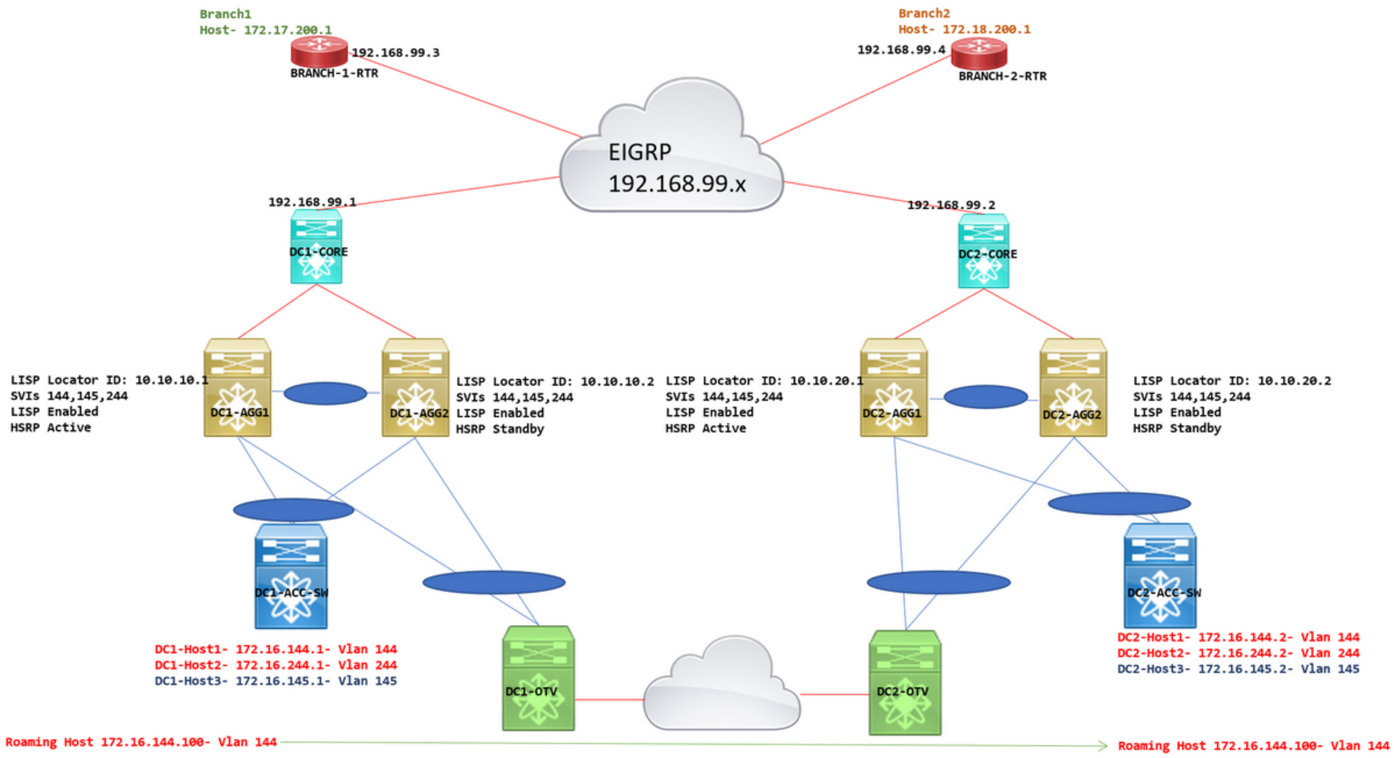
Nexus 7000配置和驗證LISP IGP協助擴充子網模式

目錄

簡介

本文檔介紹如何使用Nexus 7000部署LISP IGP協助擴展子網模式(ESM)

拓撲



拓撲詳細資訊

- DC1和DC2是OTV擴展的兩個位置
- Vlan 144、145和244在所有聚合、接入層和OTV交換機上配置
- 這些Vlan的SVI在Agg交換機上配置。SVI 144和244位於VRF租戶1中；SVI 145位於VRF tenant-2中。
- 部署LISP IGP Assist時，SVI不必位於VRF中；此示例使用多個VRF來說明所需的配置更改（在每個相關VRF上下文下）；所有SVI都可以位於同一個VRF中，並且仍然可以使用LISP IGP輔助
- HSRP在Vlan144、145和244中配置；在此拓撲中配置了FHRP隔離，這意味著總共4台交換機將運行HSRP，並且兩端將具有活動/備用對。FHRP隔離通過過濾HSRP Hello消息來實現。
- DC1-agg1和DC2-Agg2是vPC對；同樣適用於DC2-Agg1和DC2-Agg2
- LISP配置應用於SVI 144、145和244
- EIGRP鄰居關係是每個VRF從Agg到核心交換機建立的。從每個VRF的Agg交換機到核心交換機運行子介面，並在這些子介面上形成EIGRP鄰居關係。
- 遠端路由器（分支）也是同一個IGP域的一部分。
- 使用LISP IGP Assist時，沒有LISP封裝/解封裝，因此LISP路由必須重新分發到IGP（這裡是EIGRP）。 對於本文檔中描述的此部署模型，分支路由器將不具有任何LISP配置。

採用元件

- agg，核心交換機是運行8.2(4)NXOS版本的SUP2E、F3/M3的Nexus 7000
- 分支機構路由器是ASR1ks
- 這些Nexus 7000交換機上的另一個VDC中配置了OTV;OTV和LISP必須在不同的VDC上。共用VDC不是選項。

本文中的資訊是根據特定實驗室環境內的裝置所建立。文中使用到的所有裝置皆從已清除（預設）的組態來啟動。如果您的網路正在作用，請確保您已瞭解任何指令可能造成的影響。

AGG交換機上的必需配置

DC1-Agg1和DC1-Agg2上的LISP特定配置

```
Common Configuration on both DC1-Agg1 and DC1-Agg2

feature lisp
vrf context tenant-1                                                    # This example is
based on SVI 144 in VRF- tenant-1 and SVI 145 in VRF- tenant-2
  ip lisp etr                                                           # This is needed to
initialize LISP and only etr is needed on a IGP assist mode Environment
  lisp instance-id 2                                                    # Instance-ID should
be unique per VRF
  ip lisp locator-vrf default                                           # Locator Is
specified in Default VRF
  lisp dynamic-eid VLAN144                                              # Dynamic EID
definition for Vlan 144
    database-mapping 172.16.144.0/24 10.10.10.1 priority 50 weight 50      # Database-mapping
for 172.16.144.0/24 which is the Vlan 144; IP-> 10.10.10.1 is the Loopback100 IP address(which
is the unique IP on DC1-AGG1)
    database-mapping 172.16.144.0/24 10.10.10.2 priority 50 weight 50      # Database-mapping
for 172.16.144.0/24 which is the Vlan 144; IP-> 10.10.10.2 is the Loopback100 IP address(which
is the unique IP on DC1-AGG2)
    map-notify-group 239.254.254.254                                    # Multicast group
that will be used by LISP enabled switches to communicate about new EID learns or periodic EID
notification messages
    no route-export away-dyn-eid                                        # This is a hidden
command required to stop advertising any null0 /32 route for a remote host to the IGP
  lisp dynamic-eid VLAN244                                              # Dynamic EID
definition for Vlan 244
    database-mapping 172.16.244.0/24 10.10.10.1 priority 50 weight 50
    database-mapping 172.16.244.0/24 10.10.10.2 priority 50 weight 50
    map-notify-group 239.254.254.254
    no route-export away-dyn-eid

vrf context tenant-2
  ip lisp etr
  lisp instance-id 3
  ip lisp locator-vrf default
  lisp dynamic-eid VLAN145
    database-mapping 172.16.145.0/24 10.10.10.1 priority 50 weight 50
    database-mapping 172.16.145.0/24 10.10.10.2 priority 50 weight 50
    map-notify-group 239.254.254.254
    no route-export away-dyn-eid

Configuration on DC1-Agg1

interface Vlan144
  no shutdown
  vrf member tenant-1
  lisp mobility VLAN144
  lisp extended-subnet-mode                                              # SVI needs to be in
ESM Mode-Extended subnet mode
  ip address 172.16.144.250/24
  ip pim sparse-mode
  hsrp 144
    preempt
    priority 254
    ip 172.16.144.254
```

```
interface Vlan145
  no shutdown
  vrf member tenant-2
  lisp mobility VLAN145
  lisp extended-subnet-mode
  ip address 172.16.145.250/24
  ip pim sparse-mode
  hsrp 145
    preempt
    priority 254
    ip 172.16.145.254

interface Vlan244
  no shutdown
  vrf member tenant-1
  lisp mobility VLAN244
  lisp extended-subnet-mode
  ip address 172.16.244.250/24
  hsrp 244
    preempt
    priority 254
    ip 172.16.244.254

interface loopback100
  ip address 10.10.10.1/32
  ip router eigrp 100
  ip pim sparse-mode
```

Configuration on DC1-Agg2

```
interface Vlan144
  no shutdown
  vrf member tenant-1
  lisp mobility VLAN144
  lisp extended-subnet-mode
  ip address 172.16.144.251/24
  ip pim sparse-mode
  hsrp 144
    ip 172.16.144.254

interface Vlan145
  no shutdown
  vrf member tenant-2
  lisp mobility VLAN145
  lisp extended-subnet-mode
  ip address 172.16.145.251/24
  ip pim sparse-mode
  hsrp 145
    ip 172.16.145.254

interface Vlan244
  no shutdown
  vrf member tenant-1
  lisp mobility VLAN244
  lisp extended-subnet-mode
  no ip redirects
  ip address 172.16.244.251/24
  hsrp 244
    ip 172.16.244.254

interface loopback100
  ip address 10.10.10.2/32
  ip router eigrp 100
  ip pim sparse-mode
```

#資料庫對映必須這樣提供：在一端，需要指定DC1-Agg1和DC1-Agg2環回IP地址；在DC2-Agg1和DC2-Agg2中，必須建立唯一的環回，並將其放入資料庫對映中。

#在IGP輔助模式下，如果使用configuration-> "ip lisp itr-etr"，將導致為未啟用LISP的Vlan注入/32 null0主機路由;因此，IGP輔助模式的正確配置是「ip lisp etr」。

DC2-Agg1和DC2-Agg2上的LISP特定配置

```
Common Configuration on both DC2-Agg1 and DC2-Agg2

feature lisp

vrf context tenant-1
  ip lisp etr
  lisp instance-id 2
  ip lisp locator-vrf default
  lisp dynamic-eid VLAN144
    database-mapping 172.16.144.0/24 10.10.20.1 priority 50 weight 50      # Note that the IP
addresses used in DC2 Agg switches are 10.10.20.1 and 10.10.20.2(Which are Loopbacks Configured
on DC2-Agg switches)
    database-mapping 172.16.144.0/24 10.10.20.2 priority 50 weight 50
    map-notify-group 239.254.254.254
    no route-export away-dyn-eid
  lisp dynamic-eid VLAN244
    database-mapping 172.16.244.0/24 10.10.20.1 priority 50 weight 50
    database-mapping 172.16.244.0/24 10.10.20.2 priority 50 weight 50
    map-notify-group 239.254.254.254
    no route-export away-dyn-eid
vrf context tenant-2
  ip lisp etr
  lisp instance-id 3
  ip lisp locator-vrf default
  lisp dynamic-eid VLAN145
    database-mapping 172.16.145.0/24 10.10.20.1 priority 50 weight 50
    database-mapping 172.16.145.0/24 10.10.20.2 priority 50 weight 50
    map-notify-group 239.254.254.254
    no route-export away-dyn-eid
```

Configuration on DC2-Agg1

```
interface Vlan144 no shutdown vrf member tenant-1 lisp mobility VLAN144 lisp extended-subnet-
mode ip address 172.16.144.252/24 ip pim sparse-mode hsrp 144 preempt priority 254 ip
172.16.144.254 interface Vlan145 no shutdown vrf member tenant-2 lisp mobility VLAN145 lisp
extended-subnet-mode ip address 172.16.145.252/24 ip pim sparse-mode hsrp 145 preempt priority
254 ip 172.16.145.254 interface Vlan244 no shutdown vrf member tenant-1 lisp mobility VLAN244
lisp extended-subnet-mode ip redirects ip address 172.16.244.252/24 hsrp 244 preempt priority
254 ip 172.16.244.254 interface loopback100 ip address 10.10.20.1/32 ip router eigrp 100 ip pim
sparse-mode
```

Configuration on DC2-Agg2

```
interface Vlan144 no shutdown vrf member tenant-1 lisp mobility VLAN144 lisp extended-subnet-
mode ip address 172.16.144.253/24 ip pim sparse-mode hsrp 144 ip 172.16.144.254 interface
Vlan145 no shutdown vrf member tenant-2 lisp mobility VLAN145 lisp extended-subnet-mode ip
address 172.16.145.253/24 ip pim sparse-mode hsrp 145 ip 172.16.145.254 interface Vlan244 no
shutdown vrf member tenant-1 lisp mobility VLAN244 lisp extended-subnet-mode no ip redirects ip
address 172.16.244.253/24 hsrp 244 preempt ip 172.16.244.254 interface loopback100 ip address
10.10.20.2/32 ip router eigrp 100 ip pim sparse-mode
```

#DC1和DC2 Agg LISP配置之間的區別是「資料庫對映」中定義的環回。 在DC1配置中，將使用DC1-Agg1和DC1-Agg2的環回來定義資料庫對映；對於DC2，將使用DC2-Agg1和DC2-Agg2中的環回來定義資料庫對映

#下面顯示的其他IGP/路由對映/字首清單配置將相似（為介面分配的IP地址確實不同）

IGP特定

```
router eigrp 100
  address-family ipv4 unicast
  vrf tenant-1
    distance 90 245                                                 # External EIGRP
Routes have to have an AD which is higher than the default LISP AD(which is 240); Reason being,
if the redistributed route from dc1-agg1 comes back to dc1-agg2 via eigrp, default EIGRP
External is 170 which will override LISP route causing problems
    redistribute lisp route-map lisp-to-eigrp                       # This command is to
redistribute LISP /32 routes only to the IGP(EIGRP In this example)
    redistribute direct route-map direct                            # This is needed so
that the direct routes(/24 SVI routes in LISP) are redistributed to the IGP; This will be needed
if there is some device that is trying to communicate to a silent host in the LISP enabled Vlan
  vrf tenant-2
    distance 90 245
    redistribute lisp route-map lisp-to-eigrp
    redistribute direct route-map direct
```

#啟用LISP的AGG VDC也會與核心端形成IGP鄰居關係

#在本示例中，使用屬於每個租戶VRF的子介面形成面向核心的鄰居關係，如下所示。

```
interface Ethernet3/6.111
  encapsulation dot1q 111
  vrf member tenant-1
  ip address 192.168.98.1/30
  ip router eigrp 100
  no shutdown


interface Ethernet3/6.212
  encapsulation dot1q 212
  vrf member tenant-2
  ip address 192.168.198.1/30
  ip router eigrp 100
  no shutdown
```

路由對映/字首清單

```
ip prefix-list lisp-to-eigrp seq 5 permit 0.0.0.0/0 ge 32           # This is the prefix
list that is matching any /32 routes which are to be redistributed from LISP To IGP

route-map direct permit 10                                          # This is for the
Direct routes

route-map lisp-to-eigrp deny 10                                     # This is to prevent
any null0 routes from being redistributed to IGP from LISP
  match interface Null0
route-map lisp-to-eigrp permit 20                                   # This is to allow
redistribution of /32 host routes
  match ip address prefix-list lisp-to-eigrp
```

#所有AGG交換機（DC1和DC2）都需要上述所有配置。 請記住，為SVI、環回和HSRP VIP提供唯一的IP地址對於所有SVI都是相同的

OTV VDC配置

HSRP過濾

#對於IGP輔助部署，當通過OTV或任何其他機制擴展時，必須建立FHRP隔離；

#通過在OTV VDC中過濾FHRP Hello消息來完成此操作

#在本示例中，使用了N7k OTV，因此應用了以下配置來過濾OTV VDC中的FHRP資料包。

```
ip access-list ALL_IPs
  10 permit ip any any
mac access-list ALL_MACs
  10 permit any any
ip access-list HSRP_IP
  10 permit udp any 224.0.0.2/32 eq 1985
  20 permit udp any 224.0.0.102/32 eq 1985
mac access-list HSRP_VMAC
  10 permit 0000.0c07.ac00 0000.0000.00ff any
  20 permit 0000.0c9f.f000 0000.0000.0fff any
arp access-list HSRP_VMAC_ARP
  10 deny ip any mac 0000.0c07.ac00 ffff.ffff.ff00
  20 deny ip any mac 0000.0c9f.f000 ffff.ffff.f000
  30 permit ip any mac any
vlan access-map HSRP_Localization 10
        match mac address HSRP_VMAC
        match ip address HSRP_IP
        action drop
vlan access-map HSRP_Localization 20
        match mac address ALL_MACs
        match ip address ALL_IPs
        action forward
vlan filter HSRP_Localization vlan-list 144-145
ip arp inspection filter HSRP_VMAC_ARP vlan 144-145

mac-list OTV_HSRP_VMAC_deny seq 10 deny 0000.0c07.ac00 ffff.ffff.ff00
mac-list OTV_HSRP_VMAC_deny seq 11 deny 0000.0c9f.f000 ffff.ffff.f000
mac-list OTV_HSRP_VMAC_deny seq 20 permit 0000.0000.0000 0000.0000.0000
route-map OTV_HSRP_filter permit 10
  match mac-list OTV_HSRP_VMAC_deny

otv-isis default
  vpn Overlay0
    redistribute filter route-map OTV_HSRP_filter
```

#僅在OTV VDC上需要FHRP過濾配置；如果使用ASR OTV部署，則過濾機制應根據ASR配置指南的相關內容進行使用和記錄。

OTV抑制ARP

#禁用OTV VDC上的ARP和快取功能

```
interface Overlay0
 no otv suppress-arp-nd >>>>>
```

由於LISP配置的路由填充

```
DC1-AGG1# show ip route lisp vrf tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

172.16.144.0/25, ubest/mbest: 1/0
    *via Null0, [240/1], 07:22:30, lisp, dyn-eid
172.16.144.128/25, ubest/mbest: 1/0
    *via Null0, [240/1], 07:22:30, lisp, dyn-eid
```

#當SVI 144上啟用LISP時，將會自動建立兩個Null0路由；SVI 144是/24子網，因此第一條null0路由來自172.16.144.0/25，第二條null0路由來自172.16.144.128/25，如上所述。

#這是預期的，也是設計好的；這樣做是為了確保來自未發現主機的資料包觸發RPF異常，這將導致資料包被傳送到CPU，並最終有助於主機檢測(EID)

主機在啟用LISP的SVI內聯機時的事件序列

#啟用LISP的介面上的主機檢測基於從資料庫對映配置中指定的範圍內的IP地址接收L3流量。

為了方便檢測主機，請注意，在介面上啟用LISP時：
RPF異常在介面上啟用，以便由未知源生成的資料包觸發異常
LISP來源的Null0路由被安裝，以確保未知來源觸發RPF異常

由於此解決方案依賴OTV在兩個資料中心之間進行L2擴展，因此ARP信令不能直接用於檢測IP主機，因為在許多情況下會廣播給所有交換機。

但是，ARP訊號用作LISP可能存在未檢測到的主機的指示。由於主機可以駐留在OTV網橋的任何一側，LISP在學習新的IP-MAC繫結後啟動本地化機制。
定位機制的工作原理如下：
#交換機獲知新的IP-MAC繫結（通過GARP、RARP或ARP請求）。
#用作活動HSRP的交換機向主機傳送回應要求但源自HSRP VIP地址
#主機對回應請求作出回覆，但在OTV中進行FHRP隔離後，僅在主機所在的DC站點上收到回應回覆
#由於回應應答是L3資料包，因此LISP會檢測到主機。

#如果在任何啟用了LISP的SVI上收到IP資料包，則該資料包自身將向LISP進程傳送通知，通知該端點為本地；將不會傳送任何ICMP ECHO要求以進一步確認主機是否為本地主機。因此，必須注意的是，從DC2主機到DC1-AGG SVI IP地址執行Ping操作會導致終端標識損壞，這也會導致ping丟失或流量黑洞，因為主機現在被標識為DC1中的本地EID，而不是DC2。因此，Ping操作不應從LISP環境中的SVI IP地址發出，因為這可能損壞路由表並導致流量黑洞。如果啟用LISP的Vlan中的主機嘗試對SVI IP地址執行ping，也會發生相同的問題；對VIP執行ping操作應該沒問題，因為兩端都存在且處於活動狀態，而站點本地將捕獲資料包。

以下是DC1中主機聯機時的路由表條目示例：

```
DC1-AGG1# show ip route 172.16.144.1 vrf tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>
```

```
172.16.144.1/32, ubest/mbest: 1/0, attached
    *via 172.16.144.1, Vlan144, [240/1], 3d05h, lisp, dyn-eid
     via 172.16.144.1, Vlan144, [250/0], 3d05h, am

DC1-AGG2# sh ip route 172.16.144.1 vr tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

172.16.144.1/32, ubest/mbest: 1/0, attached
    *via 172.16.144.1, Vlan144, [240/1], 3d05h, lisp, dyn-eid
     via 172.16.144.1, Vlan144, [250/0], 3d05h, am
```

#如上所示，有兩條路由；一個通過LISP進程，管理距離為240，另一個通過AM->鄰接管理器（由ARP進程填充），其AD為250。

#DC1中的兩台Agg交換機將具有相同的條目。

#此外，LISP將在動態EID表中列出主機的相同條目，如下所示。

```
DC1-AGG1# show lisp dynamic-eid detail vrf tenant-1 | in 144.1, nex 1 172.16.144.1, Vlan144,
uptime: 3d05h, last activity: 00:14:38 Discovered by: packet reception DC1-AGG2# show lisp
dynamic-eid detail vrf tenant-1 | in 144.1, nex 1 172.16.144.1, Vlan144, uptime: 3d05h, last
activity: 00:00:37 Discovered by: site-based Map-Notify
```

#發現這兩種情況都不同；HSRP活動的DC1-AGG1通過「資料包接收」方式記錄條目，這基本上意味著有一個資料包傳入並新增為EID

#一旦Agg1得知某個EID，它就從源IP-> Loopback100 IP地址（在資料庫對映下定義）向組 — > 239.254.254.254（配置如上所述）傳送組播消息，vPC對等交換機也會收到該消息，並相應地填充該條目，由於資料庫對映具有dc1-agg1和dc1-agg2的IP地址，因此該條目被視為本地EID。該組播資料包也將通過OTV到達遠端站點；但是，遠端站點會檢查資料庫對映，並且由於此資料包來自與「資料庫對映」不同的IP地址，因此DC2 AGg交換機不會將其視為本地EID。

對映通知消息

#當啟用LISP的SVI檢測到主機時，觸發的「map-notify」消息將傳送到相應動態EID配置下定義的組播組

#除了觸發的對映通知消息外，該vlan中的HSRP Active（或FHRP active）交換機還會定期傳送對映通知消息；

#對映通知消息的PCAP如下所示。

```
> Frame 285: 122 bytes on wire (976 bits), 122 bytes captured (976 bits) on interface eth0, id 0
> Ethernet II, Src: de:ad:20:20:22:22 (de:ad:20:20:22:22), Dst: IPv4mcast_7e:fe:fe (01:00:5e:7e:fe:fe)
> Internet Protocol Version 4, Src: 10.10.20.2, Dst: 239.254.254.254
> User Datagram Protocol, Src Port: 4342, Dst Port: 4342
v Locator/ID Separation Protocol
    0100 .... .... .... .... .... = Type: Map-Notify (4)
    .... 0... .... .... .... .... = I bit (xTR-ID present): Not set
    .... .0.. .... .... .... .... = R bit (Built for an RTR): Not set
    .... ..00 0000 0000 0000 0000 = Reserved bits: 0x00000
    Record Count: 4
    Nonce: 0x0000000000000000
    Key ID: 0x0000
    Authentication Data Length: 0
    Authentication Data: <MISSING>
  > Mapping Record 1, EID Prefix: 172.16.144.2/32, TTL: -1610285056, Action: No-Action, Not Authoritative
  > Mapping Record 2, EID Prefix: 172.16.144.111/32, TTL: -1610285056, Action: No-Action, Not Authoritative
  > Mapping Record 3, EID Prefix: 172.16.144.252/32, TTL: -1610285056, Action: No-Action, Not Authoritative
  > Mapping Record 4, EID Prefix: 172.16.144.254/32, TTL: -1610285056, Action: No-Action, Not Authoritative
```

將LISP/32路由重分發到IGP

#這是IGP協助模式的關鍵；任何/32 LISP路由都將重新分發到IGP;這可以通過在EIGRP下應用的「redistribute LISP」命令實現。

#重新分發後，任何/32主機路由都會被視為EIGRP外部路由。為了提高EIGRP管理距離，已對其進行調整。這是為了確保LISP路由停留在URIB中，而不是傳入的EIGRP外部路由。如；DC1-Agg1和DC1-Agg2是具有DC1-core的EIGRP鄰居。DC1-AGG1通過重分發將/32路由注入到DC1-Core。既然DC1-Core是DC1-Agg2的EIGRP鄰居，那麼相同的路由可能返回DC1-Agg2，如果EIGRP AD為170，則有機會贏取LISP路由（其AD為240）；因此，為了避免這種情況，EIGRP外部路由AD已修改為245。

#由DC1-Agg交換機獲知的/32路由被重新分發到EIGRP，而DC1-core條目如下所示。

```
DC1-CORE# sh ip route 172.16.144.1
IP Route Table for VRF "default"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

172.16.144.1/32, ubest/mbest: 2/0
    *via 192.168.98.1, Eth3/20.111, [170/51456], 00:00:01, eigrp-100, external
    *via 192.168.98.5, Eth3/22.112, [170/51456], 18:14:51, eigrp-100, external
```

#該路由存在於全域性路由表中，並且在核心端未配置VRF。

#由於在AGG交換機上配置了「redistribute direct」，核心層還將為父子網提供/24 ECMP路由，如下所示。這將有助於為無提示主機（沒有/32路由）吸引流量。

```
DC1-CORE# sh ip route 172.16.144.10                # Checking for a non existent Host
172.16.144.10
IP Route Table for VRF "default"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>
```

```
172.16.144.0/24, ubest/mbest: 2/0
    *via 192.168.98.1, Eth3/20.111, [170/51456], 00:02:13, eigrp-100, external
    *via 192.168.98.5, Eth3/22.112, [170/51456], 18:17:03, eigrp-100, external
```

#此外，DC1和DC2核心都可看到/24 ECMP路由

```
Branch1-Router# sh ip route 172.16.144.10
Routing entry for 172.16.144.0/24
  Known via "eigrp 100", distance 170, metric 51712, type external
  Redistributing via eigrp 100
  Last update from 192.168.99.2 on GigabitEthernet0/0/1, 00:00:17 ago
  Routing Descriptor Blocks:
    192.168.99.2, from 192.168.99.2, 00:00:17 ago, via GigabitEthernet0/0/1      # 192.168.99.2
is DC2-Core
      Route metric is 51712, traffic share count is 1
      Total delay is 1020 microseconds, minimum bandwidth is 100000 Kbit
      Reliability 255/255, minimum MTU 1492 bytes
      Loading 1/255, Hops 2
  * 192.168.99.1, from 192.168.99.1, 00:00:17 ago, via GigabitEthernet0/0/1      # 192.168.99.1
is DC1-Core
      Route metric is 51712, traffic share count is 1
      Total delay is 1020 microseconds, minimum bandwidth is 100000 Kbit
      Reliability 255/255, minimum MTU 1492 bytes
      Loading 1/255, Hops 2
```

#此路由可確保分支主機可以到達位於任一位置的靜默主機。

VLAN內DC間的資料包路徑

#當DC1-Host1 -> 172.16.144.1嘗試到達DC2-Host1-> 172.16.144.2時，這是VLAN內資料中心間流量。DC1-Host 1發出一個ARP請求，該請求將一直穿過OTV並到達DC2-Host1

DC2-Host1使用返回到DC1-Host1的ARP應答進行響應

#後續ICMP資料包通過OTV傳送

VLAN間DC的資料包路徑（從Vlan 144到Vlan 244）

#當DC1-Host1-> 172.16.144.1嘗試到達DC2-Host2-> 172.16.244.2時，資料包不會在DC1中從VLAN 144路由到244;相反，它遵循從DC1-Agg到DC1-Core的路由路徑，然後到達DC2-Core，最終路由將由DC2-Agg交換機完成到目標Vlan-244的路由。

#從DC1-Host1到DC2-Host2的traceroute如下所示。

```
DC1-HOST# traceroute 172.16.244.2 vrf vlan144
traceroute to 172.16.244.2 (172.16.244.2), 30 hops max, 40 byte packets
 1  172.16.144.250 (172.16.144.250)  1.149 ms  0.841 ms  0.866 ms
# DC1-AGG1
 2  192.168.98.2 (192.168.98.2)  1.004 ms  0.67 ms  0.669 ms
# DC1-CORE
 3  192.168.99.2 (192.168.99.2)  0.756 ms  0.727 ms  0.714 ms
# DC2-CORE
 4  192.168.94.5 (192.168.94.5)  1.041 ms  0.937 ms 192.168.94.1 (192.168.94.1)  1.144 ms
# DC2-Agg1/DC2-Agg2
 5  172.16.244.2 (172.16.244.2)  2.314 ms *  2.046 ms
```

 # DC2-Host2

VLAN間DC的資料包路徑（從VRF租戶–1到VRF租戶–2）

#這將遵循與一個VLAN到另一個VLAN的VLAN間DC通訊相同的方式（上一個示例）

#當DC1-host1-> 172.16.144.1嘗試到達DC2-Host3-> 172.16.145.2時，這是源自Vlan 144（VRF租戶–1）且目的地為Vlan 145（VRF租戶–2）的DC間流量。 與常規N7k OTV部署不同，此流量的處理方式略有不同。DC1端不會發生任何vlan間路由；相反，此流量將被路由並傳送到DC1-core，核心層會進一步通過IGP路由到DC2-Core

#在本檔案中，VRF間洩漏是由核心交換機在每個站點完成的。可以是任何裝置（如防火牆）；如果VRF間洩漏存在，則從LISP配置的角度不會有任何更改。

```
DC1-AGG1# sh ip route 172.16.145.2 vrf tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

172.16.145.2/32, ubest/mbest: 1/0
    *via 192.168.98.2, Eth3/6.111, [245/51968], 00:00:46, eigrp-100, external
```

#從DC1-Host1到DC2-Host3的Traceroute將同樣顯示其not-inter-vlan路由，而不是第3層通過核心路由。簡而言之，VLAN間流量將不會使用OTV。

```
DC1-HOST# traceroute 172.16.145.2 vrf vlan144
traceroute to 172.16.145.2 (172.16.145.2), 30 hops max, 40 byte packets
 1  172.16.144.250 (172.16.144.250)  1.049 ms  0.811 ms  0.81 ms      # DC1-AGG1
 2  192.168.98.2 (192.168.98.2)  0.844 ms  0.692 ms  0.686 ms      # DC1-CORE
 3  192.168.99.2 (192.168.99.2)  0.814 ms  0.712 ms  0.735 ms      # DC2-CORE
 4  192.168.194.1 (192.168.194.1)  0.893 ms  0.759 ms 192.168.194.5 (192.168.194.5)  0.89 ms   # DC2-Agg1/DC2-Agg2
 5  172.16.145.2 (172.16.145.2)  1.288 ms *  1.98 ms      # DC2-Host3
DC1-HOST#
```

Branch-1主機嘗試到達DC2中的靜默主機時資料包的路徑

Branch-1-172.17.200.1中的主機嘗試到達DC2-Silent Host- 172.16.144.119。由於主機處於靜默狀態，因此DC2中將不存在任何/32路由。

```
DC2-AGG1# show ip route 172.16.144.119 vr tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

172.16.144.0/25, ubest/mbest: 1/0
    *via Null0, [240/1], 20:48:29, lisp, dyn-eid
```

```
DC2-AGG2# show ip route 172.16.144.119 vr tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

172.16.144.0/25, ubest/mbest: 1/0
    *via Null0, [240/1], 20:48:13, lisp, dyn-eid
```

#根據LISP設計，路由172.16.144.119將匹配到172.16.144.0/25 null0路由。

#當Branch路由器收到目的IP為172.16.144.119的資料包時，URIB具有到DC1-core和DC2-core的ECMP /24路由。這基本上意味著該資料包將傳送到核心層交換機之一。

```
Branch1-Router# sh ip route 172.16.144.119
Routing entry for 172.16.144.0/24
  Known via "eigrp 100", distance 170, metric 51712, type external
  Redistributing via eigrp 100
  Last update from 192.168.99.2 on GigabitEthernet0/0/1, 00:08:54 ago
  Routing Descriptor Blocks:
    192.168.99.2, from 192.168.99.2, 00:08:54 ago, via GigabitEthernet0/0/1
      Route metric is 51712, traffic share count is 1
      Total delay is 1020 microseconds, minimum bandwidth is 100000 Kbit
      Reliability 255/255, minimum MTU 1492 bytes
      Loading 1/255, Hops 2
  * 192.168.99.1, from 192.168.99.1, 00:08:54 ago, via GigabitEthernet0/0/1
      Route metric is 51712, traffic share count is 1
      Total delay is 1020 microseconds, minimum bandwidth is 100000 Kbit
      Reliability 255/255, minimum MTU 1492 bytes
      Loading 1/255, Hops 2

Branch1-Router#sh ip cef exact-route 172.17.200.1 172.16.144.119 dest-port 1
172.17.200.1 -> 172.16.144.119 =>IP adj out of GigabitEthernet0/0/1, addr 192.168.99.1
```

#根據CEF的資料包正在雜湊到192.168.99.1（即DC1-Core）

DC1-Core有2個ECMP路徑；一個指向DC1-Agg1（HSRP活動），另一個指向DC1-Agg2（HSRP備用）。 在路由雜湊中，所選路徑將是DC1-Agg2。

```
DC1-CORE# sh routing hash 172.17.200.1 172.16.144.119 1 1 Load-share parameters used for
software forwarding: load-share mode: address source-destination port source-destination
Universal-id seed: 0xfdba3ebe Hash for VRF "default" Hash Type is 1 Hashing to path
*192.168.98.5 Eth3/22.112
For route:
172.16.144.0/24, ubest/mbest: 2/0
    *via 192.168.98.1, Eth3/20.111, [170/51456], 00:19:57, eigrp-100, external
    *via 192.168.98.5, Eth3/22.112, [170/51456], 18:34:47, eigrp-100, external
```

```
DC1-CORE# sh cdp nei int e3/22
Capability Codes: R - Router, T - Trans-Bridge, B - Source-Route-Bridge
                  S - Switch, H - Host, I - IGMP, r - Repeater,
                  V - VoIP-Phone, D - Remotely-Managed-Device,
                  s - Supports-STP-Dispute

Device-ID          Local Intrfce  Hldtme Capability  Platform        Port ID
```

```
DC1-AGG2(JAF1534CHCJ)
                    Eth3/22        172    R S s     N7K-C7009        Eth3/7
```

#由於DC1-Agg2在URIB中沒有任何條目，因此將收集資料包並將其傳送到CPU，這將迫使DC1-Agg2從SVI IP地址生成ARP請求，如下所示。

```
2020-02-18 15:09:05.673165 172.17.200.1 -> 172.16.144.119 ICMP 114 Echo (ping) request
id=0x0022, seq=0/0, ttl=254
2020-02-18 15:09:05.675041 de:ad:20:19:22:22 -> Broadcast ARP 60 Who has 172.16.144.119? Tell
172.16.144.251
```

#此ARP請求是一個廣播，它通過OTV擴展在包括DC2的整個第2層域中傳播。

DC2-Silent主機現在響應來自DC1-Agg2的ARP請求

DC1-Agg2收到來自靜默主機的此ARP應答

```
2020-02-18 15:09:05.675797 64:12:25:97:46:41 -> de:ad:20:19:22:22 ARP 60 172.16.144.119 is at
64:12:25:97:46:41
```

#當收到的資料包是ARP（作為LISP的提示）時，會生成從HSRP VIP-> 172.16.144.254發源併發往靜默主機 — > 172.16.144.119的ICMP ECHO請求。從HSRP VIP發源資料包的意圖是瞭解主機是本地還是遠端。如果主機是遠端主機，則遠端資料中心中也存在FHRP Active，它將捕獲來自主機的ICMP ECHO應答資料包，因此這會導致DC2-Agg2（即HSRP Active）獲知此條目，並且LISP進程現在將基於此IP資料包進行EID Learn。最初來源為來自HSRP VIP的ICMP ECHO請求的DC1-Agg2永遠不會收到響應，因此在DC1端永遠不會進行終端學習；而是DC2端。

```
DC2-AGG2# show lisp dynamic-eid detail vrf tenant-1
LISP Dynamic EID Information for VRF "tenant-1"
Dynamic-EID name: VLAN144
  Database-mapping [2] EID-prefix: 172.16.144.0/24, LSBs: 0x00000003
    Locator: 10.10.20.1, priority: 50, weight: 50
             Uptime: 21:50:32, state: up
    Locator: 10.10.20.2, priority: 50, weight: 50
             Uptime: 21:50:13, state: up, local
  Registering more-specific dynamic-EIDs
  Registering routes: disabled
  Allowed-list filter: none applied
  Map-Server(s): none configured, use global Map-Server
  Site-based multicast Map-Notify group: 239.254.254.254
  Extended Subnet Mode configured on 1 interfaces
  Number of roaming dynamic-EIDs discovered: 3
  Last dynamic-EID discovered: 172.16.144.254, 00:01:10 ago
  Roaming dynamic-EIDs:
    172.16.144.2, Vlan144, uptime: 19:09:07, last activity: 00:05:21
      Discovered by: packet reception
    172.16.144.119, Vlan144, uptime: 00:05:55, last activity: 00:05:55 Discovered by: packet
reception
    172.16.144.252, Vlan144, uptime: 3d21h, last activity: 00:01:10
      Discovered by: packet reception

Secure-handoff pending for sources: none
```

#一旦LISP進程知道DC2-Agg2（HSRP活動）上的EID，它將

a)本地安裝/32

b)將路由重新分發到DC2-Core

c)在Vlan中作為組播消息傳送基於站點的通知（在本示例中，消息將發往組 — > 239.254.254.254）

```
DC2-AGG1# show lisp dynamic-eid detail vrf tenant-1
LISP Dynamic EID Information for VRF "tenant-1"
Dynamic-EID name: VLAN144
  Database-mapping [2] EID-prefix: 172.16.144.0/24, LSBs: 0x00000003
    Locator: 10.10.20.1, priority: 50, weight: 50
             Uptime: 21:52:39, state: up, local
    Locator: 10.10.20.2, priority: 50, weight: 50
             Uptime: 21:52:08, state: up
  Registering more-specific dynamic-EIDs
  Registering routes: disabled
  Allowed-list filter: none applied
  Map-Server(s): none configured, use global Map-Server
  Site-based multicast Map-Notify group: 239.254.254.254
  Extended Subnet Mode configured on 1 interfaces
  Number of roaming dynamic-EIDs discovered: 4
  Last dynamic-EID discovered: 172.16.144.254, 00:03:07 ago
  Roaming dynamic-EIDs:
    172.16.144.2, Vlan144, uptime: 19:11:04, last activity: 00:00:21
      Discovered by: site-based Map-Notify
    172.16.144.110, Vlan144, uptime: 20:04:09, last activity: 20:04:09
      Discovered by: site-based Map-Notify
   172.16.144.119, Vlan144, uptime: 00:07:52, last activity: 00:00:21 Discovered by: site-based
Map-Notify
    172.16.144.252, Vlan144, uptime: 21:50:51, last activity: 00:00:21
      Discovered by: site-based Map-Notify

Secure-handoff pending for sources: none
```

#最後，Branch-router1將接收到此/32路由，這將導致Branch路由器將流量傳送到正確的DC2核心交換機。

```
Branch1-Router# sh ip route 172.16.144.119
Routing entry for 172.16.144.119/32
  Known via "eigrp 100", distance 170, metric 51712, type external
  Redistributing via eigrp 100
  Last update from 192.168.99.2 on GigabitEthernet0/0/1, 00:06:25 ago
  Routing Descriptor Blocks:
  * 192.168.99.2, from 192.168.99.2, 00:06:25 ago, via GigabitEthernet0/0/1
      Route metric is 51712, traffic share count is 1
      Total delay is 1020 microseconds, minimum bandwidth is 100000 Kbit
      Reliability 255/255, minimum MTU 1492 bytes
      Loading 1/255, Hops 2
```

主機從DC1移動到DC2時的事件序列（漫遊）

#考慮到在此拓撲上配置了L2擴展，主機可以從DC1移動到DC2。

#主機 — > 172.16.144.100最初位於Vlan 144和DC1中。

#當主機在DC1中聯機時，DC1-Agg1和DC1-Agg2交換機內的路由將如下所示

```
DC1-AGG1# sh ip route 172.16.144.100 vrf tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
```

```
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

172.16.144.100/32, ubest/mbest: 1/0, attached
    *via 172.16.144.100, Vlan144, [240/1], 00:05:03, lisp, dyn-eid
     via 172.16.144.100, Vlan144, [250/0], 00:05:05, am

DC1-AGG2# sh ip route 172.16.144.100 vrf tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

172.16.144.100/32, ubest/mbest: 1/0, attached
    *via 172.16.144.100, Vlan144, [240/1], 00:08:05, lisp, dyn-eid
     via 172.16.144.100, Vlan144, [250/0], 00:08:07, am
```

#分支路由器的路由指向DC1-Core（如下所示），而traceroute將指向DC1核心/agg交換機以到達DC1中的主機

```
Branch1-Router#sh ip route 172.16.144.100
Routing entry for 172.16.144.100/32
  Known via "eigrp 100", distance 170, metric 51712, type external
  Redistributing via eigrp 100
  Last update from 192.168.99.1 on GigabitEthernet0/0/1, 00:00:06 ago
  Routing Descriptor Blocks:
  * 192.168.99.1, from 192.168.99.1, 00:00:06 ago, via GigabitEthernet0/0/1
      Route metric is 51712, traffic share count is 1
      Total delay is 1020 microseconds, minimum bandwidth is 100000 Kbit
      Reliability 255/255, minimum MTU 1492 bytes
      Loading 1/255, Hops 2

Branch1-Router#traceroute 172.16.144.100 source 172.17.200.1
Type escape sequence to abort.
Tracing the route to 172.16.144.100
VRF info: (vrf in name/id, vrf out name/id)
  1 192.168.99.1 1 msec 1 msec 0 msec                    # DC1-Core
  2 192.168.98.5 1 msec 1 msec                           # DC1-Agg2
    192.168.98.1 1 msec                                  # DC1-Agg1
  3 172.16.144.100 1 msec 0 msec 1 msec                  # DC1-Host
```

#當主機移動到DC2時，它會在Vlan 144中傳送GARP。這在DC2-Agg交換機上可見

```
2020-02-24 22:23:05.024902 Cisco_5a:4a:e7 -> Broadcast    ARP 60 Gratuitous ARP for
172.16.144.100 (Request)
```

#一旦收到帶有ARP/GARP/RARP的資料包，就會觸發本地化機制，向源自VIP的主機發出一個ICMP回應請求

```
2020-02-24 22:23:05.026781 172.16.144.254 -> 172.16.144.100 ICMP 60 Echo (ping) request
id=0xac10, seq=0/0, ttl=128
```

Host-172.16.144.100現在將響應HSRP VIP

```
2020-02-24 22:23:07.035292 172.16.144.100 -> 172.16.144.254 ICMP 60 Echo (ping) reply
id=0xac10, seq=0/0, ttl=255
```

#一旦在DC2-Agg1收到IP資料包，就會導致LISP檢測EID，並在主機路由表中建立一個條目，並開始向EIGRP重分發過程

```
DC2-AGG1# sh ip route 172.16.144.100 vrf tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

172.16.144.100/32, ubest/mbest: 1/0, attached
    *via 172.16.144.100, Vlan144, [240/1], 00:00:30, lisp, dyn-eid
     via 172.16.144.100, Vlan144, [250/0], 00:00:32, am
```

#在重分發到位後，DC1-agg站點（此主機的原始所有者）現在會看到RIB中指向EIGRP的更改

```
DC1-AGG1#  sh ip route 172.16.144.100 vrf tenant-1
IP Route Table for VRF "tenant-1"
'*' denotes best ucast next-hop
'**' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

172.16.144.100/32, ubest/mbest: 1/0
    *via 192.168.98.2, Eth3/6.111, [245/51968], 00:03:47, eigrp-100, external
```

#遠端分支路由器現在將看到路由更改，traceroute將反映DC2核心/Agg交換機的路徑更改，如下所示

```
Branch1-Router#sh ip route 172.16.144.100
Routing entry for 172.16.144.100/32
  Known via "eigrp 100", distance 170, metric 51712, type external
  Redistributing via eigrp 100
  Last update from 192.168.99.2 on GigabitEthernet0/0/1, 00:00:00 ago
  Routing Descriptor Blocks:
  * 192.168.99.2, from 192.168.99.2, 00:00:00 ago, via GigabitEthernet0/0/1
      Route metric is 51712, traffic share count is 1
      Total delay is 1020 microseconds, minimum bandwidth is 100000 Kbit
      Reliability 255/255, minimum MTU 1492 bytes
      Loading 1/255, Hops 2

Branch1-Router#traceroute 172.16.144.100 source 172.17.200.1
Type escape sequence to abort.
Tracing the route to 172.16.144.100
VRF info: (vrf in name/id, vrf out name/id)
  1 192.168.99.2 1 msec 0 msec 1 msec                  # DC2-Core
  2 192.168.94.1 1 msec 1 msec 1 msec                  # DC2-Agg1
  3 172.16.144.100 0 msec 0 msec 1 msec                # Host-after move to DC2
```

有用的驗證命令

show lisp dynamic-eid detail vrf <VRF Name>

Show ip route lisp vrf <VRF Name>

show lisp dynamic-eid summary vrf <VRF Name>