); default RD 69:69; default VPNID <-- VRF ID is important in subsequent
command
  Old CLI format, supports IPv4 only
  Flags: 0xC
  Interfaces:
    Gi1/0/1
Address family ipv4 unicast (Table ID = 0x2):
  Flags: 0x0
  Export VPN route-target communities
    RT:69:69
  Import VPN route-target communities
    RT:69:69
  No import route-map
  No global export route-map
  No export route-map
  VRF label distribution protocol: not configured
  VRF label allocation mode: per-prefix


C9300-PE-1#show platform software ip switch active r0 cef table index 2 prefix 192.168.2.0/24 <-
- Index value is the VRF ID from previous command
Forwarding Table

Prefix/Len                    Next Object      Index
-----------------------------------------------------------------
192.168.2.0/24                OBJ_LABEL        0x78



C9300-PE-1#show platform software mpls switch active r0 label index 0x78 <-- Utilize the Index
value from previous command



Label OCE 0x78 -> OBJ_LOADBALANCE (0x70) <-- Utilized in next command
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x15
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x3480644d88
```

```
C9300-PE-1#show platform software loadinfo switch active r0 index 0x70 <-- Utilize the
OBJ_LOADBALANCE value from previous command
Number of loadinfo objects: 8

Index: 0x70, Flags: unknown, Hash Algorithm: , Number of Paths: 2, Number of buckets: 16
  Anti-polarising Factor: 0xf4a19ba0
  Next Object Type: OBJ_LABEL, OBJ_LABEL
  Next obj handle: 0x6e, 0x6f
  Hash Buckets: 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1
  Color Buckets Map: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
  OM handle: 0x3480641fb8


C9300-PE-1#show platform software mpls switch active r0 label index 0x6e <-- Utilize the obj
handle value from previous command



Label OCE 0x6e -> OBJ_ADJACENCY (0x4b)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x11
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x34806420d0


C9300-PE-1#show platform software mpls switch active r0 label index 0x6f <-- Utilize the obj
handle value from previous command



Label OCE 0x6f -> OBJ_ADJACENCY (0x4e)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x11
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x3480642268


C9300-PE-1#show platform software adjacency switch active r0 index 0x4b <-- Utilize the
OBJ_ADJACENCY value from previous command
Number of adjacency objects: 10


Adjacency id: 0x4b (75)
  Interface: GigabitEthernet1/0/2, IF index: 54, Link Type: MCP_LINK_TAG
  Encap: d4:ad:71:b5:dd:e4:a0:f8:49:11:d1:d6:88:47 <-- MAC ending in DDE4 is the DMAC, MAC
ending in D1D6 is SMAC, 8847 is MPLS ETYPE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: unknown
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 10.0.0.6 <-- Next-hop IP address
  IP FRR MCP_ADJ_IPFRR_NONE 0
  OM handle: 0x34806375f8


C9300-PE-1#show platform software adjacency switch active r0 index 0x4e <-- Utilize the
OBJ_ADJACENCY value from previous command
Number of adjacency objects: 10


Adjacency id: 0x4e (78)
  Interface: GigabitEthernet1/0/3, IF index: 55, Link Type: MCP_LINK_TAG
  Encap: d4:ad:71:b5:dd:c2:a0:f8:49:11:d1:d8:88:47 <-- MAC ending DDC2 is the DMAC, MAC ending
in D1D8 is the SMAC, 8847 is the MPLS ETPYE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: unknown
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 10.0.0.10 <-- Next-hop IP address
  IP FRR MCP_ADJ_IPFRR_NONE 0
```

```
    OM handle: 0x3480638200


***FMAN FP Prefix Programming***
C9300-PE-1#show ip vrf detail
VRF RED (VRF Id = 2); default RD 69:69; default VPNID
  Old CLI format, supports IPv4 only
  Flags: 0xC
  Interfaces:
    Gi1/0/1
Address family ipv4 unicast (Table ID = 0x2):
  Flags: 0x0
  Export VPN route-target communities
    RT:69:69
  Import VPN route-target communities
    RT:69:69
  No import route-map
  No global export route-map
  No export route-map
  VRF label distribution protocol: not configured
  VRF label allocation mode: per-prefix

C9300-PE-1#show platform software ip switch active f0 cef table index 2 prefix 192.168.2.0/24
detail <-- Index value is the VRF ID from previous command
Forwarding Table

192.168.2.0/24 -> OBJ_LABEL (0x78), urpf: 118
Prefix Flags: unknown
aom id: 618, HW handle: (nil) (created)

C9300-PE-1#show platform software mpls switch active f0 label index 0x78 <-- Use the OBJ_LABEL
value from previous command


Label OCE 0x78 -> OBJ_LOADBALANCE (0x70)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x15
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 617, CPP handle: 0xdeadbeef (created)

C9300-PE-1#show platform software object-manager switch active f0 object 617 parents <-- Use the
aom id from previous command
Object identifier: 600
  Description: LB 0x70
  Status: Done

C9300-PE-1#show platform software loadinfo switch active f0 index 0x70 <-- Use the LB value from
previous command
Number of loadinfo objects: 8

Index: 0x70, Flags: unknown, Hash Algorithm: , Number of Paths: 2, Number of buckets: 16
  Anti-polarising Factor: 0xf4a19ba0
  Next Object Type: OBJ_LABEL, OBJ_LABEL
  Next obj handle: 0x6e, 0x6f
  Hash Buckets: 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1
  Color Buckets Map: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
  aom id: 600, HW handle: (nil)

C9300-PE-1#show platform software mpls switch active f0 label index 0x6e <-- Use the obj handle
values from previous commands


Label OCE 0x6e -> OBJ_ADJACENCY (0x4b)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x11
```

```
     Backup flags: Pop, UHP, backup label 0x100001
     aom id: 598, CPP handle: 0xdeadbeef (created)


C9300-PE-1#show platform software mpls switch active f0 label index 0x6f <-- Use the obj handle
values from previous command



Label OCE 0x6f -> OBJ_ADJACENCY (0x4e)
   Flags: Real, Number of labels in the OCE: 1
   Label values: 0x11
   Backup flags: Pop, UHP, backup label 0x100001
   aom id: 599, CPP handle: 0xdeadbeef (created)

C9300-PE-1#show platform software adjacency switch active f0 index 0x4b <-- Use the
OBJ_ADJACENCY value from previous command
Number of adjacency objects: 10


Adjacency id: 0x4b (75)
   Interface: GigabitEthernet1/0/2, IF index: 54, Link Type: MCP_LINK_TAG
   Encap: d4:ad:71:b5:dd:e4:a0:f8:49:11:d1:d6:88:47
   Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
   Flags: unknown
   Incomplete behavior type: None
   Fixup: unknown
   Fixup_Flags_2: unknown
   Nexthop addr: 10.0.0.6
   IP FRR MCP_ADJ_IPFRR_NONE 0
   aom id: 531, HW handle: (nil) (created)


C9300-PE-1#show platform software adjacency switch active f0 index 0x4e <-- Use the
OBJ_ADJACENCY value from previous command
Number of adjacency objects: 10


Adjacency id: 0x4e (78)
   Interface: GigabitEthernet1/0/3, IF index: 55, Link Type: MCP_LINK_TAG
   Encap: d4:ad:71:b5:dd:c2:a0:f8:49:11:d1:d8:88:47
   Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
   Flags: unknown
   Incomplete behavior type: None
   Fixup: unknown
   Fixup_Flags_2: unknown
   Nexthop addr: 10.0.0.10
   IP FRR MCP_ADJ_IPFRR_NONE 0
   aom id: 535, HW handle: (nil) (created)

***FED Prefix Programming***
C9300-PE-1#show platform software fed switch active ip route vrf-name RED 192.168.2.0/24
vrf   dest                                       htm            flags   SGT    DGID MPLS Last-
modified
---   ----                                       ---            -----   ---    ---- ---- -----
-------------------
2     192.168.2.0/24                             0x7fbae8d86228 0x0     0      0    lspa0x2
2021/06/23 18:50:13.079 <-- HTM value significant for next command
   FIB: prefix_hdl:0x50000026, mpls_ecr_prefix_hdl:0
   ========= OCE chain =====
   LABEL:objid:120 link_type:IP local_label:1048577 outlabel:(21, 0) <-- VPNv4 label
        flags:0x1:(REAL,) pdflags:0x80:(INSTALL_HW_OK,RECIR_ADJ,) adj_handle:0xcb00003c <--
adj_handle and local_adj_hdl values must match
        unsupported recursion:0 olbl_changed 0 local_adj:1 modify_cnt:0
        bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
        AAL: id:3405774908 lbl:19 smac:0000.0000.0000 dmac:0000.0000.0000 <-- Label 19 matches the
local transport label
            sub_type:0 link_type:0 adj_flags:0x10 label_type:0 rewrite_type:PSH2(121)
```

```
            vlan_id:0 vrf_id:0 ri:0x7fbae8d73648, ri_id:0x46 phdl:0, ref_cnt:2 <-- ri_id and
ri_idx values must match
              si:0x7fbae8d834d8, si_id:0xb6, di_id:0x5013
  LB:obj_id:112 link_type:IP num_choices:2 Flags:0
      mpls_ecr:1 local_label:19 path_inhw:2 ecrh:0x7d000002 old_ecrh:0
      modify_cnt:0 bwalk_cnt:0 subwalk_cnt:0 finish_cnt:0
      bwalk:[req:0 in_prog:0 nested:0]
    AAL: ecr:id:2097152002 af:0 ecr_type:0 ref:7 ecrh:0x7fbae8a99268(28:2)
    hwhdl:3903427176 ::0x7fbae8a98b98,0x7fbae8a9ad48,0x7fbae8a98b98,0x7fbae8a9ad48
  Sw Enh ECR scale: objid:112 llabel:19 eos:1 #adjs:2 mixed_adj:0
    reprogram_hw:0 ecrhdl:0x7d000002 ecr_hwhdl:0x7fbae8a99268
    mod_cnt:0 prev_npath:0 pmismatch:0 pordermatch:0
    ecr_adj: id:4278190135 is_mpls_adj:1 l3adj_flags:0x100000
      recirc_adj_id:1744830509
          sih:0x7fbae8a98b98(179) di_id:20499 rih:0x7fbae8a985d8(33)
        adj_lentry [eos0:0x7fbae8d7bf48 eos1:0x7fbae8d76e88]
    ecr_adj: id:1392508984 is_mpls_adj:1 l3adj_flags:0x100000
      recirc_adj_id:2013265966
          sih:0x7fbae8a9ad48(180) di_id:20499 rih:0x7fbae8a9a788(46)
        adj_lentry [eos0:0x7fbae8d7c1b8 eos1:0x7fbae8d77158]
    ecr_prefix_adj: id:2164260921 (ref:1)
        sih:0x7fbae8d7df08(181) di_id:20499 rih:0x7fbae8d7db98(68)
      LABEL:objid:110 link_type:MPLS local_label:19 outlabel:(17, 0) <-- Label 19 is the local
transport label, Label 17 is the LDP label
        flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0xff000037
        unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
        bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
        AAL: id:4278190135 lbl:0 smac:a0f8.4911.d1d6 dmac:d4ad.71b5.dde4 <-- Matches next-hop
information to reach 192.168.2.0/24
            sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
            vlan_id:0 vrf_id:0 ri:0x7fbae8d78c48, ri_id:0x40 phdl:0x9f00004b, ref_cnt:1
            si:0x7fbae8d78fd8, si_id:0x4013, di_id:0x535f <-- di_id utilized in subsequent
commands
      ADJ:objid:75 {link_type:MPLS ifnum:0x36, si:0x22000023, }
      LABEL:objid:111 link_type:MPLS local_label:19 outlabel:(17, 0) <-- Label 19 is the local
transport label, Label 17 is the LDP label
        flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0x53000038
        unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
        bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
        AAL: id:1392508984 lbl:0 smac:a0f8.4911.d1d8 dmac:d4ad.71b5.ddc2 <-- Matches next-hop
information to reach 192.168.2.0/24
            sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
            vlan_id:0 vrf_id:0 ri:0x7fbae8d7d0a8, ri_id:0x42 phdl:0x8400004c, ref_cnt:1
            si:0x7fbae8d7a908, si_id:0x4014, di_id:0x5360 <-- di_id utilized in subsequent
commands
      ADJ:objid:78 {link_type:MPLS ifnum:0x37, si:0x74000026, }
  ===============
  MPLS info: mpls_ecr_scale_prefix_adj:0, mpls_lspa_hdl:0xa7000002
    AAL:LSPA: id:2801795074 num_path:1 prefix_id:0x2 delete_hw_hdl_cnt:0
        cookie[64]:
15000000000000000000000000000000000000000000000000000000000000004600000000000000000000000000000000
000000000000000000000000000000000 status:ok
        vpn_lbl:21 local_adj_hdl:0xcb00003c hw_hdl:0x7fbae8d86018 ri_idx:0x46 <-- vpn_lbl
matches the VPNv4 label, adj_handle and local_adj_hdl values must match, ri_id and ri_idx must
match
  ===============

C9300-PE-1#show platform hardware fed switch active fwd-asic abstraction print-resource-handle
0x7fbae8d86228 1 <-- Utilize the HTM value from previous command
Handle:0x7fbae8d86228 Res-Type:ASIC_RSC_HASH_TCAM Res-Switch-Num:0 Asic-Num:255 Feature-
ID:AL_FID_L3_UNICAST_IPV4 Lkp-ftr-id:LKP_FEAT_IPV4_L3_UNICAST ref_count:1
priv_ri/priv_si Handle: (nil)Hardware Indices/Handles: handle [ASIC: 0]: 0x7fbae8d71f58

Detailed Resource Information (ASIC# 0)
```

```
----------------------------------------
Number of HTM Entries: 1


Entry 0: (handle 0x7fbae8d71f58)


Absolute Index: 92181
Time Stamp: 1
KEY - vrf:2 mtr:0 prefix:192.168.2.0 rcp_redirect_index:0x0
MASK - vrf:255 mtr:0 prefix:255.255.255.0 rcp_redirect_index:0x0
FWD-AD = afd_label_flag:0 icmp_redir_enable:1 lvx_smr_enabled:0, dstNatType:0 priority:5
afdLabelOrDestClientId:0 SI:182 destined_to_us:0 hw_stats_idx:0 stats_id:0
redirectSetRouterMac:0 dgtIdx:0 destModIndex:0 dstNatTypeOrVpnPrefixPtrMsb:0 vpnPrefixPtr:0x2
SRC-AD = learning_violation:1 need_to_learn:1  locally_connected:0 staticentryViolation:0
rpfValid:1 rpfLe:0 rpfLePointer:0 rpfForcePass:0 rpfForceFail:0 reachableviaSome:0
rpfCheckIncomplete:0 defaultRoute:0 ChainPtrValid:0 ChainPtrOrPortLeIndex:72 UseRpfmatchTable:0
rpfIncomplete:0 is_src_ce:0 sgtValid:0 sgt:0 src_rloc_trusted:0,sgtCacheControl1 = 0,
sgtCacheControl0 = 0
port_label:0x0 port_mask:0x0 vlan_label:0x0 vlan_mask:0x0 l3if_label:0x0 l3if_mask:0x0
group_label:0x0 group_mask:0x0



==============================================================

C9300-PE-1#show platform hardware fed switch active fwd-asic resource asic all destination-index
range 0x535f 0x535f <-- Utilize the di_id from the previous command
ASIC#0:

index = 0x535f
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0
ASIC#1:

index = 0x535f
pmap = 0x00000000 0x00000002 <-- Looking at 0x00000002, in binary that is 0000 0000 0000 0000
000 0000 0000 0010 = Port 1 (Zero based, count right to left)
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0


C9300-PE-1#show platform hardware fed switch active fwd-asic resource asic all destination-index
range 0x5360 0x5360 <-- Utilize the di_id from the previous command ASIC#0:
ASIC#0:
```

```
index = 0x5360
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0
ASIC#1:

index = 0x5360
pmap = 0x00000000 0x00000004 <-- Looking at 0x00000004, in binary that is 0000 0000 0000 0000
0000 0000 0000 0100 = Port 2 (Zero based, count right to left)
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0


C9300-PE-1#show platform software fed switch active ifm map
Interface              IF_ID   Inst Asic Core Port SubPort Mac  Cntx LPN  GPN  Type Active
GigabitEthernet1/0/2   0x36      1   0    1    1     0       6    7    2    2   NIF  Y  <--
Port 1 is an egress port, Gi1/0/2
GigabitEthernet1/0/3   0x37      1   0    1    2     0      28    8    3    3   NIF  Y  <--
Port 2 is an egress port, Gi1/0/3
```

Programmation du préfixe C9500

```
***Software Prefix Programming***
C9500-P#show ip route 192.168.1.4
Routing entry for 192.168.1.4/32
  Known via "ospf 420", distance 110, metric 2, type intra area
  Last update from 10.0.0.18 on TenGigabitEthernet2/0/2, 20:15:25 ago
  Routing Descriptor Blocks:
    10.0.0.18, from 192.168.1.4, 20:15:25 ago, via TenGigabitEthernet2/0/2 <-- Next-hop towards
192.168.1.4
      Route metric is 2, traffic share count is 1
  * 10.0.0.14, from 192.168.1.4, 20:15:25 ago, via TenGigabitEthernet1/0/2 <-- Next-hop towards
192.168.1.4
      Route metric is 2, traffic share count is 1

C9500-P#show ip cef 192.168.1.4 detail
192.168.1.4/32, epoch 4, per-destination sharing
  dflt local label info: global/17 [0x3]
  nexthop 10.0.0.14 TenGigabitEthernet1/0/2 label explicit-null-(local:17) <-- Explicit null to
reach 192.168.1.4
```

```
    nexthop 10.0.0.18 TenGigabitEthernet2/0/2 label explicit-null-(local:17) <-- Explicit null to
reach 192.168.1.4


***FMAN RP Prefix Programming***
C9500-P#show platform software ip switch active r0 cef prefix 192.168.1.4/32
Forwarding Table


Prefix/Len                      Next Object      Index
------------------------------------------------------------------
192.168.1.4/32                  OBJ_LOADBALANCE  0x6a


C9500-P#show platform software loadinfo switch active r0 index 0x6a <-- Use the OBJ_LOADBALANCE
value from previous command
Number of loadinfo objects: 4


Index: 0x6a, Flags: unknown, Hash Algorithm: , Number of Paths: 2, Number of buckets: 16
  Anti-polarising Factor: 0x57a70068
  Next Object Type: OBJ_LABEL, OBJ_LABEL
  Next obj handle: 0x68, 0x69
  Hash Buckets: 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1
  Color Buckets Map: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
  OM handle: 0x348064de58


C9500-P#show platform software mpls switch active r0 label index 0x68 <-- Use the obj handle
values from the previous command



Label OCE 0x68 -> OBJ_ADJACENCY (0x49)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x348064df70


C9500-P#show platform software mpls switch active r0 label index 0x69



Label OCE 0x69 -> OBJ_ADJACENCY (0x4e)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x348064e108


C9500-P#show platform software adjacency switch active r0 index 0x49 <-- Use the OBJ_ADJACENCY
values from previous commands
Number of adjacency objects: 16


Adjacency id: 0x49 (73)
  Interface: TenGigabitEthernet1/0/2, IF index: 66, Link Type: MCP_LINK_TAG
  Encap: 70:d3:79:be:ae:71:d4:ad:71:b5:dd:d6:88:47 <-- MAC ending in AE71 is the DMAC, MAC
ending is B5DD is SMAC, 8847 is MPLS ETYPE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: unknown
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 10.0.0.14 <-- Next-hop IP address
  IP FRR MCP_ADJ_IPFRR_NONE 0
  OM handle: 0x3480647700



C9500-P#show platform software adjacency switch active r0 index 0x4e <-- Use the OBJ_ADJACENCY
values from previous commands
Number of adjacency objects: 16
```

```
Adjacency id: 0x4e (78)
  Interface: TenGigabitEthernet2/0/2, IF index: 68, Link Type: MCP_LINK_TAG
  Encap: 70:d3:79:be:ae:61:d4:ad:71:b5:dd:f1:88:47 <-- MAC ending in AE61 is DMAC, MAC ending in
B5DD is SMAC, 8847 is MPLS ETYPE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: unknown
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 10.0.0.18 <-- Next-hop IP address
  IP FRR MCP_ADJ_IPFRR_NONE 0
  OM handle: 0x3480648f68


***FMAN FP Prefix Programming***
C9500-P#show platform software ip switch active f0 cef prefix 192.168.1.4/32
Forwarding Table

Prefix/Len                   Next Object      Index
-----------------------------------------------------------------
192.168.1.4/32               OBJ_LOADBALANCE  0x6a

C9500-P#show platform software loadinfo switch active f0 index 0x6a <-- Use the OBJ_LOADBALANCE
value from previous command
Number of loadinfo objects: 4

Index: 0x6a, Flags: unknown, Hash Algorithm: , Number of Paths: 2, Number of buckets: 16
  Anti-polarising Factor: 0x57a70068
  Next Object Type: OBJ_LABEL, OBJ_LABEL
  Next obj handle: 0x68, 0x69
  Hash Buckets: 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1
  Color Buckets Map: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
  aom id: 578, HW handle: (nil)

C9500-P#show platform software mpls switch active f0 label index 0x68 <-- Use the obj handle
values from previous command



Label OCE 0x68 -> OBJ_ADJACENCY (0x49)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 576, CPP handle: 0xdeadbeef (created)


C9500-P#show platform software mpls switch active f0 label index 0x69 <-- Use the obj handle
values from previous command



Label OCE 0x69 -> OBJ_ADJACENCY (0x4e)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 577, CPP handle: 0xdeadbeef (created)


C9500-P#show platform software adjacency switch active f0 index 0x49 <-- Use the OBJ_ADJACENCY
values from previous commands
Number of adjacency objects: 16

Adjacency id: 0x49 (73)
  Interface: TenGigabitEthernet1/0/2, IF index: 66, Link Type: MCP_LINK_TAG
  Encap: 70:d3:79:be:ae:71:d4:ad:71:b5:dd:d6:88:47 <-- MAC ending in AE71 is the DMAC, MAC
ending in DDD6 is the SMAC, 8847 is the MPLS ETYPE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: unknown
  Incomplete behavior type: None
```

```
   Fixup: unknown
   Fixup_Flags_2: unknown
   Nexthop addr: 10.0.0.14 <-- Next-hop IP address
   IP FRR MCP_ADJ_IPFRR_NONE 0
   aom id: 536, HW handle: (nil) (created)


C9500-P#show platform software adjacency switch active f0 index 0x4e <-- Use the OBJ_ADJACENCY
values from previous commands
Number of adjacency objects: 16


Adjacency id: 0x4e (78)
   Interface: TenGigabitEthernet2/0/2, IF index: 68, Link Type: MCP_LINK_TAG
   Encap: 70:d3:79:be:ae:61:d4:ad:71:b5:dd:f1:88:47 <-- MAC ending in AE61 is the DMAC, MAC
ending in DDF1 is the SMAC, 8847 is the MPLS ETYPE
   Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
   Flags: unknown
   Incomplete behavior type: None
   Fixup: unknown
   Fixup_Flags_2: unknown
   Nexthop addr: 10.0.0.18 <-- Next-hop IP address
   IP FRR MCP_ADJ_IPFRR_NONE 0
   aom id: 545, HW handle: (nil) (created)


***FED Prefix Programming***
C9500-P#show platform software fed switch active ip route 192.168.1.4/32
vrf    dest                                         htm           flags  SGT  DGID MPLS Last-
modified
---    ----                                         ---           -----  ---  ---- ---- -----
------------------
0      192.168.1.4/32                               0x7f0b284c1118 0x0     0    0
2021/06/23 18:47:01.761 <-- HTM value important for subsequent command
   FIB: prefix_hdl:0x9b000020, mpls_ecr_prefix_hdl:0xdd00003a
   ========== OCE chain =====
   LB:obj_id:106 link_type:IP num_choices:2 Flags:0
      mpls_ecr:1 local_label:17 path_inhw:2 ecrh:0x44000002 old_ecrh:0
      modify_cnt:0 bwalk_cnt:0 subwalk_cnt:0 finish_cnt:0
      bwalk:[req:0 in_prog:0 nested:0]
    AAL: ecr:id:1140850690 af:0 ecr_type:0 ref:2 ecrh:0x7f0b284a3998(28:2)
    hwhdl:675953048 ::0x7f0b284b4268,0x7f0b284a1d78,0x7f0b284b4268,0x7f0b284a1d78
   Sw Enh ECR scale: objid:106 llabel:17 eos:1 #adjs:2 mixed_adj:0
      reprogram_hw:0 ecrhdl:0x44000002 ecr_hwhdl:0x7f0b284a3998
      mod_cnt:0 prev_npath:0 pmismatch:0 pordermatch:0
      ecr_adj: id:4127195192 is_mpls_adj:1 l3adj_flags:0x100000
        recirc_adj_id:1207959601
           sih:0x7f0b284b4268(181) di_id:23709 rih:0x7f0b284b3ca8(31)
        adj_lentry [eos0:0x7f0b284c38e8 eos1:0x7f0b284cd858]
      ecr_adj: id:1157627961 is_mpls_adj:1 l3adj_flags:0x100000
        recirc_adj_id:67108914
           sih:0x7f0b284a1d78(182) di_id:23709 rih:0x7f0b284b47d8(44)
        adj_lentry [eos0:0x7f0b284c3af8 eos1:0x7f0b284cdb28]
      ecr_prefix_adj: id:3707764794 (ref:1)
        sih:0x7f0b284c5028(184) di_id:23709 rih:0x7f0b284c4c48(60)
      LABEL:objid:104 link_type:MPLS local_label:17 outlabel:(0, 0) <-- Label 17 is the local
transport label, 0 is the LDP label
        flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0xf6000038
        unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
        bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
        AAL: id:4127195192 lbl:0 smac:d4ad.71b5.ddd6 dmac:70d3.79be.ae71 <-- Matches the next-
hop information to reach 192.168.1.4/32
           sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
           vlan_id:0 vrf_id:0 ri:0x7f0b284ceaa8, ri_id:0x38 phdl:0x76000058, ref_cnt:1
           si:0x7f0b284ceeb8, si_id:0x400b, di_id:0x2 <-- Used in subsequent commands
      ADJ:objid:73 {link_type:MPLS ifnum:0x42, si:0x1f000028, }
      LABEL:objid:105 link_type:MPLS local_label:17 outlabel:(0, 0) <-- Label 17 is the local
```

transport label, 0 is the LDP label
         flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0x45000039
         unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
         bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
         AAL: id:1157627961 lbl:0 **smac:d4ad.71b5.ddf1 dmac:70d3.79be.ae61 <-- Matches the next-**
hop information to reach 192.168.1.4/32
             sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
             vlan_id:0 vrf_id:0 ri:0x7f0b284c4588, ri_id:0x3a phdl:0x5500005a, ref_cnt:1
             si:0x7f0b284d0548, si_id:0x400c, **di_id:0x62 <-- Used in subsequent commands**
      ADJ:objid:78 {link_type:MPLS ifnum:0x44, si:0x4900002a, }
   ==============
   MPLS info: mpls_ecr_scale_prefix_adj:0xdd00003a, mpls_lspa_hdl:0
   ==============

C9500-P#**show platform hardware fed switch active fwd-asic abstraction print-resource-handle**
0x7f0b284c1118 1 <-- Use the HTM value from previous command
Handle:0x7f0b284c1118 Res-Type:ASIC_RSC_HASH_TCAM Res-Switch-Num:0 Asic-Num:255 Feature-
ID:AL_FID_L3_UNICAST_IPV4 Lkp-ftr-id:LKP_FEAT_IPV4_L3_UNICAST ref_count:1
priv_ri/priv_si Handle: (nil)Hardware Indices/Handles: handle [ASIC: 0]: 0x7f0b284c1328
Features sharing this resource:Cookie length: 12
04 01 a8 c0 00 00 00 d0 07 00 00 00

Detailed Resource Information (ASIC# 0)

Number of HTM Entries: 1

Entry 0: (handle 0x7f0b284c1328)

Absolute Index: 126650
Time Stamp: 1
KEY - vrf:0 mtr:0 **prefix:192.168.1.4** rcp_redirect_index:0x0
MASK - vrf:0 mtr:0 **prefix:0.0.0.0** rcp_redirect_index:0x0
FWD-AD = afd_label_flag:0 icmp_redir_enable:1 lvx_smr_enabled:0, dstNatType:0 priority:5
afdLabelOrDestClientId:0 SI:184 destined_to_us:0 hw_stats_idx:1 stats_id:0
redirectSetRouterMac:0 dgtIdx:0 destModIndex:0 dstNatTypeOrVpnPrefixPtrMsb:0 vpnPrefixPtr:0
SRC-AD = learning_violation:0 need_to_learn:0 locally_connected:0 staticentryViolation:0
rpfValid:1 rpfLe:2 rpfLePointer:0 rpfForcePass:0 rpfForceFail:0 reachableviaSome:1
rpfCheckIncomplete:0 defaultRoute:0 ChainPtrValid:0 ChainPtrOrPortLeIndex:72 UseRpfmatchTable:1
rpfIncomplete:0 is_src_ce:0 sgtValid:0 sgt:0 src_rloc_trusted:0,sgtCacheControl1 = 0,
sgtCacheControl0 = 0
port_label:0x0 port_mask:0x0 vlan_label:0x0 vlan_mask:0x0 l3if_label:0x0 l3if_mask:0x0
group_label:0x0 group_mask:0x0

===

C9500-P#**show platform hardware fed switch active fwd-asic resource asic all destination-index**
range 0x2 0x2 <-- Use the di_id values from previous command
ASIC#0:

index = 0x2
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0

```
copySeg = 0
ASIC#1:

index = 0x2
pmap = 0x00000000 0x00000002 <-- Looking at 0x00000002, in binary that is 0000 0000 0000 0000
0000 0000 0000 0010 = Port 1 (Zero based, count right to left)
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0

C9500-P#show platform hardware fed switch active fwd-asic resource asic all destination-index
range 0x62 0x62
ASIC#0:

index = 0x62
pmap = 0x00000000 0x00008000 <-- Looking at 0x00008000, in binary that is 0000 0000 0000 0000
1000 0000 0000 0000 = Port 15 (Zero based, count right to left)
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0
ASIC#1:

index = 0x62
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0


C9500-P#show platform software fed switch standby ip route 192.168.1.4/32
vrf   dest                                        htm           flags   SGT   DGID MPLS Last-
modified
---   ----                                        ---           -----   ---   ---- ---- -----
-------------------
0     192.168.1.4/32                              0x7f57c0545938 0x0      0       0
```

```
2021/06/23 18:46:51.399 <-- HTM value used in subsequent command
  FIB: prefix_hdl:0x29000020, mpls_ecr_prefix_hdl:0x8f000039
  ========== OCE chain =====
  LB:obj_id:106 link_type:IP num_choices:2 Flags:0
      mpls_ecr:1 local_label:17 path_inhw:2 ecrh:0xf1000002 old_ecrh:0
      modify_cnt:0 bwalk_cnt:0 subwalk_cnt:0 finish_cnt:0
      bwalk:[req:0 in_prog:0 nested:0]
    AAL: ecr:id:4043309058 af:0 ecr_type:0 ref:2 ecrh:0x7f57c04d2148(28:2)
    hwhdl:3226280264 ::0x7f57c0547538,0x7f57c05497d8,0x7f57c0547538,0x7f57c05497d8
  Sw Enh ECR scale: objid:106 llabel:17 eos:1 #adjs:2 mixed_adj:0
      reprogram_hw:0 ecrhdl:0xf1000002 ecr_hwhdl:0x7f57c04d2148
      mod_cnt:0 prev_npath:0 pmismatch:0 pordermatch:0
      ecr_adj: id:201326647 is_mpls_adj:1 l3adj_flags:0x100000
        recirc_adj_id:3925868592
            sih:0x7f57c0547538(181) di_id:23717 rih:0x7f57c0546f18(31)
        adj_lentry [eos0:0x7f57c04c8a08 eos1:0x7f57c04d07f8]
      ecr_adj: id:738197560 is_mpls_adj:1 l3adj_flags:0x100000
        recirc_adj_id:3070230577
            sih:0x7f57c05497d8(182) di_id:23717 rih:0x7f57c0547838(44)
        adj_lentry [eos0:0x7f57c04c8c18 eos1:0x7f57c04d0ac8]
      ecr_prefix_adj: id:2399141945 (ref:1)
          sih:0x7f57c04c8788(184) di_id:23717 rih:0x7f57c04c8508(60)
      LABEL:objid:104 link_type:MPLS local_label:17 outlabel:(0, 0) <-- Label 17 is the local
transport label, 0 is the LDP label
          flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0xc000037
          unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
          bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
          AAL: id:201326647 lbl:0 smac:d4ad.71b5.ddd6 dmac:70d3.79be.ae71 <-- Matches next-hop
information to reach 192.168.1.4/32
              sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
              vlan_id:0 vrf_id:0 ri:0x7f57c04d18e8, ri_id:0x38 phdl:0x76000058, ref_cnt:1
              si:0x7f57c04d1b18, si_id:0x400b, di_id:0x2 <-- di_id utilized in subsequent
commands
      ADJ:objid:73 {link_type:MPLS ifnum:0x42, si:0xdf000027, }
      LABEL:objid:105 link_type:MPLS local_label:17 outlabel:(0, 0) <-- Label 17 is the local
transport label, 0 is the LDP label
          flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0x2c000038
          unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
          bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
          AAL: id:738197560 lbl:0 smac:d4ad.71b5.ddf1 dmac:70d3.79be.ae61 <-- Matches next-hop
information to reach 192.168.1.4/32
              sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
              vlan_id:0 vrf_id:0 ri:0x7f57c04da418, ri_id:0x3a phdl:0x5500005a, ref_cnt:1
              si:0x7f57c04da838, si_id:0x400c, di_id:0x62 <-- di_id utilized in subsequent
commands
      ADJ:objid:78 {link_type:MPLS ifnum:0x44, si:0xfa000029, }
  ===============
  MPLS info: mpls_ecr_scale_prefix_adj:0x8f000039, mpls_lspa_hdl:0
  ===============


C9500-P#show platform hardware fed switch standby fwd-asic resource asic all destination-index
range 0x62 0x62
ASIC#0:

index = 0x62
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
```

```
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0
ASIC#1:

index = 0x62
pmap = 0x00000000 0x00000002 <-- Looking at 0x000000002, in binary that is 0000 0000 0000 0000
0000 0000 0000 0010 = Port 1 (Zero based, count right to left)
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0

C9500-P#show platform hardware fed switch standby fwd-asic resource asic all destination-index
range 0x2 0x2
ASIC#0:

index = 0x2
pmap = 0x00000000 0x00008000 <-- Looking at 0x00008000, in binary that is 0000 0000 0000 0000
1000 0000 0000 0000 = Port 15 (Zero based, count right to left)
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0
ASIC#1:

index = 0x2
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0

C9500-P#show platform software fed switch active ifm mappings
Interface              IF_ID   Inst Asic Core Port SubPort Mac  Cntx LPN  GPN  Type Active
```

```
TenGigabitEthernet1/0/2   0x42     1   0   1   1    0    10  1   2   2    NIF  Y <--
Port 1 is an egres port, TenGi1/0/2
TenGigabitEthernet1/0/16  0x18     0   0   0   15   0    8   11  16  2360 NIF  Y <--
Port 15 is the SVL
```

```
C9500-P#show platform software fed switch standby ifm mappings
Interface                 IF_ID    Inst Asic Core Port SubPort Mac Cntx LPN GPN  Type Active
TenGigabitEthernet2/0/2   0x44     1   0   1   1    0    10  1   2   98   NIF  Y <--
Port 1 is an egres port, TenGi2/0/2
TenGigabitEthernet2/0/16  0x33     0   0   0   15   0    8   11  16  2360 NIF  Y <--
Port 15 is the SVL
```

Vérifier les préfixes C9300-PE-2

```
***Software Prefix Programming***
C9300-PE-2#show ip route vrf RED 192.168.2.0

Routing Table: RED
Routing entry for 192.168.2.0/24
  Known via "eigrp 400", distance 90, metric 130816, precedence routine (0), type internal
  Redistributing via eigrp 400, bgp 69420
  Advertised by bgp 69420
  Last update from 10.0.0.22 on GigabitEthernet2/0/1, 21:35:22 ago
  Routing Descriptor Blocks:
  * 10.0.0.22, from 10.0.0.22, 21:35:22 ago, via GigabitEthernet2/0/1 <-- Next-hop to reach
192.168.2.0/24
      Route metric is 130816, traffic share count is 1
      Total delay is 5010 microseconds, minimum bandwidth is 1000000 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 1
```

```
C9300-PE-2#show ip route vrf RED 10.0.0.22

Routing Table: RED
Routing entry for 10.0.0.20/30
  Known via "connected", distance 0, metric 0 (connected, via interface)
  Redistributing via eigrp 400, bgp 69420
  Advertised by bgp 69420
  Routing Descriptor Blocks:
  * directly connected, via GigabitEthernet2/0/1
      Route metric is 0, traffic share count is 1
```

```
C9300-PE-2#show ip cef vrf RED 192.168.2.0/24 detail
192.168.2.0/24, epoch 0
  QOS: Precedence routine (0)
  dflt local label info: other/21 [0x2] <-- VPNv4 Label
  nexthop 10.0.0.22 GigabitEthernet2/0/1
```

```
***FMAN RP Prefix Programming***
C9300-PE-2#show ip vrf detail
VRF RED (VRF Id = 2); default RD 69:69; default VPNID <-- VRF ID used in next command
  Old CLI format, supports IPv4 only
  Flags: 0xC
  Interfaces:
    Gi2/0/1
Address family ipv4 unicast (Table ID = 0x2):
  Flags: 0x0
  Export VPN route-target communities
    RT:69:69
  Import VPN route-target communities
    RT:69:69
  No import route-map
```

```
  No global export route-map
  No export route-map
  VRF label distribution protocol: not configured
  VRF label allocation mode: per-prefix
```

C9300-PE-2#**show platform software ip switch active r0 cef table index 2 prefix 192.168.2.0/24 <-
- Use the VRF ID from previous command**
```
Forwarding Table


Prefix/Len                     Next Object        Index
------------------------------------------------------------------
192.168.2.0/24                 OBJ_ADJACENCY      0x3a
```

C9300-PE-2#**show platform software adjacency switch active r0 index 0x3a <-- Use the
OBJ_ADJACENCY value from previous command**
```
Number of adjacency objects: 10


Adjacency id: 0x3a (58)
  Interface: GigabitEthernet2/0/1, IF index: 53, Link Type: MCP_LINK_IP
  Encap: 0:72:78:c8:c9:c2:70:d3:79:be:ae:42:8:0 <-- MAC ending in C9C2 is the DMAC, MAC ending
in AE42 is SMAC, 0800 is IP ETYPE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: no-l3-inject
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 10.0.0.22 <-- Next-hop IP address
  IP FRR MCP_ADJ_IPFRR_NONE 0
  OM handle: 0x348062b578
```

FMAN FP Prefix Programming
C9300-PE-2#**show platform software ip switch active f0 cef table index 2 prefix 192.168.2.0/24**
```
Forwarding Table


Prefix/Len                     Next Object        Index
------------------------------------------------------------------
192.168.2.0/24                 OBJ_ADJACENCY      0x3a
```

C9300-PE-2#**show platform software adjacency switch active f0 index 0x3a <-- Use the
OBJ_ADJACENCY value from previous command**
```
Number of adjacency objects: 10


Adjacency id: 0x3a (58)
  Interface: GigabitEthernet2/0/1, IF index: 53, Link Type: MCP_LINK_IP
  Encap: 0:72:78:c8:c9:c2:70:d3:79:be:ae:42:8:0 <-- MAC ending in C9C2 is the DMAC, MAC ending
in AE42 is SMAC, 0800 is IP ETYPE
  Encap Length: 14, Encap Type: MCP_ET_ARPA, MTU: 1500
  Flags: no-l3-inject
  Incomplete behavior type: None
  Fixup: unknown
  Fixup_Flags_2: unknown
  Nexthop addr: 10.0.0.22 <-- Next-hop IP address
  IP FRR MCP_ADJ_IPFRR_NONE 0
  aom id: 477, HW handle: (nil) (created)
```

FED Prefix Programming
C9300-PE-2#**show platform hardware fed switch active ip route vrf-name RED 192.168.2.0/24**
```
vrf   dest                                    htm            flags  SGT   DGID MPLS Last-
modified
---   ----                                    ---            -----  ---   ---- ---- -----
------------------
2     192.168.2.0/24                          0x7f0650a7e3e8 0x0    0     0
2021/06/23 18:46:56.801 <-- HTM value used in subsequent command
  FIB: prefix_hdl:0x38000016, mpls_ecr_prefix_hdl:0
```

```
========= OCE chain =====
  ADJ:objid:58 {link_type:IP ifnum:0x35, si:0x9700001b, IPv4:        10.0.0.22 } <-- objid
relevant in subsequent command, 10.0.0.22 is the next-hop IP
  ==============
  MPLS info: mpls_ecr_scale_prefix_adj:0, mpls_lspa_hdl:0
  ==============


C9300-PE-2#show platform hardware fed switch active fwd-asic abstraction print-resource-handle
0x7f0650a7e3e8 1 <-- Use the HTM value from previous command
Handle:0x7f0650a7e3e8 Res-Type:ASIC_RSC_HASH_TCAM Res-Switch-Num:0 Asic-Num:255 Feature-
ID:AL_FID_L3_UNICAST_IPV4 Lkp-ftr-id:LKP_FEAT_IPV4_L3_UNICAST ref_count:1
priv_ri/priv_si Handle: (nil)Hardware Indices/Handles: handle [ASIC: 0]: 0x7f0650ba4028


Detailed Resource Information (ASIC# 0)
----------------------------------------
Number of HTM Entries: 1


Entry 0: (handle 0x7f0650ba4028)


Absolute Index: 92180
Time Stamp: 1
KEY - vrf:2 mtr:0 prefix:192.168.2.0 rcp_redirect_index:0x0
MASK - vrf:255 mtr:0 prefix:255.255.255.0 rcp_redirect_index:0x0
(SI value used later)
FWD-AD = afd_label_flag:0 icmp_redir_enable:1 lvx_smr_enabled:0, dstNatType:0 priority:5
afdLabelOrDestClientId:0 SI:173 destined_to_us:0 hw_stats_idx:1 stats_id:0
redirectSetRouterMac:0 dgtIdx:0 destModIndex:0 dstNatTypeOrVpnPrefixPtrMsb:0 vpnPrefixPtr:0
SRC-AD = learning_violation:1 need_to_learn:1  locally_connected:0 staticentryViolation:0
rpfValid:1 rpfLe:37 rpfLePointer:0 rpfForcePass:0 rpfForceFail:0 reachableviaSome:1
rpfCheckIncomplete:0 defaultRoute:0 ChainPtrValid:0 ChainPtrOrPortLeIndex:72 UseRpfmatchTable:0
rpfIncomplete:0 is_src_ce:0 sgtValid:0 sgt:0 src_rloc_trusted:0,sgtCacheControl1 = 0,
sgtCacheControl0 = 0
port_label:0x0 port_mask:0x0 vlan_label:0x0 vlan_mask:0x0 l3if_label:0x0 l3if_mask:0x0
group_label:0x0 group_mask:0x0




===============================================================

C9300-PE-2#show platform software fed switch active ip adj
IPV4 Adj entries
dest            if_name                 dst_mac          si_hdl          ri_hdl          pd_flags
adj_id  Last-modified
----            -------                 -------          ------          ------          --------
-----   -----------------------
10.0.0.22       GigabitEthernet2/0/1    0072.78c8.c9c2   0x7f0650a32858 0x7f0650a1af48 0x0
0x3a      2021/06/23 18:46:52.956


C9300-PE-2#show ip arp vrf RED 10.0.0.22
Protocol    Address        Age (min)  Hardware Addr  Type Interface
Internet    10.0.0.22         131     0072.78c8.c9c2 ARPA GigabitEthernet2/0/1  <-- dst_mac
matches the ARP entry


C9300-PE-2#show platform hardware fed fwd-asic abstraction print-resource-handle 0x7f0650a32858
1 <-- Use the HTM value from previous command
Handle:0x7f0650a32858 Res-Type:ASIC_RSC_SI Res-Switch-Num:255 Asic-Num:255 Feature-
ID:AL_FID_L3_UNICAST_IPV4 Lkp-ftr-id:LKP_FEAT_INVALID ref_count:1
priv_ri/priv_si Handle: 0x7f0650a1af48Hardware Indices/Handles: index0:0xad
mtu_index/l3u_ri_index0:0x0  index1:0xad  mtu_index/l3u_ri_index1:0x0
Features sharing this resource:66 (1)]
Cookie length: 56
00 00 00 00 00 00 00 00 25 00 00 00 00 00 00 00 00 00 00 00 08 00 00 72 78 c8 c9 c2 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00


Detailed Resource Information (ASIC# 0)
```

```
----------------------------------------

Station Index (SI) [0xad]
RI = 0x18
DI = 0x5338
stationTableGenericLabel = 0
stationFdConstructionLabel = 0x7
lookupSkipIdIndex = 0
rcpServiceId = 0
dejaVuPreCheckEn = 0
Replication Bitmap: CD

Detailed Resource Information (ASIC# 1)
----------------------------------------


Station Index (SI) [0xad]
RI = 0x18
DI = 0x5338
stationTableGenericLabel = 0
stationFdConstructionLabel = 0x7
lookupSkipIdIndex = 0
rcpServiceId = 0
dejaVuPreCheckEn = 0
Replication Bitmap: LD

================================================================

C9300-PE-2#show platform hardware fed switch active fwd-asic resource asic all destination-index
range 0x5338 0x5338 <-- Use the DI value from previous command
ASIC#0:

index = 0x5338
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0
ASIC#1:

index = 0x5338
pmap = 0x00000000 0x00000001 <-- Looking at 0x00000001, in binary that is 0000 0000 0000 0000
0000 0000 0000 0001 = Port 0 (Zero based, count right to left)
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
```

```
stripSeg = 0
copySeg = 0

C9300-PE-2#show platform software fed switch active ifm mappings
Interface              IF_ID    Inst Asic Core Port SubPort Mac  Cntx LPN  GPN  Type Active
GigabitEthernet2/0/1   0x35      1    0    1    0      0     26    6    1    97  NIF  Y    <-
- Port 0 is the egress port, Gi2/0/1
```

Programmation des étiquettes VPNv4

La section suivante traite de la programmation d'étiquettes VPNv4 sur les routeurs PE MPLS,
C9300-PE-1 et C9300-PE-2. Le C9500=P ne transfère pas sur l'étiquette VPNv4, il n'y a donc
aucune sortie du C9500-P.

C9300-PE-1 VPNv4 Étiquette Programmation :

Vérifiez le préfixe local sur le PE, et non le préfixe distant. Vérifiez l'étiquette d'un point de vue
FED, puis revenez à FMAN RP et FMAN FP.

```
***Software VPNv4 Label Programming***
C9300-PE-1#show ip cef vrf RED 192.168.3.0/24 detail
192.168.3.0/24, epoch 0
  QOS: Precedence routine (0)
  dflt local label info: other/21 [0x2] <-- VPNv4 label assocaited with the local prefix
  nexthop 10.0.0.1 GigabitEthernet1/0/1

***FMAN RP VPNv4 Label Programming***
C9300-PE-1#show platform software mpls switch active r0 eos index 117 <-- Utilize the objid from
the FED command


EOS Choice 0x75, Number of paths: 2
  Next Object Type: OBJ_ADJ_DROP,OBJ_LABEL
  Next Object Index: 0,0x74
  OM handle: 0x3480644470

***FMAN FP VPNv4 Label Programming***
C9300-PE-1#show platform software mpls switch active f0 eos index 117 <-- Utilize the objid from
the FED command


EOS Choice 0x75, Number of paths: 2
  Next Object Type: OBJ_ADJ_DROP,OBJ_LABEL
  Next Object Index: 0,0x74
  aom id: 612, CPP handle: 0xdeadbeef (created), flags: 0

C9300-PE-1#show platform software object-manager switch active f0 object 612 <-- Use the aom id
from previous command
Object identifier: 612
  Description: EOS Choice 0x75
  Status: Done, Epoch: 0, Client data: 0xe05e9318

C9300-PE-1#show platform software object-manager switch active f0 object 612 parents <-- Use the
aom id from previous command
Object identifier: 7
  Description: Special Object adj_drop
  Status: Done

Object identifier: 611
```

```
  Description: label 0x74
  Status: Done


***FED VPNv4 Label Programming***
C9300-PE-1#show platform software fed switch active mpls forwarding label 21 detail
 LENTRY:label:21 nobj:(EOS, 117) lentry_hdl:0x8b000009
   modify_cnt:0 backwalk_cnt:0
   lspa_handle:0
   AAL: id:2332033033 lbl:21
        eos0:[adj_hdl:0, hw_hdl:0x7fbae8d87428]
        eos1:[adj_hdl:0x4300003b, hw_hdl:0x7fbae8d87278]
        deagg_vrf_id = 0 lspa_handle:0
   EOS:objid:117 local_label:0 flags:0:() pdflags:0 <-- Utilized in previous commands
      nobj0:(ADJ SPECIAL,DROP 0), nobj1:(LABEL, 116) modify:0 bwalk:0
      LABEL:objid:116 link_type:IP local_label:21 outlabel:(1048577, 0)
          flags:0xc:(UHP,POP,) pdflags:0x2:(INSTALL_HW_OK,) adj_handle:0x4300003b
          unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
          bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
          AAL: id:1124073531 lbl:0 smac:a0f8.4911.d1e4 dmac:0072.78c8.06e4
              sub_type:0 link_type:0 adj_flags:0x2 label_type:1 rewrite_type:POP2IP(135)
              vlan_id:0 vrf_id:0 ri:0x7fbae8d811b8, ri_id:0x3e phdl:0xf1000024, ref_cnt:1
              si:0x7fbae8d72078, si_id:0x4012, di_id:0x5338
      ADJ:objid:58 {link_type:IP ifnum:0x35, si:0x1900001b, IPv4:        10.0.0.1 }
```

Vérification des étiquettes VPNv4 C9300-PE-2

Vérifiez le préfixe local sur le PE, pas le préfixe distant. Vérifiez l'étiquette d'un point de vue FED, puis revenez à FMAN RP et FMAN FP.

```
C9300-PE-2#show ip cef vrf RED 192.168.2.0/24 detail
192.168.2.0/24, epoch 0
  QOS: Precedence routine (0)
  dflt local label info: other/21 [0x2] <-- VPNv4 label associated with the local prefix
  nexthop 10.0.0.22 GigabitEthernet2/0/1

C9300-PE-2#show platform software mpls switch active r0 eos index 118 <-- Utilize the objid
value from the FED command


EOS Choice 0x76, Number of paths: 2
  Next Object Type: OBJ_ADJ_DROP,OBJ_LABEL
  Next Object Index: 0,0x75
  OM handle: 0x34806402d0


C9300-PE-2#show platform software mpls switch active f0 eos index 118 <-- Utilize the objid
value from the FED command


EOS Choice 0x76, Number of paths: 2
  Next Object Type: OBJ_ADJ_DROP,OBJ_LABEL
  Next Object Index: 0,0x75
  aom id: 589, CPP handle: 0xdeadbeef (created), flags: 0

C9300-PE-2#show platform software object-manager switch active f0 object 589 <-- Utilize the aom
id from the previous command
Object identifier: 589
  Description: EOS Choice 0x76
  Status: Done, Epoch: 0, Client data: 0x248cac8


C9300-PE-2#show platform software object-manager switch active f0 object 589 parents <-- Utilize
```

```
the aom id from the previous command
Object identifier: 7
  Description: Special Object adj_drop
  Status: Done

Object identifier: 588
  Description: label 0x75
  Status: Done

C9300-PE-2#show platform software fed switch active mpls forwarding label 21 detail
 LENTRY:label:21 nobj:(EOS, 118) lentry_hdl:0x63000009
   modify_cnt:0 backwalk_cnt:0
   lspa_handle:0
   AAL: id:1660944393 lbl:21
        eos0:[adj_hdl:0, hw_hdl:0x7f0650a40408]
        eos1:[adj_hdl:0xcb00003a, hw_hdl:0x7f0650a401f8]
        deagg_vrf_id = 0 lspa_handle:0
   EOS:objid:118 local_label:0 flags:0:() pdflags:0
      nobj0:(ADJ SPECIAL,DROP 0), nobj1:(LABEL, 117) modify:0 bwalk:0
      LABEL:objid:117 link_type:IP local_label:21 outlabel:(1048577, 0)
           flags:0xc:(UHP,POP,) pdflags:0x2:(INSTALL_HW_OK,) adj_handle:0xcb00003a
           unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
           bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
           AAL: id:3405774906 lbl:0 smac:70d3.79be.ae42 dmac:0072.78c8.c9c2
                sub_type:0 link_type:0 adj_flags:0x2 label_type:1 rewrite_type:POP2IP(135)
                vlan_id:0 vrf_id:0 ri:0x7f0650a3f2a8, ri_id:0x48 phdl:0xf1000024, ref_cnt:1
                si:0x7f0650a3d5e8, si_id:0x400a, di_id:0x5338
      ADJ:objid:58 {link_type:IP ifnum:0x35, si:0x9700001b, IPv4:        10.0.0.22 }
```

Programmation des étiquettes LDP

La section suivante traite de la programmation d'étiquettes LDP sur les routeurs MPLS, C9300-PE-1, C9500-P et C9300-PE-2.

L'étiquette LDP (externe) correspond à l'étiquette réseau MPLS sur laquelle bascule les paquets. Validez l'étiquette LDP locale qui est annoncée au périphérique PE distant, ne validez pas l'étiquette LDP distante.

C9300-PE-1 LDP Label Programming :

Validez l'étiquette LDP locale qui est annoncée au périphérique PE distant, ne validez pas l'étiquette LDP distante. Vérifiez l'étiquette d'un point de vue FED, puis revenez à FMAN RP et FMAN FP.

```
***Software LDP Label Programming***
C9300-PE-1#show mpls forwarding-table
Local      Outgoing    Prefix          Bytes Label   Outgoing    Next Hop
Label      Label       or Tunnel Id    Switched      interface
16         Pop Label   192.168.1.3/32  0             Gi1/0/2     10.0.0.6
           Pop Label   192.168.1.3/32  0             Gi1/0/3     10.0.0.10
17         Pop Label   10.0.0.16/30    0             Gi1/0/2     10.0.0.6
           Pop Label   10.0.0.16/30    0             Gi1/0/3     10.0.0.10
18         Pop Label   10.0.0.12/30    0             Gi1/0/2     10.0.0.6
           Pop Label   10.0.0.12/30    0             Gi1/0/3     10.0.0.10
19         17          192.168.1.4/32  0             Gi1/0/2     10.0.0.6     <-- LDP label 19 is
advertised to reach PE 192.168.1.4
           17          192.168.1.4/32  0             Gi1/0/3     10.0.0.10
20         No Label    10.0.0.0/30[V]  630           aggregate/RED
```

```
21          No Label   192.168.3.0/24[V]   \
                                    0              Gi1/0/1    10.0.0.1

***FMAN RP LDP Label Programming***
C9300-PE-1#show platform software mpls switch active r0 label index 110 <-- Use the objid value
from the FED commands


Label OCE 0x6e -> OBJ_ADJACENCY (0x4b)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x11
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x34806420d0


C9300-PE-1#show platform software mpls switch active r0 label index 111 <-- Use the objid value
from the FED commands


Label OCE 0x6f -> OBJ_ADJACENCY (0x4e)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x11
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x3480642268

***FMAN FP LDP Label Programming***
C9300-PE-1#show platform software mpls switch active f0 label index 110 <-- Use the objid value
from the FED commands


Label OCE 0x6e -> OBJ_ADJACENCY (0x4b)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x11
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 598, CPP handle: 0xdeadbeef (created)


C9300-PE-1#show platform software mpls switch active f0 label index 111 <-- Use the objid value
from the FED commands


Label OCE 0x6f -> OBJ_ADJACENCY (0x4e)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x11
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 599, CPP handle: 0xdeadbeef (created)

C9300-PE-1#show platform software object-manager switch active f0 object 598 <-- Utilize the aom
id from previous commands
Object identifier: 598
  Description: label 0x6e
  Status: Done, Epoch: 0, Client data: 0xe05e6d78

C9300-PE-1#show platform software object-manager switch active f0 object 598 parents <-- Utilize
the aom id from previous commands
Object identifier: 531
  Description: adj 0x4b, Flags None
  Status: Done

C9300-PE-1#show platform software object-manager switch active f0 object 599 <-- Utilize the aom
id from previous commands
Object identifier: 599
  Description: label 0x6f
  Status: Done, Epoch: 0, Client data: 0xe05e6f78
```

```
C9300-PE-1#show platform software object-manager switch active f0 object 599 parents <-- Utilize
the aom id from previous commands
Object identifier: 535
  Description: adj 0x4e, Flags None
  Status: Done


C9300-PE-1#show platform software fed switch active mpls forwarding label 19 detail
 LENTRY:label:19 nobj:(LB, 112) lentry_hdl:0x9000007
   modify_cnt:1 backwalk_cnt:0
   lspa_handle:0
   AAL: id:150994951 lbl:19
        eos0:[adj_hdl:0x7d000002, hw_hdl:0x7fbae8d778b8]
        eos1:[adj_hdl:0x7d000002, hw_hdl:0x7fbae8d776a8]
        deagg_vrf_id = 0 lspa_handle:0
   LB:obj_id:112 link_type:IP num_choices:2 Flags:0
        mpls_ecr:1 local_label:19 path_inhw:2 ecrh:0x7d000002 old_ecrh:0
        modify_cnt:0 bwalk_cnt:0 subwalk_cnt:0 finish_cnt:0
        bwalk:[req:0 in_prog:0 nested:0]
     AAL: ecr:id:2097152002 af:0 ecr_type:0 ref:7 ecrh:0x7fbae8a99268(28:2)
     hwhdl:3903427176 ::0x7fbae8a98b98,0x7fbae8a9ad48,0x7fbae8a98b98,0x7fbae8a9ad48
   Sw Enh ECR scale: objid:112 llabel:19 eos:1 #adjs:2 mixed_adj:0
     reprogram_hw:0 ecrhdl:0x7d000002 ecr_hwhdl:0x7fbae8a99268
     mod_cnt:0 prev_npath:0 pmismatch:0 pordermatch:0
     ecr_adj: id:4278190135 is_mpls_adj:1 l3adj_flags:0x100000
       recirc_adj_id:1744830509
           sih:0x7fbae8a98b98(179) di_id:20499 rih:0x7fbae8a985d8(33)
       adj_lentry [eos0:0x7fbae8d7bf48 eos1:0x7fbae8d76e88]
     ecr_adj: id:1392508984 is_mpls_adj:1 l3adj_flags:0x100000
       recirc_adj_id:2013265966
           sih:0x7fbae8a9ad48(180) di_id:20499 rih:0x7fbae8a9a788(46)
       adj_lentry [eos0:0x7fbae8d7c1b8 eos1:0x7fbae8d77158]
     ecr_prefix_adj: id:2164260921 (ref:1)
         sih:0x7fbae8d7df08(181) di_id:20499 rih:0x7fbae8d7db98(68)
     LABEL:objid:110 link_type:MPLS local_label:19 outlabel:(17, 0) <-- Used in previous
commands
         flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0xff000037
         unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
         bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
         AAL: id:4278190135 lbl:0 smac:a0f8.4911.d1d6 dmac:d4ad.71b5.dde4
             sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
             vlan_id:0 vrf_id:0 ri:0x7fbae8d78c48, ri_id:0x40 phdl:0x9f00004b, ref_cnt:1
             si:0x7fbae8d78fd8, si_id:0x4013, di_id:0x535f
     ADJ:objid:75 {link_type:MPLS ifnum:0x36, si:0x22000023, }
     LABEL:objid:111 link_type:MPLS local_label:19 outlabel:(17, 0) <-- Used in previous
commands
         flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0x53000038
         unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
         bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
         AAL: id:1392508984 lbl:0 smac:a0f8.4911.d1d8 dmac:d4ad.71b5.ddc2
             sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
             vlan_id:0 vrf_id:0 ri:0x7fbae8d7d0a8, ri_id:0x42 phdl:0x8400004c, ref_cnt:1
             si:0x7fbae8d7a908, si_id:0x4014, di_id:0x5360
     ADJ:objid:78 {link_type:MPLS ifnum:0x37, si:0x74000026, }
```

C9500-P LDP Label Programming :

Validez l'étiquette LDP locale qui est annoncée au périphérique PE distant, ne validez pas
l'étiquette LDP distante. Vérifiez l'étiquette d'un point de vue FED, puis revenez à FMAN RP et
FMAN FP.


```
***Software LDP Label Programming***
```

```
C9500-P#show mpls forwarding-table
Local      Outgoing   Prefix          Bytes Label   Outgoing    Next Hop
Label      Label      or Tunnel Id    Switched      interface
16         explicit-n 192.168.1.2/32  1240          Te1/0/1     10.0.0.5  <-- LDP Label 16
advertised to reach PE 192.168.1.2
           explicit-n 192.168.1.2/32  226537        Te2/0/1     10.0.0.9
17         explicit-n 192.168.1.4/32  610           Te1/0/2     10.0.0.14 <-- LDP LAbel 17
advertised to reach PE 192.168.1.4
           explicit-n 192.168.1.4/32  227592        Te2/0/2     10.0.0.18

***FMAN RP LDP Label Programming***
C9500-P#show platform software mpls switch active r0 label index 94


Label OCE 0x5e -> OBJ_ADJACENCY (0x3f)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x348064c530

C9500-P#show platform software mpls switch active r0 label index 95


Label OCE 0x5f -> OBJ_ADJACENCY (0x44)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x348064c6c8

C9500-P#show platform software mpls switch active r0 label index 104


Label OCE 0x68 -> OBJ_ADJACENCY (0x49)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x348064df70

C9500-P#show platform software mpls switch active r0 label index 105


Label OCE 0x69 -> OBJ_ADJACENCY (0x4e)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x348064e108

***FMAN FP LDP Label Programming***
C9500-P#show platform software mpls switch active f0 label index 94


Label OCE 0x5e -> OBJ_ADJACENCY (0x3f)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 564, CPP handle: 0xdeadbeef (created)

C9500-P#show platform software mpls switch active f0 label index 95


Label OCE 0x5f -> OBJ_ADJACENCY (0x44)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
```

```
  aom id: 565, CPP handle: 0xdeadbeef (created)

C9500-P#show platform software mpls switch active f0 label index 104


Label OCE 0x68 -> OBJ_ADJACENCY (0x49)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 576, CPP handle: 0xdeadbeef (created)

C9500-P#show platform software mpls switch active f0 label index 105


Label OCE 0x69 -> OBJ_ADJACENCY (0x4e)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 577, CPP handle: 0xdeadbeef (created)


C9500-P#show platform software object-manager switch active f0 object 564
Object identifier: 564
  Description: label 0x5e
  Status: Done, Epoch: 0, Client data: 0x4f737108


C9500-P#show platform software object-manager switch active f0 object 564 parents
Object identifier: 515
  Description: adj 0x3f, Flags None
  Status: Done

C9500-P#show platform software object-manager switch active f0 object 565
Object identifier: 565
  Description: label 0x5f
  Status: Done, Epoch: 0, Client data: 0x4f737448


C9500-P#show platform software object-manager switch active f0 object 565 parents
Object identifier: 525
  Description: adj 0x44, Flags None
  Status: Done

C9500-P#show platform software object-manager switch active f0 object 576
Object identifier: 576
  Description: label 0x68
  Status: Done, Epoch: 0, Client data: 0x4f6d4bf8

C9500-P#show platform software object-manager switch active f0 object 576 parents
Object identifier: 536
  Description: adj 0x49, Flags None
  Status: Done

C9500-P#show platform software object-manager switch active f0 object 577
Object identifier: 577
  Description: label 0x69
  Status: Done, Epoch: 0, Client data: 0x4f737f78


C9500-P#show platform software object-manager switch active f0 object 577 parents
Object identifier: 545
  Description: adj 0x4e, Flags None
  Status: Done
```

```
***FED LDP Label Programming***
C9500-P#show platform software fed switch active mpls forwarding label 16 detail
 LENTRY:label:16 nobj:(LB, 96) lentry_hdl:0xeb000004
   modify_cnt:2 backwalk_cnt:0
   lspa_handle:0
   AAL: id:3942645764 lbl:16
        eos0:[adj_hdl:0x44000002, hw_hdl:0x7f0b284b4d98]
        eos1:[adj_hdl:0x44000002, hw_hdl:0x7f0b284b4be8]
        deagg_vrf_id = 0 lspa_handle:0
   LB:obj_id:96 link_type:IP num_choices:2 Flags:0
       mpls_ecr:1 local_label:16 path_inhw:2 ecrh:0x44000002 old_ecrh:0
       modify_cnt:0 bwalk_cnt:0 subwalk_cnt:0 finish_cnt:0
       bwalk:[req:0 in_prog:0 nested:0]
     AAL: ecr:id:1140850690 af:0 ecr_type:0 ref:2 ecrh:0x7f0b284a3998(28:2)
     hwhdl:675953048 ::0x7f0b284b4268,0x7f0b284a1d78,0x7f0b284b4268,0x7f0b284a1d78
   Sw Enh ECR scale: objid:96 llabel:16 eos:1 #adjs:2 mixed_adj:0
     reprogram_hw:0 ecrhdl:0x44000002 ecr_hwhdl:0x7f0b284a3998
     mod_cnt:0 prev_npath:0 pmismatch:0 pordermatch:0
     ecr_adj: id:1610612787 is_mpls_adj:1 l3adj_flags:0x100000
       recirc_adj_id:1207959601
          sih:0x7f0b284b4268(181) di_id:23709 rih:0x7f0b284b3ca8(31)
       adj_lentry [eos0:0x7f0b284a32d8 eos1:0x7f0b284a3cc8]
     ecr_adj: id:805306420 is_mpls_adj:1 l3adj_flags:0x100000
       recirc_adj_id:67108914
          sih:0x7f0b284a1d78(182) di_id:23709 rih:0x7f0b284b47d8(44)
       adj_lentry [eos0:0x7f0b284c1608 eos1:0x7f0b284a2138]
     ecr_prefix_adj: id:3976200245 (ref:1)
        sih:0x7f0b284c2bf8(183) di_id:23709 rih:0x7f0b284c2888(50)
     LABEL:objid:94 link_type:MPLS local_label:16 outlabel:(0, 0)
         flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0x60000033
         unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
         bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
         AAL: id:1610612787 lbl:0 smac:d4ad.71b5.dde4 dmac:a0f8.4911.d1d6
             sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
             vlan_id:0 vrf_id:0 ri:0x7f0b284a2cd8, ri_id:0x2e phdl:0xe9000057, ref_cnt:1
             si:0x7f0b284a3048, si_id:0x4009, di_id:0x1
     ADJ:objid:63 {link_type:MPLS ifnum:0x41, si:0x2d000023, }
     LABEL:objid:95 link_type:MPLS local_label:16 outlabel:(0, 0)
         flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0x30000034
         unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
         bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
         AAL: id:805306420 lbl:0 smac:d4ad.71b5.ddc2 dmac:a0f8.4911.d1d8
             sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
             vlan_id:0 vrf_id:0 ri:0x7f0b284a57c8, ri_id:0x30 phdl:0x67000059, ref_cnt:1
             si:0x7f0b284a6008, si_id:0x400a, di_id:0x61
     ADJ:objid:68 {link_type:MPLS ifnum:0x43, si:0xef000026, }

C9500-P#show platform software fed switch active mpls forwarding label 17 detail
 LENTRY:label:17 nobj:(LB, 106) lentry_hdl:0xf6000005
   modify_cnt:1 backwalk_cnt:0
   lspa_handle:0
   AAL: id:4127195141 lbl:17
        eos0:[adj_hdl:0x44000002, hw_hdl:0x7f0b284ce2f8]
        eos1:[adj_hdl:0x44000002, hw_hdl:0x7f0b284ce0e8]
        deagg_vrf_id = 0 lspa_handle:0
   LB:obj_id:106 link_type:IP num_choices:2 Flags:0
       mpls_ecr:1 local_label:17 path_inhw:2 ecrh:0x44000002 old_ecrh:0
       modify_cnt:0 bwalk_cnt:0 subwalk_cnt:0 finish_cnt:0
       bwalk:[req:0 in_prog:0 nested:0]
     AAL: ecr:id:1140850690 af:0 ecr_type:0 ref:2 ecrh:0x7f0b284a3998(28:2)
     hwhdl:675953048 ::0x7f0b284b4268,0x7f0b284a1d78,0x7f0b284b4268,0x7f0b284a1d78
   Sw Enh ECR scale: objid:106 llabel:17 eos:1 #adjs:2 mixed_adj:0
     reprogram_hw:0 ecrhdl:0x44000002 ecr_hwhdl:0x7f0b284a3998
     mod_cnt:0 prev_npath:0 pmismatch:0 pordermatch:0
```

```
      ecr_adj: id:4127195192 is_mpls_adj:1 l3adj_flags:0x100000
        recirc_adj_id:1207959601
            sih:0x7f0b284b4268(181) di_id:23709 rih:0x7f0b284b3ca8(31)
        adj_lentry [eos0:0x7f0b284c38e8 eos1:0x7f0b284cd858]
      ecr_adj: id:1157627961 is_mpls_adj:1 l3adj_flags:0x100000
        recirc_adj_id:67108914
            sih:0x7f0b284a1d78(182) di_id:23709 rih:0x7f0b284b47d8(44)
        adj_lentry [eos0:0x7f0b284c3af8 eos1:0x7f0b284cdb28]
      ecr_prefix_adj: id:3707764794 (ref:1)
         sih:0x7f0b284c5028(184) di_id:23709 rih:0x7f0b284c4c48(60)
    LABEL:objid:104 link_type:MPLS local_label:17 outlabel:(0, 0)
        flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0xf6000038
        unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
        bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
        AAL: id:4127195192 lbl:0 smac:d4ad.71b5.ddd6 dmac:70d3.79be.ae71
            sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
            vlan_id:0 vrf_id:0 ri:0x7f0b284ceaa8, ri_id:0x38 phdl:0x76000058, ref_cnt:1
            si:0x7f0b284ceeb8, si_id:0x400b, di_id:0x2
    ADJ:objid:73 {link_type:MPLS ifnum:0x42, si:0x1f000028, }
    LABEL:objid:105 link_type:MPLS local_label:17 outlabel:(0, 0)
        flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0x45000039
        unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
        bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
        AAL: id:1157627961 lbl:0 smac:d4ad.71b5.ddf1 dmac:70d3.79be.ae61
            sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
            vlan_id:0 vrf_id:0 ri:0x7f0b284c4588, ri_id:0x3a phdl:0x5500005a, ref_cnt:1
            si:0x7f0b284d0548, si_id:0x400c, di_id:0x62
    ADJ:objid:78 {link_type:MPLS ifnum:0x44, si:0x4900002a, }
```

C9300-PE-2 LDP Label Programming :

Validez l'étiquette LDP locale qui est annoncée au périphérique PE distant, ne validez pas l'étiquette LDP distante. Commencez par vérifier l'étiquette d'un point de vue FED, puis revenez à FMAN RP et FMAN FP.

```
***Software LDP Label Programming***
C9300-PE-2#show mpls forwarding-table
Local      Outgoing   Prefix           Bytes Label   Outgoing    Next Hop
Label      Label      or Tunnel Id     Switched      interface
16         Pop Label  192.168.1.3/32   0             Gi2/0/2     10.0.0.13
           Pop Label  192.168.1.3/32   0             Gi2/0/3     10.0.0.17
17         16         192.168.1.2/32   0             Gi2/0/2     10.0.0.13 <-- LDP Label 17 is
advertised to Remote PE 192.168.1.2
           16         192.168.1.2/32   0             Gi2/0/3     10.0.0.17
18         Pop Label  10.0.0.4/30      0             Gi2/0/2     10.0.0.13
           Pop Label  10.0.0.4/30      0             Gi2/0/3     10.0.0.17
19         Pop Label  10.0.0.8/30      0             Gi2/0/2     10.0.0.13
           Pop Label  10.0.0.8/30      0             Gi2/0/3     10.0.0.17
20         No Label   10.0.0.20/30[V]  630           aggregate/RED
21         No Label   192.168.2.0/24[V]  \
                                        0             Gi2/0/1     10.0.0.22


***FMAN RP Label Programming***
C9300-PE-2#show platform software mpls switch active r0 label index 106 <-- Use the objid values
from the FED commands


Label OCE 0x6a -> OBJ_ADJACENCY (0x4b)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x10
  Backup flags: Pop, UHP, backup label 0x100001
```

```
    OM handle: 0x3480637358


C9300-PE-2#show platform software mpls switch active r0 label index 107 <-- Use the objid values
from the FED commands


Label OCE 0x6b -> OBJ_ADJACENCY (0x4e)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x10
  Backup flags: Pop, UHP, backup label 0x100001
  OM handle: 0x3480638c10

***FMAN FP LDP Label Programming***
C9300-PE-2#show platform software mpls switch active f0 label index 106


Label OCE 0x6a -> OBJ_ADJACENCY (0x4b)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x10
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 548, CPP handle: 0xdeadbeef (created)

C9300-PE-2#show platform software mpls switch active f0 label index 107


Label OCE 0x6b -> OBJ_ADJACENCY (0x4e)
  Flags: Real, Number of labels in the OCE: 1
  Label values: 0x10
  Backup flags: Pop, UHP, backup label 0x100001
  aom id: 549, CPP handle: 0xdeadbeef (created)

C9300-PE-2#show platform software object-manager switch active f0 object 548 <-- Use the aom id
value from the previous commands
Object identifier: 548
  Description: label 0x6a
  Status: Done, Epoch: 0, Client data: 0x24843d8


C9300-PE-2#show platform software object-manager switch active f0 object 548 parents <-- Use the
aom id value from the previous commands
Object identifier: 509
  Description: adj 0x4b, Flags None
  Status: Done

C9300-PE-2#show platform software object-manager switch active f0 object 549 <-- Use the aom id
value from the previous commands
Object identifier: 549
  Description: label 0x6b
  Status: Done, Epoch: 0, Client data: 0x2484518

C9300-PE-2#show platform software object-manager switch active f0 object 549 parents <-- Use the
aom id value from the previous commands
Object identifier: 513
  Description: adj 0x4e, Flags None
  Status: Done


***FED LDP Label Programming***
C9300-PE-2#show platform software fed switch active mpls forwarding label 17 detail
 LENTRY:label:17 nobj:(LB, 108) lentry_hdl:0x64000005
   modify_cnt:1 backwalk_cnt:0
   lspa_handle:0
   AAL: id:1677721605 lbl:17
        eos0:[adj_hdl:0xa0000002, hw_hdl:0x7f0650a5c8e8]
        eos1:[adj_hdl:0xa0000002, hw_hdl:0x7f0650a5b908]
```

```
        deagg_vrf_id = 0 lspa_handle:0
   LB:obj_id:108 link_type:IP num_choices:2 Flags:0
      mpls_ecr:1 local_label:17 path_inhw:2 ecrh:0xa0000002 old_ecrh:0
      modify_cnt:0 bwalk_cnt:0 subwalk_cnt:0 finish_cnt:0
      bwalk:[req:0 in_prog:0 nested:0]
    AAL: ecr:id:2684354562 af:0 ecr_type:0 ref:7 ecrh:0x7f0650a62888(28:2)
    hwhdl:1353066632 ::0x7f0650a60998,0x7f0650a630d8,0x7f0650a60998,0x7f0650a630d8
   Sw Enh ECR scale: objid:108 llabel:17 eos:1 #adjs:2 mixed_adj:0
      reprogram_hw:0 ecrhdl:0xa0000002 ecr_hwhdl:0x7f0650a62888
      mod_cnt:0 prev_npath:0 pmismatch:0 pordermatch:0
      ecr_adj: id:436207667 is_mpls_adj:1 l3adj_flags:0x100000
        recirc_adj_id:2113929262
            sih:0x7f0650a60998(178) di_id:20507 rih:0x7f0650a60378(50)
        adj_lentry [eos0:0x7f0650a877d8 eos1:0x7f0650a1cf78]
      ecr_adj: id:3976200246 is_mpls_adj:1 l3adj_flags:0x100000
        recirc_adj_id:1509949487
            sih:0x7f0650a630d8(179) di_id:20507 rih:0x7f0650a62b18(51)
        adj_lentry [eos0:0x7f0650a87a48 eos1:0x7f0650a1d188]
      ecr_prefix_adj: id:2919235640 (ref:1)
        sih:0x7f0650a87558(180) di_id:20507 rih:0x7f0650a871d8(68)
    LABEL:objid:106 link_type:MPLS local_label:17 outlabel:(16, 0) <-- Used in previous
commands
          flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0x1a000033
          unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
          bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
          AAL: id:436207667 lbl:0 smac:70d3.79be.ae71 dmac:d4ad.71b5.ddd6
              sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
              vlan_id:0 vrf_id:0 ri:0x7f0650a67d48, ri_id:0x3a phdl:0x9f00004b, ref_cnt:1
              si:0x7f0650a65408, si_id:0x4010, di_id:0x535f
    ADJ:objid:75 {link_type:MPLS ifnum:0x36, si:0x35000023, }
    LABEL:objid:107 link_type:MPLS local_label:17 outlabel:(16, 0) <-- Used in previous
commands
          flags:0x1:(REAL,) pdflags:0:(INSTALL_HW_OK,) adj_handle:0xed000036
          unsupported recursion:0 olbl_changed 0 local_adj:0 modify_cnt:0
          bwalk_cnt:0 subwalk_cnt:0 collapsed_oce:0
          AAL: id:3976200246 lbl:0 smac:70d3.79be.ae61 dmac:d4ad.71b5.ddf1
              sub_type:0 link_type:2 adj_flags:0 label_type:2 rewrite_type:PSH1(119)
              vlan_id:0 vrf_id:0 ri:0x7f0650a6f4f8, ri_id:0x40 phdl:0x8400004c, ref_cnt:1
              si:0x7f0650a73088, si_id:0x4013, di_id:0x5360
    ADJ:objid:78 {link_type:MPLS ifnum:0x37, si:0xa2000025, }
```

Dépannage de l'évolutivité matérielle

Cette section fournit des informations que vous pouvez utiliser pour dépanner votre configuration.

Syslogs matériel MPLS

Si vous n'avez plus une ressource particulière, telle que les étiquettes MPLS, le message SYSLOG est généré par le système.

Points importants à retenir

- L'ÉTIQUETTE MPLS est utilisée pour la **disposition des étiquettes.** (Cette ressource est consommée lorsque les préfixes sont appris à partir d'un CE local)
- LSPA est utilisé pour l'**imposition d'étiquettes.** (Cette ressource est utilisée lorsque des préfixes sont appris à partir d'un PE distant)

| Message du journal MPLS | Définition | Action de récupération |

		Effectuez l'une de ces actions réduire le nombre de préfixes [cut] par le **PE local ou distant** :
%FED_L3_ERRMSG-3-RSRC_ERR : Commutateur 1 R0/0 : fed : échec de l'allocation de la ressource matérielle pour l'**entrée fib en raison de l'épuisement des ressources matérielles**	Le matériel réservé aux préfixes IP est à court d'espace (EM ou TCAM)	1. Récapituler les préfixes au [cut] de CE 2. Modifier le mode d'allocation [cut] d'étiquette de par préfixe à par [cut]
%FED_L3_ERRMSG-3-**mpls_out_of_resource** : Commutateur 1 R0/0 : nourri : **Ressource manquante pour l'ENTRÉE DE L'ÉTIQUETTE MPLS**. Échec du programme de l'étiquette locale : 8205 (8192/8192) dans le matériel	**Attribution d'étiquettes locales** : le matériel réservé aux étiquettes locales MPLS est épuisé (EM ou TCAM)	Effectuez l'une de ces actions réduire le nombre de câbles ut[cut] sur le **PE local** : 1. Récapituler les préfixes au [cut] du CE local ou du PE local 2. Modifier le mode d'allocation [cut] d'étiquette de par préfixe à par [cut] sur le PE local
%FED_L3_ERRMSG-3-MPLS_LENTRY_PAUSE : Commutateur 1 R0/0 : nourri : **Limite critique atteinte pour la** ressource **ENTRÉE DE L'ÉTIQUETTE MPLS. La création de la légende a été annulée.**	**Attribution de l'étiquette locale** : Le matériel réservé aux étiquettes locales MPLS est épuisé (EM ou TCAM)	Effectuez l'une de ces actions réduire le nombre de câbles ut[cut] sur le **PE local** : 1. Récapituler les préfixes au [cut] du CE local ou du PE local 2. Modifier le mode d'allocation [cut] d'étiquette de par préfixe à par [cut] sur le PE local
%FED_L3_ERRMSG-3-mpls_out_of_resource : Commutateur 1 R0/0 : nourri : **Ressources insuffisantes pour MPLS LSPA. Échec du programme dans le matériel**	**Attribution d'étiquettes distantes** : le matériel réservé aux étiquettes distantes LSPA est à court d'espace	Effectuez l'une de ces actions réduire le nombre de câbles ut[cut] sur le **PE distant** : 1. Récapituler les préfixes au [cut] du CE ou du PE distant 2. Modifier le mode d'allocation [cut] d'étiquette de par préfixe à par [cut] sur le PE distant

Commandes de validation du matériel

show platform hardware fed active fwd-asic resource tcam utilzationcommand est le premier endroit que vous voulez examiner pour évaluer si vous avez un problème d'échelle matérielle. Il affiche des informations par ASIC.

Cette section présente les préfixes d'apprentissage PE de BGP dans vrf MPLS avec les paramètres décrits ici :

- L'allocation d'étiquette par préfixe par défaut est utilisée
- PE est C9300-48U avec Cisco IOS-XE 17.3.4
- CE est Ixia en tant que voisin BGP qui annonce des préfixes à une interface dans vrf MPLS
- La longueur de préfixe utilisée est /28. Ainsi, la plate-forme utilise TCAM pour les longueurs de préfixe /31 ou plus courtes
- Cette plate-forme utilise d'abord la mémoire EM pour les étiquettes MPLS/BGP, puis déborde vers TCAM si EM devient saturé

Topologie
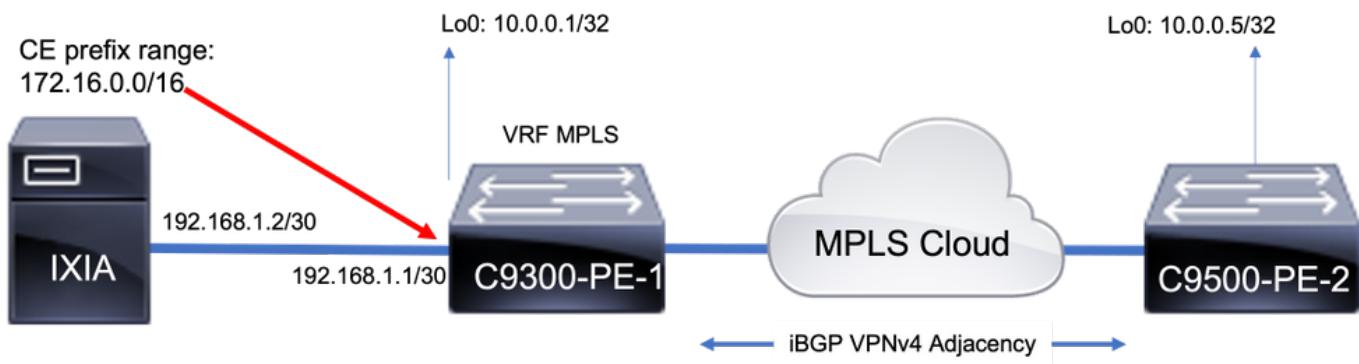
Utilisation des ressources de référence

Avant l'ajout de préfixes, il y a une utilisation de base :

- Cette ligne de base a été prise après la formation des voisins LDP MPLS dans la table globale
- Àpartir de cette ligne de base, les préfixes VPNv4 sont ajoutés dans VRF MPLS
- Vos numéros de référence peuvent varier. Cela dépend de ce qui est déjà programmé sur le commutateur.

Note: Dans cet exemple, les préfixes sont ajoutés d'un côté CE-PE, ce qui entraîne l'allocation de ressources telles que LSPA uniquement sur le PE distant qui doit utiliser une pile d'étiquettes pour l'accessibilité. Dans des scénarios réels, la ressource serait allouée aux deux périphériques PE.

```
C9300-48U#show version | inc IOS
Cisco IOS XE Software, Version 17.03.04
Cisco IOS Software [Amsterdam], Catalyst L3 Switch Software (CAT9K_IOSXE), Version 17.3.4,
RELEASE SOFTWARE (fc3)

C9300-48U#show platform hardware fed switch active fwd-asic resource tcam utilization
Codes: EM - Exact_Match, I - Input, O - Output, IO - Input & Output, NA - Not Applicable

CAM Utilization for ASIC  [0]
 Table                  Subtype      Dir    Max     Used    %Used    V4     V6     MPLS
Other
 -------------------------------------------------------------------------------------
-------
 Mac Address Table      EM           I      32768    20     0.06%    0      0      0
20
 Mac Address Table      TCAM         I       1024    21     2.05%    0      0      0
21
 L3 Multicast           EM           I       8192     0     0.00%    0      0      0
0
 L3 Multicast           TCAM         I        512     9     1.76%    3      6      0
0
 L2 Multicast           EM           I       8192     0     0.00%    0      0      0
0
 L2 Multicast           TCAM         I        512    11     2.15%    3      8      0
0
 IP Route Table         EM           I      24576    23     0.09%    14     0      9
0  <-- 23 EM (hash) base usage
 IP Route Table         TCAM         I       8192    25     0.31%    12     10     2
1  <-- 25 TCAM base usage
```

```
C9300-48U#show platform software fed switch active mpls summary | b Resource shar
Resource sharing info:
SI: 4/65536
RI: 10/65536
Well Known Index: 49/2048
Tcam: 21/57344
lv1_ecr: 0/64
lv2_ecr: 0/256
lspa: 0/16385
label_stack_id: 2/65537
vpn_spoke_id: 0/255
indirect_si: 0/255
RSM resource database stats:
Num of (L3+mpls) ADJ entries allocated: 36/131072
  Num of LABEL entries allocated: 4/8192          <-- Baseline label usage = 4 (label entries
allocated on local PE-CE side)
Num of LSPA entries allocated: 0/8192          <-- LSPA resource used when prefix learnt
from another PE, not from a local CE (The SDM template determines max value)
Num of local adjs in mpls adjs: 3
Num of SI stats allocated: 6/49152
Adjs stats allocated by MPLS:
Num of mpls adjs: 11
Num of L3 adjs: 0
Num of VPN prefix_id: 0
<...snip...>
Other MPLS resource alloc error stats:          <-- reported resource allocation issues
shown here
LENTRY out-of-resource errors: 0
LENTRY general errors: 0
LSPA out-of-resource errors: 0
LSPA general errors: 0
ADJ out-of-resource errors: 0
SI stats alloc error: 0
MPLS ADJ stats error: 0
MPLS ADJ stats last error rc: 0
```

> Remarque : SI/RI/DI sont des ressources requises pour la réécriture des paquets, le port de
> destination, etc. Pour résoudre les problèmes liés à SI/DI/RI, voir l'article Comprendre les
> ressources matérielles sur les commutateurs Catalyst 9000

Ajouter 1 000 préfixes VPNv4 BGP

Neighbor (Ixia) avec 1000 préfixes ajoutés à VRF MPLS à partir de CE

9300 PE local (connecté à CE)

```
C9300-48U#show bgp vpnv4 unicast all summary
BGP router identifier 10.0.0.1, local AS number 65000
<...snip...> Neighbor V AS MsgRcvd MsgSent TblVer InQ OutQ Up/Down State/PfxRcd 10.0.0.5 4 65000
102 304 3001 0 0 01:28:23 0 192.168.1.2    4    65005    102    5    3001    0    0
00:00:58    1000 <-- PE learns 1000 prefixes from CE device
C9300-48U#show bgp vpnv4 unicast all | count /28
Number of lines which match regexp = 1000          <-- All 1000 prefixes are /28
C9300-48U#show platform hardware fed switch active fwd-asic resource tcam utilization
Codes: EM - Exact_Match, I - Input, O - Output, IO - Input & Output, NA - Not Applicable

CAM Utilization for ASIC  [0]
 Table              Subtype    Dir    Max    Used    %Used    V4    V6    MPLS
Other
 --------------------------------------------------------------------------------------------
```

```
-------
 Mac Address Table      EM        I      32768      20     0.06%        0          0          0
20
 Mac Address Table      TCAM      I       1024      21     2.05%        0          0          0
21
 L3 Multicast           EM        I       8192       0     0.00%        0          0          0
0
 L3 Multicast           TCAM      I        512       9     1.76%        3          6          0
0
 L2 Multicast           EM        I       8192       0     0.00%        0          0          0
0
 L2 Multicast           TCAM      I        512      11     2.15%        3          8          0
0
 IP Route Table         EM        I      24576    2023     8.23%       14          0       2009
0
 IP Route Table         TCAM      I       8192    1025    12.51%     1012         10          2
1
```

<-- 25 base + 1000 /28 prefixes = 1025 TCAM entries
<-- MPLS labels are added to EM, and each MPLS label uses 2 entries (one IPv4 prefix, and one
MPLS label results in 3 entries used in hardware)

```
C9300-48U#show platform software fed switch active mpls summary | b Resource shar
  Resource sharing info:
    SI: 4/65536
    RI: 1010/65536
    Well Known Index: 49/2048
    Tcam: 1021/57344
    lv1_ecr: 0/64
    lv2_ecr: 0/256
    lspa: 0/16385
    label_stack_id: 1002/65537
    vpn_spoke_id: 0/255
    indirect_si: 0/255
  RSM resource database stats:
    Num of (L3+mpls) ADJ entries allocated: 1036/131072
    Num of LABEL entries allocated: 1004/8192          <-- Increased by 1000 on local PE
    Num of LSPA entries allocated: 0/8192              <-- No prefixes learnt from remote
PE, no LSPA allocated
    Num of local adjs in mpls adjs: 3
    Num of SI stats allocated: 1006/49152
    Adjs stats allocated by MPLS:
    Num of mpls adjs: 1011
      Num of L3 adjs: 0
    Num of VPN prefix_id: 0
<...snip...>
  Other MPLS resource alloc error stats:  <-- no resource allocation issues
    LENTRY out-of-resource errors: 0
    LENTRY general errors: 0
    LSPA out-of-resource errors: 0
    LSPA general errors: 0
    ADJ out-of-resource errors: 0
    SI stats alloc error: 0
    MPLS ADJ stats error: 0
    MPLS ADJ stats last error rc: 0
```

<-- Resources shown in baseline outputs are now increased by 1000
Périphérique distant 9500H (appris sur MPLS)

```
C9500-24Y4C#show platform hardware fed active fwd-asic resource tcam utilization
Codes: EM - Exact_Match, I - Input, O - Output, IO - Input & Output, NA - Not Applicable
```

```
CAM Utilization for ASIC  [0]
 Table                 Subtype     Dir     Max     Used   %Used      V4      V6    MPLS
Other
 ----------------------------------------------------------------------------------------
-------
 Mac Address Table     EM          I      32768      19   0.06%       0       0       0
19
 Mac Address Table     TCAM        I        768      21   2.73%       0       0       0
21
 L3 Multicast          EM          I      32768       0   0.00%       0       0       0
0
 L3 Multicast          TCAM        I        768       6   0.78%       3       3       0
0
 L2 Multicast          TCAM        I       2304       7   0.30%       3       4       0
0
 IP Route Table        EM/LPM      I     212992    1012   0.48%    1003       0       9
0
 IP Route Table        TCAM        I       1536      28   1.82%      23       3       2
0
CTS Cell Matrix/VPN
Label                  EM          O      32768     992   3.03%       0       0     992
0   <-- MPLS VPN used 992 entries
CTS Cell Matrix/VPN
Label TCAM O 768 9 1.17% 0 0 8 1


<-- 1000 /28 IPv4 prefixes learned from remote PE (On the 9500HP these /28 prefixes are be
stored in EM/LPM memory, not TCAM)
<-- Hardware shared between CTS and VPN (resource is used when prefixes learned PE-PE, label
imposition)
C9500-24Y4C#show platform software fed active mpls summary | b Resource shar
  Resource sharing info:
    SI: 4/131072
    RI: 11/98304
    Well Known Index: 48/2048
    Tcam: 20/245760
    lv1_ecr: 0/64
    lv2_ecr: 0/256
    lspa: 1000/65536
    label_stack_id: 2/65537
    vpn_spoke_id: 0/255
    indirect_si: 0/255
  RSM resource database stats:
    Num of (L3+mpls) ADJ entries allocated: 37/196608
    Num of LABEL entries allocated: 4/45056            <-- LABEL does not increase (no
prefixes learnt from a local CE)
    Num of LSPA entries allocated: 1000/32768          <-- LSPA usage increased by 1000
(these prefixes require label stack to reach)
    Num of local adjs in mpls adjs: 4
    Num of SI stats allocated: 6/49152
    Adjs stats allocated by MPLS:
      Num of mpls adjs: 12
      Num of L3 adjs: 0
    Num of VPN prefix_id: 1000
  AL MPLS SI/RI resource alloc stats:
    SI allocated: 1
    RI allocated: 6
    SI_STATS allocated: 6
    Unknowns allocs: 0
    Alloc no resource: 0
    Alloc errors: 0
    Free errors: 0
    Invalid free: 0
    Free unknown: 0
  Other MPLS resource alloc error stats:              <-- no resource allocation issues
```

```
    LENTRY out-of-resource errors: 0
    LENTRY general errors: 0
    LSPA out-of-resource errors: 0
    LSPA general errors: 0
    ADJ out-of-resource errors: 0
    SI stats alloc error: 0
    MPLS ADJ stats error: 0
    MPLS ADJ stats last error rc: 0
```

<-- Different resources are allocated to reach a local prefix (LABEL) versus a remote prefix (LSPA)

> **Note**: Pour obtenir des informations générales sur la TCAM du Catalyst 9000 ou des détails sur la vérification de la TCAM pour d'autres fonctionnalités, reportez-vous à l'article [Comprendre les ressources matérielles sur les commutateurs Catalyst 9000.](#)

> **Note**: ADJ (contiguïtés) est une ressource partagée. Pour résoudre des problèmes avec ADJ, voir l'article [Comprendre les ressources matérielles sur les commutateurs Catalyst 9000.](#)

Étiquette MPLS et limites d'évolutivité et correction IPv4

Dans la plupart des cas, lorsque la fonctionnalité MPLS est utilisée et que trop de ressources matérielles sont utilisées, une modification de l'allocation d'étiquette (par défaut) par préfixe à par VRF peut être utile. Dans cet exemple, considérez l'allocation de ressources avant et après (**dans ce cas, le 9500 est le périphérique CE-PE**).

```
### Usage with per-prefix label allocation ###

C9500-24Y4C#show platform hardware fed active fwd-asic resource tcam utilization
Codes: EM - Exact_Match, I - Input, O - Output, IO - Input & Output, NA - Not Applicable

CAM Utilization for ASIC  [0]
 Table                    Subtype        Dir     Max     Used     %Used      V4        V6       MPLS
Other
 ------------------------------------------------------------------------------------------------
-------
 Mac Address Table        EM             I       32768      19     0.06%       0         0          0
19
 Mac Address Table        TCAM           I         768      21     2.73%       0         0          0
21
 L3 Multicast             EM             I       32768       0     0.00%       0         0          0
0
 L3 Multicast             TCAM           I         768       6     0.78%       3         3          0
0
 L2 Multicast             TCAM           I        2304       7     0.30%       3         4          0
0
 IP Route Table           EM/LPM         I      212992    3023     1.42%    1014         0       2009
0  <-- 1 IPv4 prefix entry + 2 entries for labels (2 labels created per every 1 IPv4 prefix)
 IP Route Table           TCAM           I        1536      17     1.11%      12         3          2
0


### New usage after change to per-vrf lable allocation ###
C9500-24Y4C(config)#mpls label mode vrf MPLS protocol all-afs per-vrf
C9500-24Y4C#show bgp vpnv4 unicast all BGP table version is 164901, local router ID is 10.0.0.5
```

```
       Network          Next Hop          Metric LocPrf Weight Path
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
              t secondary path, L long-lived-stale,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found
Network Next Hop Metric LocPrf Weight Path
Route Distinguisher: 1:1 (default for vrf MPLS) *>   172.30.0.0/24    192.168.3.2           2219
0 65100 65101 65102 65103 {65104} e
<...snip...>


C9500-24Y4C#show bgp vpnv4 unicast all 172.30.0.0
BGP routing table entry for 1:1:172.30.0.0/24, version 163902
Paths: (1 available, best #1, table MPLS)
  Advertised to update-groups:
     8
  Refresh Epoch 1
  65100 65101 65102 65103 {65104}
    192.168.3.2 (via vrf MPLS) from 192.168.3.2 (192.168.3.2)
      Origin EGP, metric 2219, localpref 100, valid, external, best
      Extended Community: RT:1:1
      mpls labels in/out IPv4 VRF Aggr:18116/nolabel    <-- Verify you see a 'VRF Aggr' label
type
      rx pathid: 0, tx pathid: 0x0
      Updated on Dec 9 2021 19:50:22 UTC



### Usage with per-vrf label allocation ###
Allocation on both local and remote PE is dramatically reduced via change to label allocation
mode


local switch (PE-CE)
C9500-24Y4C#show platform hardware fed active fwd-asic resource tcam utilization
Codes: EM - Exact_Match, I - Input, O - Output, IO - Input & Output, NA - Not Applicable

CAM Utilization for ASIC  [0]
 Table              Subtype     Dir     Max     Used    %Used     V4      V6     MPLS
Other
 ------------------------------------------------------------------------------------------
-------
 Mac Address Table  EM          I       32768      19    0.06%      0       0        0
19
 Mac Address Table  TCAM        I         768      21    2.73%      0       0        0
21
 L3 Multicast       EM          I       32768       0    0.00%      0       0        0
0
 L3 Multicast       TCAM        I         768       6    0.78%      3       3        0
0
 L2 Multicast       TCAM        I        2304       7    0.30%      3       4        0
0
 IP Route Table     EM/LPM      I      212992    1025    0.48%   1014       0       11
0  <-- one local LABEL used to reach the CE learnt prefixes
 IP Route Table     TCAM        I        1536      17    1.11%     12       3        2
0
 QOS ACL            TCAM        I        1024      45    4.39%     15      20        0
10


remote switch (PE-PE)
C9300-48U#show platform hardware fed switch active fwd-asic resource tcam utilization
Codes: EM - Exact_Match, I - Input, O - Output, IO - Input & Output, NA - Not Applicable

CAM Utilization for ASIC  [0]
```

```
 Table                  Subtype      Dir      Max       Used    %Used        V4        V6      MPLS
Other
 -----------------------------------------------------------------------------------------------------
-------
<...snip...>
 IP Route Table         EM           I       24576        23    0.09%        14         0         9
0
 IP Route Table         TCAM         I        8192      1025   12.51%      1012        10         2
1  <-- Still 1:1 usage for IPv4 prefixes
<...snip...>
 CTS Cell Matrix/VPN
 Label                  EM           O        8192         1    0.01%         0         0         1
0  <-- one remote LSPA used to reach the PE learnt prefixes
```

Note: L'utilisation des ressources dans **show platform software fed switch active mpls summary** montre également cette réduction dans LABEL ou LSPA (selon le cas).

Commandes à collecter pour TAC

Les problèmes de ressources matérielles les plus courants liés à MPLS sont traités dans ce guide, avec les étapes de correction appropriées. Toutefois, si ce guide ne résout pas votre problème, veuillez collecter la liste de commandes affichée et les joindre à la demande de service.

```
show ip route summary
show ip bgp vpnv4 all | redirect flash:bgp_vpnv4_all
show ip bgp vpnv4 all summary
show ip route vrf  <vrf-name>  summary
show mpls forwarding-table summary
show ip cef vrf <name>  | redirect flash:sh_ip_cef_vrf_<name>
show ip cef vrf <name> summary
show platform software fed switch active ip route summary
show platform software mpls switch <all switches> f0 forwarding-table
show platform software mpls switch <all switches>  f0 label
show platform software mpls switch <all switches>  f0 eos
show platform software object-manager switch <all switches>  f0 error-object
show platform software object-manager switch <all switches>  f0 pending-issue-update
show platform software fed switch <all switches>  mpls label_oce all detail
show platform software fed switch  <all switches> mpls eos all det
show platform software fed switch <all switches> mpls summary
show platform software fed switch active mpls forwarding all detail
show platform software object-manager switch 1 f0 statistics
show tech-support mpls | redirect flash:sh_tech_mpls
show logging | redirect flash:sh_logging_console
show platform hard fed switch active fwd resource tcam table sghash asic 0 format 0 | redirect
flash:vpn_lspa

request platform software trace archive last 30 days target flash
```

Informations connexes

[Support et documentation techniques - Cisco Systems](#)

[Guide de configuration MPLS (Multiprotocol Label Switching), Cisco IOS XE Cupertino 17.7.x (commutateurs Catalyst 9300)](#)

[Guide de configuration MPLS (Multiprotocol Label Switching), Cisco IOS XE Cupertino 17.7.x](#)

[(commutateurs Catalyst 9500)](#)

[Comprendre les ressources matérielles des commutateurs Catalyst 9000](#)