排除Firepower威脅防禦路由故障

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簡介

本檔案將說明Firepower威脅防禦(FTD)如何轉送封包和實施各種路由概念。

必要條件

需求

- 基本的路由知識

採用元件

本文中的資訊係根據以下軟體和硬體版本：

- Cisco Firepower 41xx威脅防禦版本7.1.x
- Firepower管理中心(FMC)版本7.1.x

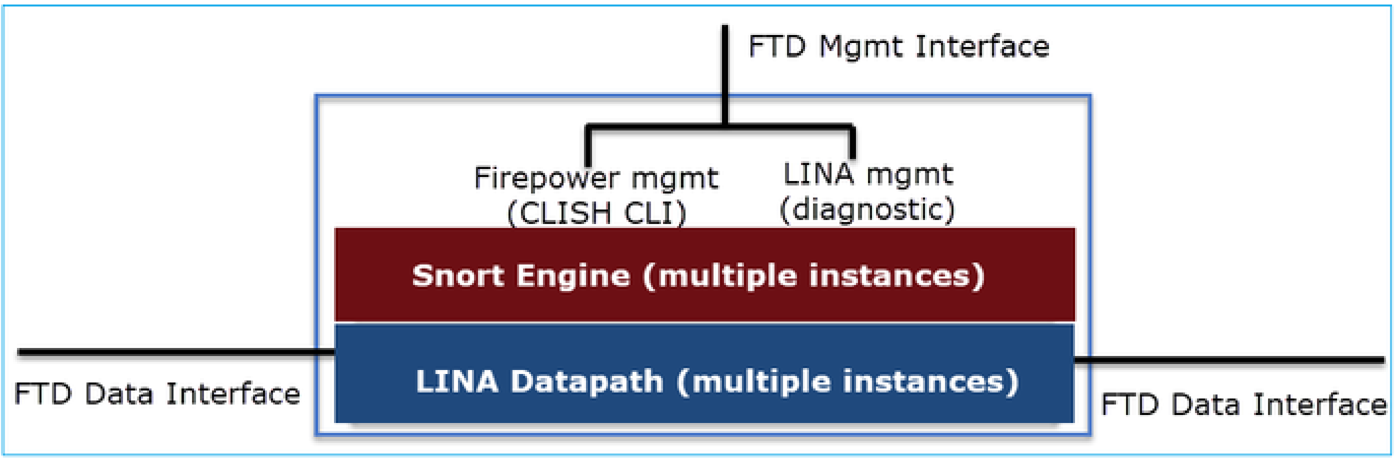
本文中的資訊是根據特定實驗室環境內的裝置所建立。文中使用到的所有裝置皆從已清除（預設）的組態來啟動。如果您的網路運作中，請確保您瞭解任何指令可能造成的影響。

背景資訊

FTD封包轉送機制

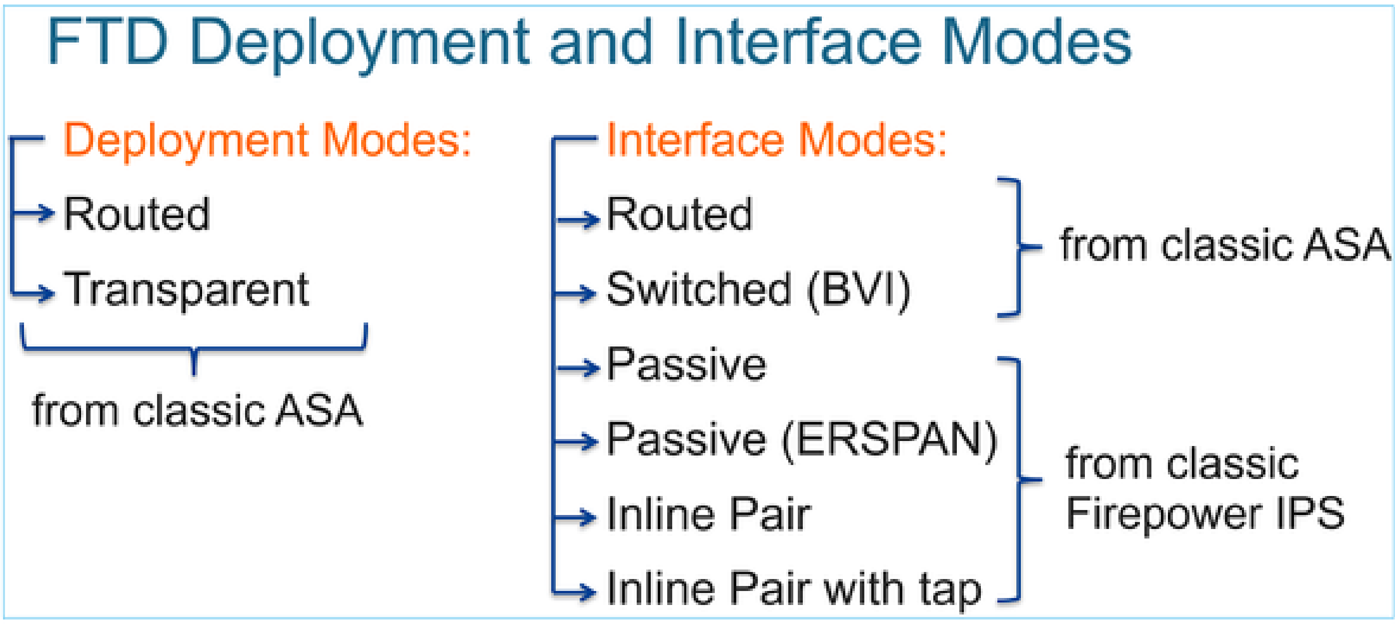
FTD 是一個整合的軟體映像，其中包括 2 個主引擎：

- 資料路徑引擎(LINA)
- Snort 引擎

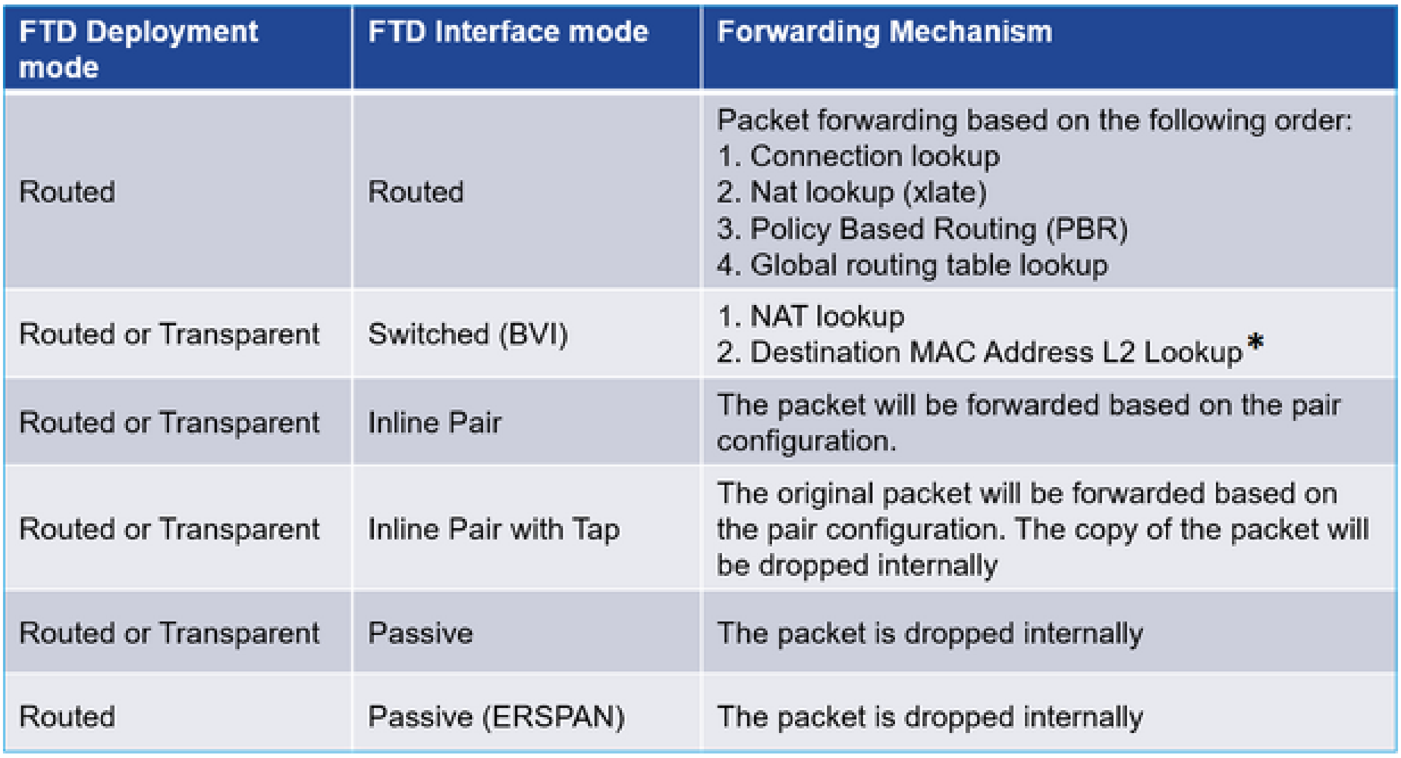


資料路徑和Snort引擎是FTD資料平面的主要部分。

FTD資料平面轉送機制取決於介面模式。下一張圖總結了各種介面模式以及FTD部署模式：

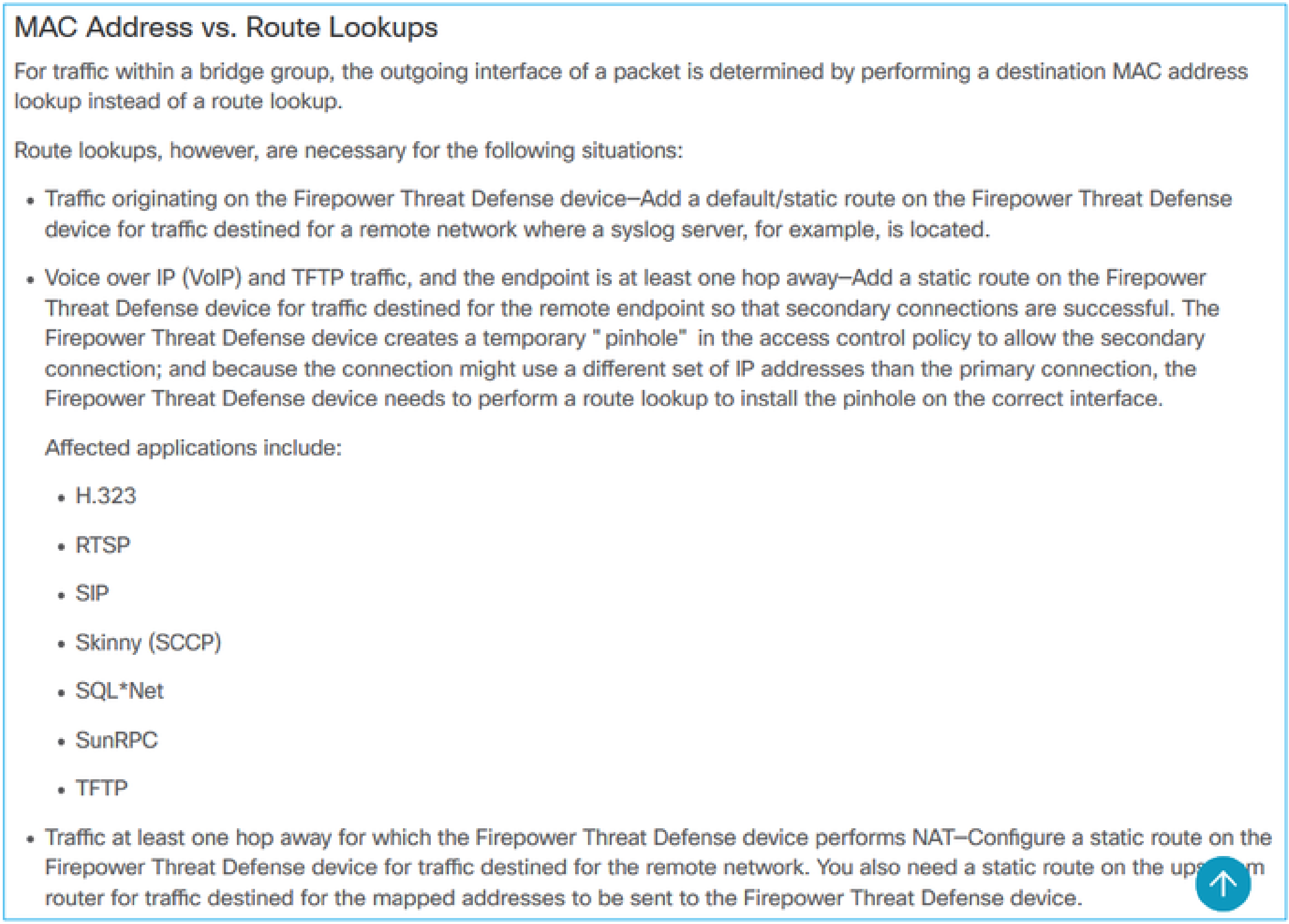


下表總結FTD如何根據介面模式在資料平面中轉送封包。轉送機制按優先順序排列：



FTD Deployment mode	FTD Interface mode	Forwarding Mechanism
Routed	Routed	Packet forwarding based on the following order: 1. Connection lookup 2. Nat lookup (xlate) 3. Policy Based Routing (PBR) 4. Global routing table lookup
Routed or Transparent	Switched (BVI)	1. NAT lookup 2. Destination MAC Address L2 Lookup*
Routed or Transparent	Inline Pair	The packet will be forwarded based on the pair configuration.
Routed or Transparent	Inline Pair with Tap	The original packet will be forwarded based on the pair configuration. The copy of the packet will be dropped internally
Routed or Transparent	Passive	The packet is dropped internally
Routed	Passive (ERSPAN)	The packet is dropped internally

*在某些情況下，處於透明模式的FTD會執行路由查詢：



MAC Address vs. Route Lookups

For traffic within a bridge group, the outgoing interface of a packet is determined by performing a destination MAC address lookup instead of a route lookup.

Route lookups, however, are necessary for the following situations:

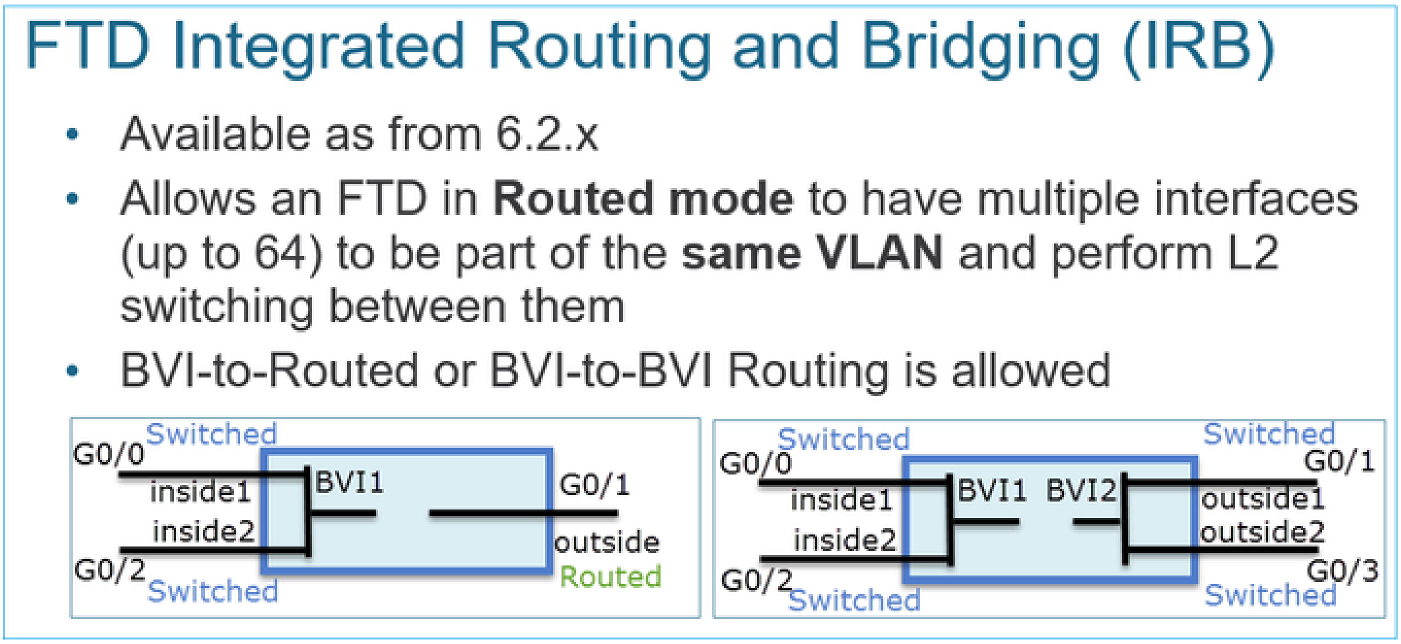
- Traffic originating on the Firepower Threat Defense device–Add a default/static route on the Firepower Threat Defense device for traffic destined for a remote network where a syslog server, for example, is located.
- Voice over IP (VoIP) and TFTP traffic, and the endpoint is at least one hop away–Add a static route on the Firepower Threat Defense device for traffic destined for the remote endpoint so that secondary connections are successful. The Firepower Threat Defense device creates a temporary "pinhole" in the access control policy to allow the secondary connection; and because the connection might use a different set of IP addresses than the primary connection, the Firepower Threat Defense device needs to perform a route lookup to install the pinhole on the correct interface.

  Affected applications include:

  - H.323
  - RTSP
  - SIP
  - Skinny (SCCP)
  - SQL*Net
  - SunRPC
  - TFTP
- Traffic at least one hop away for which the Firepower Threat Defense device performs NAT–Configure a static route on the Firepower Threat Defense device for traffic destined for the remote network. You also need a static route on the upstream router for traffic destined for the mapped addresses to be sent to the Firepower Threat Defense device.

檢視FMC指南以瞭解更多詳細資訊。

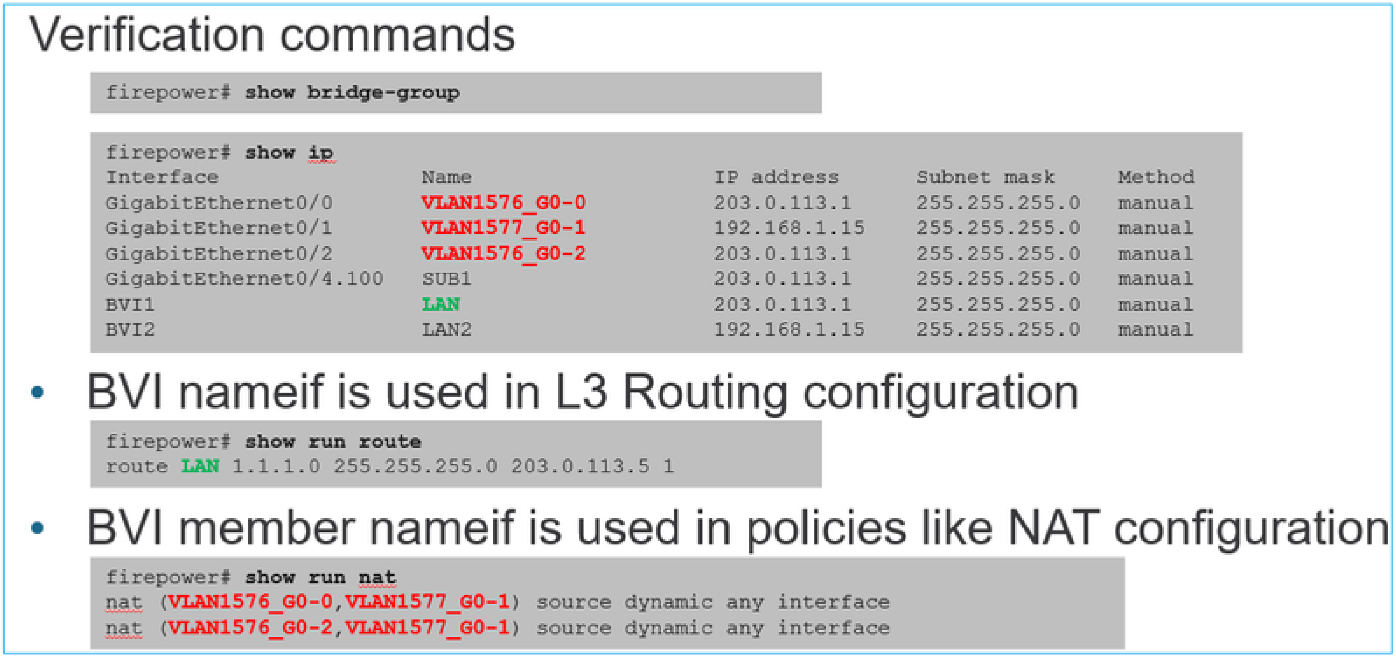
自6.2.x版本起，FTD支援整合路由和橋接(IRB):



FTD Integrated Routing and Bridging (IRB)

- Available as from 6.2.x
- Allows an FTD in **Routed mode** to have multiple interfaces (up to 64) to be part of the **same VLAN** and perform L2 switching between them
- BVI-to-Routed or BVI-to-BVI Routing is allowed

BVI驗證命令：



Verification commands

```
firepower# show bridge-group
```

```
firepower# show ip
Interface                Name            IP address      Subnet mask     Method
GigabitEthernet0/0       VLAN1576_G0-0   203.0.113.1     255.255.255.0   manual
GigabitEthernet0/1       VLAN1577_G0-1   192.168.1.15    255.255.255.0   manual
GigabitEthernet0/2       VLAN1576_G0-2   203.0.113.1     255.255.255.0   manual
GigabitEthernet0/4.100   SUB1            203.0.113.1     255.255.255.0   manual
BVI1                     LAN             203.0.113.1     255.255.255.0   manual
BVI2                     LAN2            192.168.1.15    255.255.255.0   manual
```

- BVI nameif is used in L3 Routing configuration

```
firepower# show run route
route LAN 1.1.1.0 255.255.255.0 203.0.113.5 1
```

- BVI member nameif is used in policies like NAT configuration

```
firepower# show run nat
nat (VLAN1576_G0-0,VLAN1577_G0-1) source dynamic any interface
nat (VLAN1576_G0-2,VLAN1577_G0-1) source dynamic any interface
```

要點

對於路由介面或BVI(IRB)，資料包轉發基於以下順序：

- 連線查詢
- NAT查詢（目標NAT，也稱為UN-NAT）
- 原則型路由(PBR)
- 全域性路由表查詢

源NAT呢？

在全域性路由查詢之後檢查源NAT。

本文檔的其餘部分將重點介紹路由介面模式。

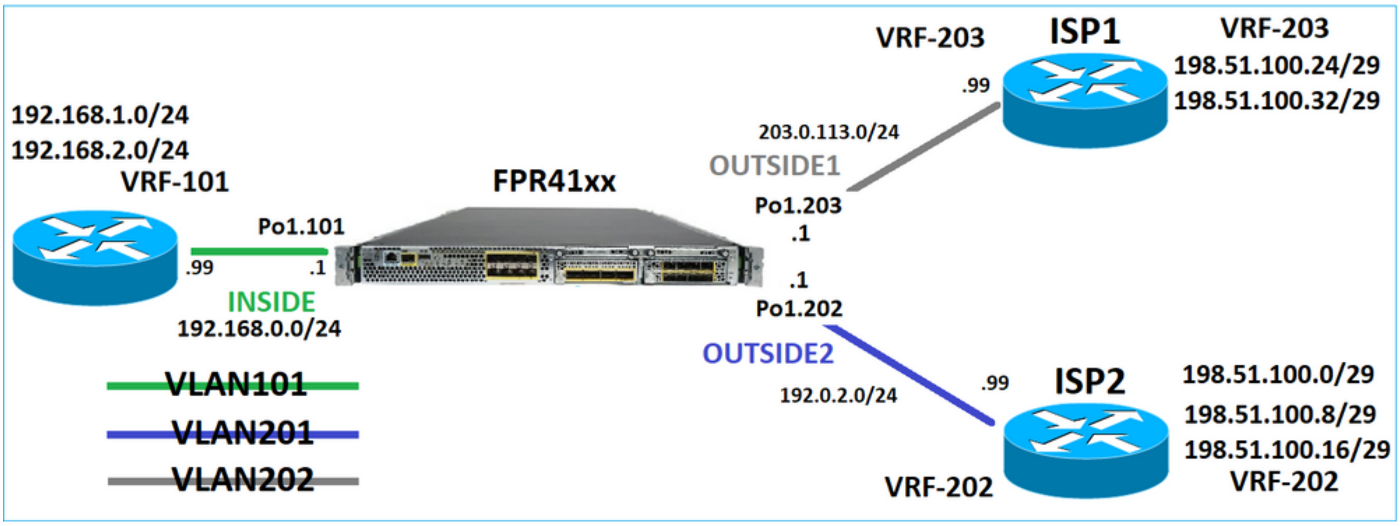
資料平面(LINA)路由行為

在路由介面模式下，FTD LINA分兩個階段轉送封包：

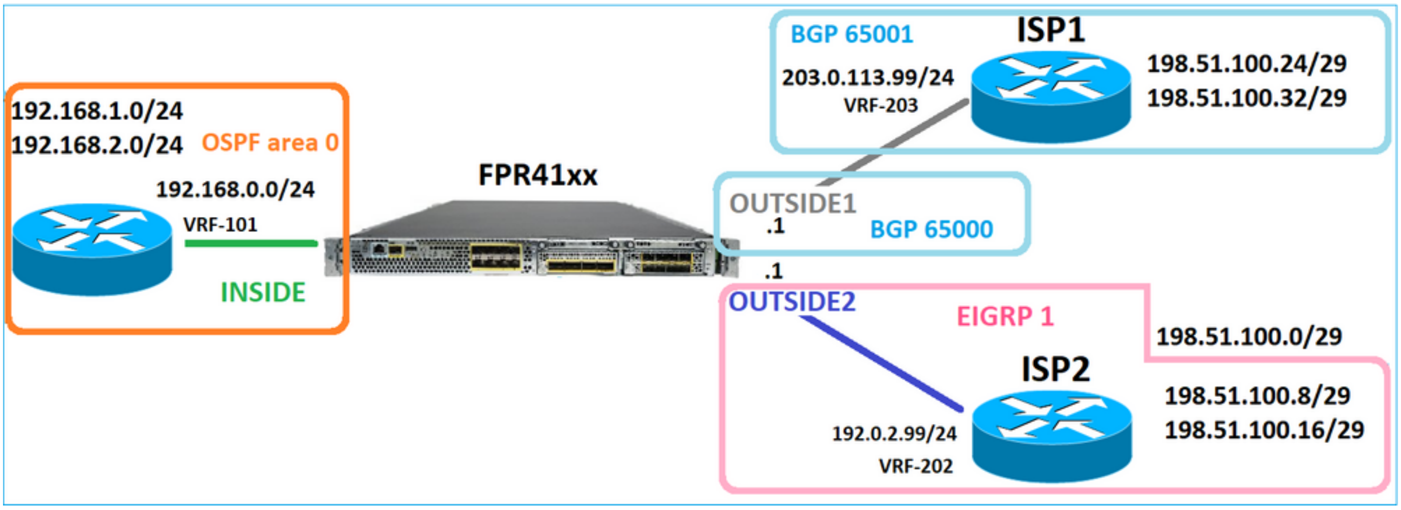
第1階段 — 輸出介面確定

第2階段 — 下一跳選擇

請考慮使用此拓樸：



此路由設計：



FTD路由組態：

```
firepower# show run router
router ospf 1
network 192.168.0.0 255.255.255.0 area 0
log-adj-changes
```

```
!
router bgp 65000
bgp log-neighbor-changes
bgp router-id vrf auto-assign
address-family ipv4 unicast
neighbor 203.0.113.99 remote-as 65001
neighbor 203.0.113.99 ebgp-multihop 255
neighbor 203.0.113.99 transport path-mtu-discovery disable
neighbor 203.0.113.99 activate
no auto-summary
no synchronization
exit-address-family
!
router eigrp 1
no default-information in
no default-information out
no eigrp log-neighbor-warnings
no eigrp log-neighbor-changes
network 192.0.2.0 255.255.255.0
!
firepower# show run route
route OUTSIDE2 198.51.100.0 255.255.255.248 192.0.2.99 1
```

FTD路由資訊庫(RIB) — 控制平面：

```
firepower# show route | begin Gate
Gateway of last resort is not set

C 192.0.2.0 255.255.255.0 is directly connected, OUTSIDE2
L 192.0.2.1 255.255.255.255 is directly connected, OUTSIDE2
C 192.168.0.0 255.255.255.0 is directly connected, INSIDE
L 192.168.0.1 255.255.255.255 is directly connected, INSIDE
O 192.168.1.1 255.255.255.255
[110/11] via 192.168.0.99, 01:11:25, INSIDE
O 192.168.2.1 255.255.255.255
[110/11] via 192.168.0.99, 01:11:15, INSIDE
S 198.51.100.0 255.255.255.248 [1/0] via 192.0.2.99, OUTSIDE2
D 198.51.100.8 255.255.255.248
[90/130816] via 192.0.2.99, 01:08:11, OUTSIDE2
D 198.51.100.16 255.255.255.248
[90/130816] via 192.0.2.99, 01:08:04, OUTSIDE2
B 198.51.100.24 255.255.255.248 [20/0] via 203.0.113.99, 00:28:29
B 198.51.100.32 255.255.255.248 [20/0] via 203.0.113.99, 00:28:16
C 203.0.113.0 255.255.255.0 is directly connected, OUTSIDE1
L 203.0.113.1 255.255.255.255 is directly connected, OUTSIDE1
```

對應的FTD加速安全路徑(ASP)路由表 — 資料平面：

```
firepower# show asp table routing
route table timestamp: 91
in 169.254.1.1 255.255.255.255 identity
in 192.168.0.1 255.255.255.255 identity
in 192.0.2.1 255.255.255.255 identity
in 192.168.1.1 255.255.255.255 via 192.168.0.99, INSIDE
in 192.168.2.1 255.255.255.255 via 192.168.0.99, INSIDE
in 203.0.113.1 255.255.255.255 identity
in 169.254.1.0 255.255.255.248 nlp_int_tap
in 198.51.100.0 255.255.255.248 via 192.0.2.99, OUTSIDE2
in 198.51.100.8 255.255.255.248 via 192.0.2.99, OUTSIDE2
in 198.51.100.16 255.255.255.248 via 192.0.2.99, OUTSIDE2
in 198.51.100.24 255.255.255.248 via 203.0.113.99 (unresolved, timestamp: 89)
in 198.51.100.32 255.255.255.248 via 203.0.113.99 (unresolved, timestamp: 90)
in 192.168.0.0 255.255.255.0 INSIDE
in 192.0.2.0 255.255.255.0 OUTSIDE2
in 203.0.113.0 255.255.255.0 OUTSIDE1
in ff02::1 ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff identity
in ff02::1:ff01:3 ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff identity
in ff02::1:ff00:1 ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff identity
in fe80::200:ff:fe01:3 ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff identity
in fd00:0:0:1::1 ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff identity
in fd00:0:0:1:: ffff:ffff:ffff:ffff:: nlp_int_tap
out 255.255.255.255 255.255.255.255 OUTSIDE1
out 203.0.113.1 255.255.255.255 OUTSIDE1
out 203.0.113.0 255.255.255.0 OUTSIDE1
out 224.0.0.0 240.0.0.0 OUTSIDE1
out 255.255.255.255 255.255.255.255 OUTSIDE2
out 192.0.2.1 255.255.255.255 OUTSIDE2
out 198.51.100.0 255.255.255.248 via 192.0.2.99, OUTSIDE2
out 198.51.100.8 255.255.255.248 via 192.0.2.99, OUTSIDE2
out 198.51.100.16 255.255.255.248 via 192.0.2.99, OUTSIDE2
out 192.0.2.0 255.255.255.0 OUTSIDE2
out 224.0.0.0 240.0.0.0 OUTSIDE2
out 255.255.255.255 255.255.255.255 INSIDE
out 192.168.0.1 255.255.255.255 INSIDE
out 192.168.1.1 255.255.255.255 via 192.168.0.99, INSIDE
out 192.168.2.1 255.255.255.255 via 192.168.0.99, INSIDE
out 192.168.0.0 255.255.255.0 INSIDE
out 224.0.0.0 240.0.0.0 INSIDE
out 255.255.255.255 255.255.255.255 cmi_mgmt_int_tap
out 224.0.0.0 240.0.0.0 cmi_mgmt_int_tap
out 255.255.255.255 255.255.255.255 ha_ctl_nlp_int_tap
out 224.0.0.0 240.0.0.0 ha_ctl_nlp_int_tap
out 255.255.255.255 255.255.255.255 ccl_ha_nlp_int_tap
out 224.0.0.0 240.0.0.0 ccl_ha_nlp_int_tap
out 255.255.255.255 255.255.255.255 nlp_int_tap
out 169.254.1.1 255.255.255.255 nlp_int_tap
out 169.254.1.0 255.255.255.248 nlp_int_tap
out 224.0.0.0 240.0.0.0 nlp_int_tap
out fd00:0:0:1::1 ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff nlp_int_tap
out fd00:0:0:1:: ffff:ffff:ffff:ffff:: nlp_int_tap
out fe80:: ffc0:: nlp_int_tap
out ff00:: ff00:: nlp_int_tap
out 0.0.0.0 0.0.0.0 via 0.0.0.0, identity
out :: :: via 0.0.0.0, identity
```

要點

FTD（在某種意義上類似於調適型安全裝置 — ASA）首先確定封包的出口（輸出）介面（為此，它會檢視ASP路由表的「in」專案）。然後，對於確定的介面，它會嘗試查詢下一個躍點（為此，它會檢視ASP路由表中的「out」條目）。舉例來說：

```
firepower# show asp table routing | include in.*198.51.100.0
in 198.51.100.0 255.255.255.248 via 192.0.2.99, OUTSIDE2
firepower#
firepower# show asp table routing | include out.*OUTSIDE2
out 255.255.255.255 255.255.255.255 OUTSIDE2
out 192.0.2.1 255.255.255.255 OUTSIDE2
out 198.51.100.0 255.255.255.248 via 192.0.2.99, OUTSIDE2
out 198.51.100.8 255.255.255.248 via 192.0.2.99, OUTSIDE2
out 198.51.100.16 255.255.255.248 via 192.0.2.99, OUTSIDE2
out 192.0.2.0 255.255.255.0 OUTSIDE2
out 224.0.0.0 240.0.0.0 OUTSIDE2
```

最後，對於已解析的下一跳，LINA會檢查ARP快取中的有效鄰接關係。

FTD Packet Tracer工具可確認此程式：

```
firepower# packet-tracer input INSIDE icmp 192.168.1.1 8 0 198.51.100.1

Phase: 1
Type: ACCESS-LIST
Subtype:
Result: ALLOW
Elapsed time: 7582 ns
Config:
Implicit Rule
Additional Information:
MAC Access list

Phase: 2
Type: INPUT-ROUTE-LOOKUP
Subtype: Resolve Egress Interface
Result: ALLOW
Elapsed time: 8474 ns
Config:
Additional Information:
Found next-hop 192.0.2.99 using egress ifc OUTSIDE2(vrfid:0)

Phase: 3
Type: ACCESS-LIST
Subtype: log
Result: ALLOW
Elapsed time: 5017 ns
Config:
access-group CSM_FW_ACL_ global
access-list CSM_FW_ACL_ advanced permit ip any any rule-id 268434433
access-list CSM_FW_ACL_ remark rule-id 268434433: ACCESS POLICY: mzafeiro_empty - Default
access-list CSM_FW_ACL_ remark rule-id 268434433: L4 RULE: DEFAULT ACTION RULE
Additional Information:
This packet will be sent to snort for additional processing where a verdict will be reached

Phase: 4
Type: CONN-SETTINGS
Subtype:
Result: ALLOW
Elapsed time: 5017 ns
Config:
```

```
class-map class-default
match any
policy-map global_policy
class class-default
set connection advanced-options UM_STATIC_TCP_MAP
service-policy global_policy global
Additional Information:

Phase: 5
Type: NAT
Subtype: per-session
Result: ALLOW
Elapsed time: 5017 ns
Config:
Additional Information:

Phase: 6
Type: IP-OPTIONS
Subtype:
Result: ALLOW
Elapsed time: 5017 ns
Config:
Additional Information:

Phase: 7
Type: INSPECT
Subtype: np-inspect
Result: ALLOW
Elapsed time: 57534 ns
Config:
class-map inspection_default
match default-inspection-traffic
policy-map global_policy
class inspection_default
inspect icmp
service-policy global_policy global
Additional Information:

Phase: 8
Type: INSPECT
Subtype: np-inspect
Result: ALLOW
Elapsed time: 3122 ns
Config:
Additional Information:

Phase: 9
Type: NAT
Subtype: per-session
Result: ALLOW
Elapsed time: 29882 ns
Config:
Additional Information:

Phase: 10
Type: IP-OPTIONS
Subtype:
Result: ALLOW
Elapsed time: 446 ns
Config:
Additional Information:
```

```
Phase: 11
Type: FLOW-CREATION
Subtype:
Result: ALLOW
Elapsed time: 20962 ns
Config:
Additional Information:
New flow created with id 178, packet dispatched to next module

Phase: 12
Type: EXTERNAL-INSPECT
Subtype:
Result: ALLOW
Elapsed time: 20070 ns
Config:
Additional Information:
Application: 'SNORT Inspect'

Phase: 13
Type: SNORT
Subtype:
Result: ALLOW
Elapsed time: 870592 ns
Config:
Additional Information:
Snort Trace:
Packet: ICMP
Session: new snort session
Snort id 1, NAP id 1, IPS id 0, Verdict PASS
Snort Verdict: (pass-packet) allow this packet

Phase: 14
Type: INPUT-ROUTE-LOOKUP-FROM-OUTPUT-ROUTE-LOOKUP
Subtype: Resolve Preferred Egress interface
Result: ALLOW
Elapsed time: 6244 ns
Config:
Additional Information:
Found next-hop 192.0.2.99 using egress ifc OUTSIDE2(vrfid:0)

Phase: 15
Type: ADJACENCY-LOOKUP
Subtype: Resolve Nexthop IP address to MAC
Result: ALLOW
Elapsed time: 1784 ns
Config:
Additional Information:
Found adjacency entry for Next-hop 192.0.2.99 on interface OUTSIDE2
Adjacency :Active
MAC address 4c4e.35fc.fcd8 hits 5 reference 1

Result:
input-interface: INSIDE(vrfid:0)
input-status: up
input-line-status: up
output-interface: OUTSIDE2(vrfid:0)
output-status: up
output-line-status: up
Action: allow
Time Taken: 1046760 ns
```

FTD ARP表（如控制平面所示）：

```
firepower# show arp
OUTSIDE1 203.0.113.99 4c4e.35fc.fcd8 3051
OUTSIDE2 192.0.2.99 4c4e.35fc.fcd8 5171
```

要強制ARP解析，請執行以下操作：

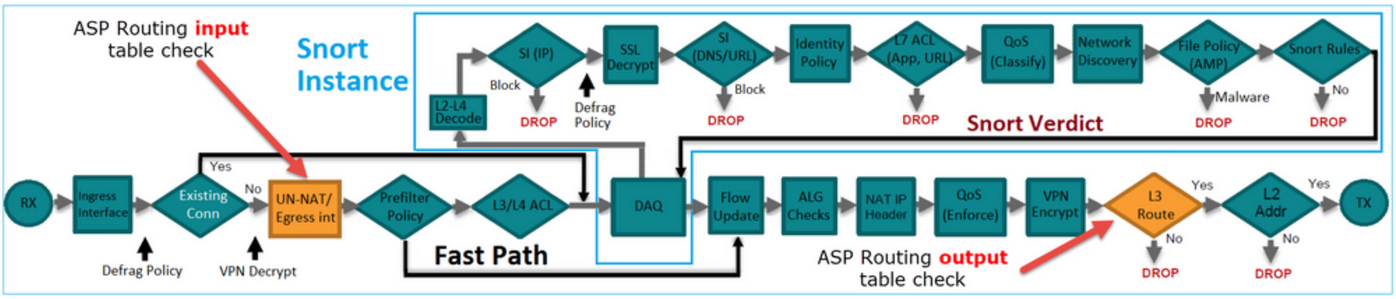
```
firepower# ping 192.168.0.99
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.0.99, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
firepower# show arp
INSIDE 192.168.0.99 4c4e.35fc.fcd8 45
OUTSIDE1 203.0.113.99 4c4e.35fc.fcd8 32
OUTSIDE2 192.0.2.99 4c4e.35fc.fcd8 1
```

資料平面中看到的FTD ARP表：

```
firepower# show asp table arp

Context: single_vf, Interface: OUTSIDE1
203.0.113.99 Active 4c4e.35fc.fcd8 hits 2 reference 1

Context: single_vf, Interface: OUTSIDE2
192.0.2.99 Active 4c4e.35fc.fcd8 hits 5 reference 0

Context: single_vf, Interface: INSIDE
192.168.0.99 Active 4c4e.35fc.fcd8 hits 5 reference 0

Context: single_vf, Interface: identity
:: Active 0000.0000.0000 hits 0 reference 0
0.0.0.0 Active 0000.0000.0000 hits 848 reference 0

Last clearing of hits counters: Never
```

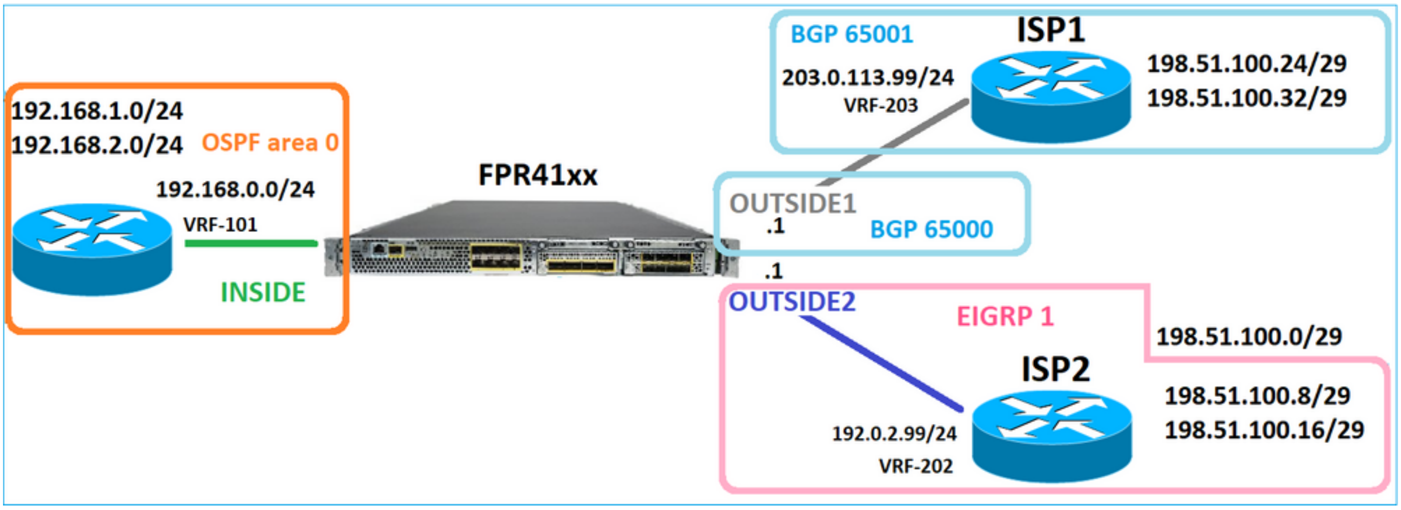
FTD營運順序

該圖顯示了操作的順序以及執行輸入和輸出ASP Routing檢查的位置：



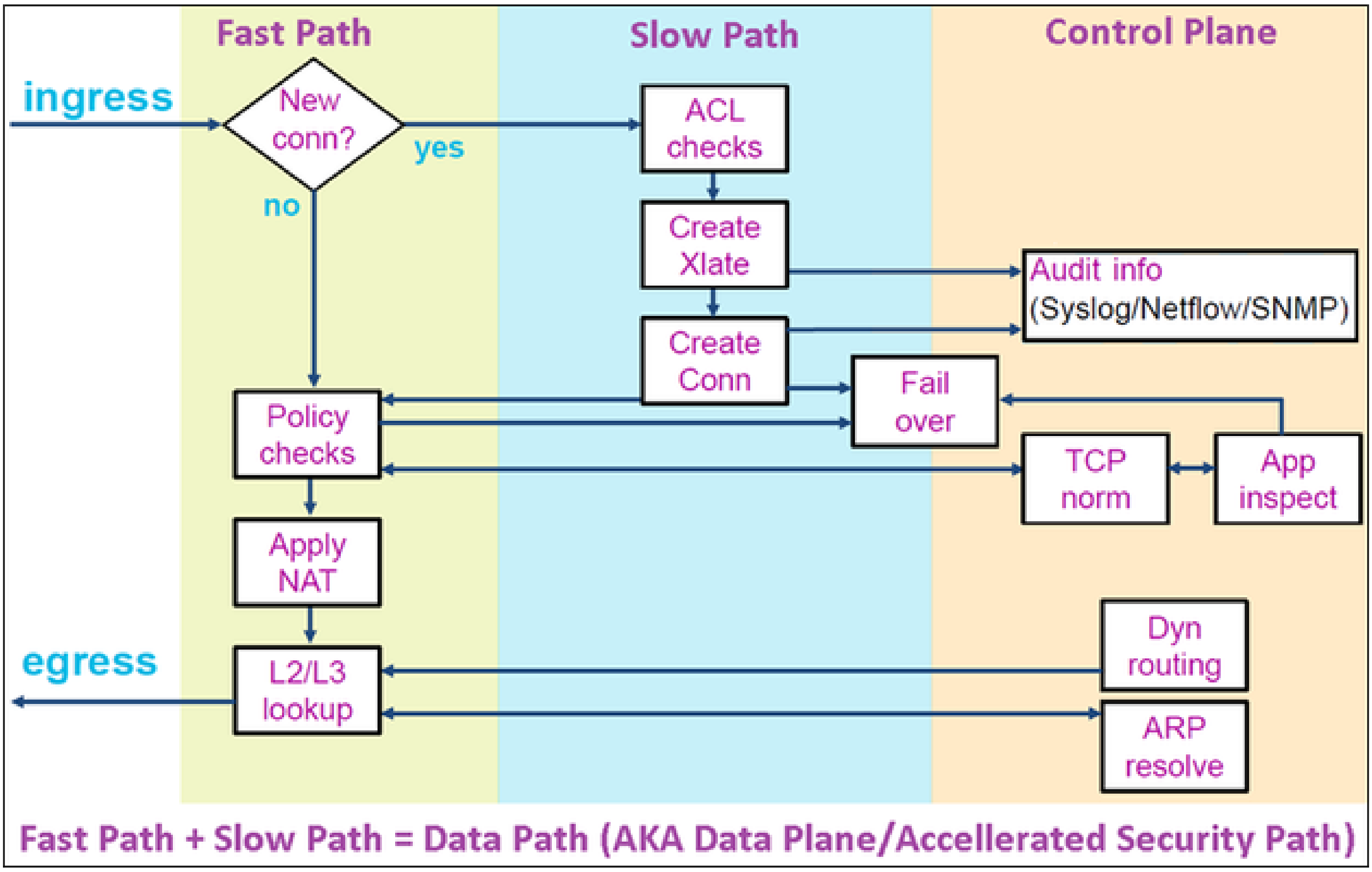
設定

案例1 — 基於連線查詢的轉發



如前所述，FTD LINA引擎的主要元件是資料路徑程式（多個例項，基於裝置核心數量）。此外，資料路徑（也稱為加速安全路徑 — ASP）由2個路徑組成：

1. 慢速路徑=負責建立新連線（它填充快速路徑）。
2. 快速路徑=處理屬於已建立連線的資料包。



- show route和show arp等命令會顯示控制平面的內容。
- 另一方面，show asp table routing和show asp table arp等命令會顯示實際應用的ASP(Datapath)的內容。

在FTD INSIDE介面上啟用含有追蹤軌跡的擷取：

```
firepower# capture CAPI trace detail interface INSIDE match ip host 192.168.1.1 host 198.51.100.1
```

透過FTD開啟Telnet作業階段：

```
Router1# telnet 198.51.100.1 /vrf VRF-101 /source-interface lo1
Trying 198.51.100.1 ... Open
```

FTD擷取顯示連線開始時的封包（擷取TCP三次握手）：

```
firepower# show capture CAPI

26 packets captured
```

```
1: 10:50:38.407190 802.1Q vlan#101 P0 192.168.1.1.57734 > 198.51.100.1.23: S 1306692135:1306692135(0) w
2: 10:50:38.408929 802.1Q vlan#101 P0 198.51.100.1.23 > 192.168.1.1.57734: S 1412677784:1412677784(0) a
3: 10:50:38.409265 802.1Q vlan#101 P0 192.168.1.1.57734 > 198.51.100.1.23: . ack 1412677785 win 4128
4: 10:50:38.409433 802.1Q vlan#101 P0 192.168.1.1.57734 > 198.51.100.1.23: P 1306692136:1306692154(18) a
5: 10:50:38.409845 802.1Q vlan#101 P0 192.168.1.1.57734 > 198.51.100.1.23: . ack 1412677785 win 4128
6: 10:50:38.410135 802.1Q vlan#101 P0 198.51.100.1.23 > 192.168.1.1.57734: . ack 1306692154 win 4110
7: 10:50:38.411355 802.1Q vlan#101 P0 198.51.100.1.23 > 192.168.1.1.57734: P 1412677785:1412677797(12) a
8: 10:50:38.413049 802.1Q vlan#101 P0 192.168.1.1.57734 > 198.51.100.1.23: P 1306692154:1306692157(3) a
9: 10:50:38.413140 802.1Q vlan#101 P0 192.168.1.1.57734 > 198.51.100.1.23: P 1306692157:1306692166(9) a
10: 10:50:38.414071 802.1Q vlan#101 P0 198.51.100.1.23 > 192.168.1.1.57734: . 1412677797:1412678322(525
...
```

追蹤第一個封包(TCP SYN)。此封包會通過FTD LINA慢速路徑，並在此案例中執行全域路由查詢：

```
firepower# show capture CAPI packet-number 1 trace

26 packets captured

   1: 10:50:38.407190 802.1Q vlan#101 P0 192.168.1.1.57734 > 198.51.100.1.23: S 1306692135:1306692135(0
Phase: 1
Type: CAPTURE
Subtype:
Result: ALLOW
Elapsed time: 4683 ns
Config:
Additional Information:
Forward Flow based lookup yields rule:
in id=0x1505f1d17940, priority=13, domain=capture, deny=false
hits=1783, user_data=0x1505f2096910, cs_id=0x0, l3_type=0x0
src mac=0000.0000.0000, mask=0000.0000.0000
dst mac=0000.0000.0000, mask=0000.0000.0000
input_ifc=INSIDE, output_ifc=any

Phase: 2
Type: ACCESS-LIST
Subtype:
Result: ALLOW
Elapsed time: 4683 ns
Config:
Implicit Rule
Additional Information:
Forward Flow based lookup yields rule:
in id=0x1502a7ba4d40, priority=1, domain=permit, deny=false
hits=28, user_data=0x0, cs_id=0x0, l3_type=0x8
src mac=0000.0000.0000, mask=0000.0000.0000
dst mac=0000.0000.0000, mask=0100.0000.0000
input_ifc=INSIDE, output_ifc=any

Phase: 3
Type: INPUT-ROUTE-LOOKUP
Subtype: Resolve Egress Interface
Result: ALLOW
Elapsed time: 5798 ns
Config:
Additional Information:
Found next-hop 192.0.2.99 using egress ifc OUTSIDE2(vrfid:0)
```

```
Phase: 4
Type: ACCESS-LIST
Subtype: log
Result: ALLOW
Elapsed time: 3010 ns
Config:
access-group CSM_FW_ACL_ global
access-list CSM_FW_ACL_ advanced permit ip any any rule-id 268434433
access-list CSM_FW_ACL_ remark rule-id 268434433: ACCESS POLICY: mzafeiro_empty - Default
access-list CSM_FW_ACL_ remark rule-id 268434433: L4 RULE: DEFAULT ACTION RULE
Additional Information:
This packet will be sent to snort for additional processing where a verdict will be reached
Forward Flow based lookup yields rule:
in id=0x1505f1e2e980, priority=12, domain=permit, deny=false
hits=4, user_data=0x15024a56b940, cs_id=0x0, use_real_addr, flags=0x0, protocol=0
src ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any, ifc=any
dst ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any, ifc=any,, dscp=0x0, nsg_id=none
input_ifc=any, output_ifc=any

Phase: 5
Type: CONN-SETTINGS
Subtype:
Result: ALLOW
Elapsed time: 3010 ns
Config:
class-map class-default
match any
policy-map global_policy
class class-default
set connection advanced-options UM_STATIC_TCP_MAP
service-policy global_policy global
Additional Information:
Forward Flow based lookup yields rule:
in id=0x1505f1f18bc0, priority=7, domain=conn-set, deny=false
hits=4, user_data=0x1505f1f13f70, cs_id=0x0, use_real_addr, flags=0x0, protocol=0
src ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any
dst ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any, dscp=0x0, nsg_id=none
input_ifc=INSIDE(vrfid:0), output_ifc=any

Phase: 6
Type: NAT
Subtype: per-session
Result: ALLOW
Elapsed time: 3010 ns
Config:
Additional Information:
Forward Flow based lookup yields rule:
in id=0x15052e96b150, priority=0, domain=nat-per-session, deny=false
hits=125, user_data=0x0, cs_id=0x0, reverse, use_real_addr, flags=0x0, protocol=6
src ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any
dst ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any, dscp=0x0, nsg_id=none
input_ifc=any, output_ifc=any

Phase: 7
Type: IP-OPTIONS
Subtype:
Result: ALLOW
Elapsed time: 3010 ns
Config:
Additional Information:
Forward Flow based lookup yields rule:
```

```
in id=0x1502a7bacde0, priority=0, domain=inspect-ip-options, deny=true
hits=19, user_data=0x0, cs_id=0x0, reverse, flags=0x0, protocol=0
src ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any
dst ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any, dscp=0x0, nsg_id=none
input_ifc=INSIDE(vrfid:0), output_ifc=any

Phase: 8
Type: NAT
Subtype: per-session
Result: ALLOW
Elapsed time: 52182 ns
Config:
Additional Information:
Reverse Flow based lookup yields rule:
in id=0x15052e96b150, priority=0, domain=nat-per-session, deny=false
hits=127, user_data=0x0, cs_id=0x0, reverse, use_real_addr, flags=0x0, protocol=6
src ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any
dst ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any, dscp=0x0, nsg_id=none
input_ifc=any, output_ifc=any

Phase: 9
Type: IP-OPTIONS
Subtype:
Result: ALLOW
Elapsed time: 892 ns
Config:
Additional Information:
Reverse Flow based lookup yields rule:
in id=0x1502a7f9b460, priority=0, domain=inspect-ip-options, deny=true
hits=38, user_data=0x0, cs_id=0x0, reverse, flags=0x0, protocol=0
src ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any
dst ip/id=0.0.0.0, mask=0.0.0.0, port=0, tag=any, dscp=0x0, nsg_id=none
input_ifc=OUTSIDE2(vrfid:0), output_ifc=any

Phase: 10
Type: FLOW-CREATION
Subtype:
Result: ALLOW
Elapsed time: 25422 ns
Config:
Additional Information:
New flow created with id 244, packet dispatched to next module
Module information for forward flow ...
snp_fp_inspect_ip_options
snp_fp_tcp_normalizer
snp_fp_tcp_proxy
snp_fp_snort
snp_fp_tcp_proxy
snp_fp_translate
snp_fp_tcp_normalizer
snp_fp_adjacency
snp_fp_fragment
snp_ifc_stat

Module information for reverse flow ...
snp_fp_inspect_ip_options
snp_fp_tcp_normalizer
snp_fp_translate
snp_fp_tcp_proxy
snp_fp_snort
snp_fp_tcp_proxy
snp_fp_tcp_normalizer
```

```
snp_fp_adjacency
snp_fp_fragment
snp_ifc_stat

Phase: 11
Type: EXTERNAL-INSPECT
Subtype:
Result: ALLOW
Elapsed time: 36126 ns
Config:
Additional Information:
Application: 'SNORT Inspect'

Phase: 12
Type: SNORT
Subtype:
Result: ALLOW
Elapsed time: 564636 ns
Config:
Additional Information:
Snort Trace:
Packet: TCP, SYN, seq 182318660
Session: new snort session
AppID: service unknown (0), application unknown (0)
Snort id 28, NAP id 1, IPS id 0, Verdict PASS
Snort Verdict: (pass-packet) allow this packet

Phase: 13
Type: INPUT-ROUTE-LOOKUP-FROM-OUTPUT-ROUTE-LOOKUP
Subtype: Resolve Preferred Egress interface
Result: ALLOW
Elapsed time: 7136 ns
Config:
Additional Information:
Found next-hop 192.0.2.99 using egress ifc OUTSIDE2(vrfid:0)

Phase: 14
Type: ADJACENCY-LOOKUP
Subtype: Resolve Nexthop IP address to MAC
Result: ALLOW
Elapsed time: 2230 ns
Config:
Additional Information:
Found adjacency entry for Next-hop 192.0.2.99 on interface OUTSIDE2
Adjacency :Active
MAC address 4c4e.35fc.fcd8 hits 10 reference 1

Phase: 15
Type: CAPTURE
Subtype:
Result: ALLOW
Elapsed time: 5352 ns
Config:
Additional Information:
Forward Flow based lookup yields rule:
out id=0x150521389870, priority=13, domain=capture, deny=false
hits=1788, user_data=0x1505f1d2b630, cs_id=0x0, l3_type=0x0
src mac=0000.0000.0000, mask=0000.0000.0000
dst mac=0000.0000.0000, mask=0000.0000.0000
input_ifc=OUTSIDE2, output_ifc=any

Result:
```

```
input-interface: INSIDE(vrfid:0)
input-status: up
input-line-status: up
output-interface: OUTSIDE2(vrfid:0)
output-status: up
output-line-status: up
Action: allow
Time Taken: 721180 ns

1 packet shown
firepower#
```

跟蹤來自同一流的另一個入口資料包。與活動連線匹配的資料包：

```
firepower# show capture CAPI packet-number 3 trace

33 packets captured

3: 10:50:38.409265 802.1Q vlan#101 P0 192.168.1.1.57734 > 198.51.100.1.23: . ack 1412677785 win 4128
Phase: 1
Type: CAPTURE
Subtype:
Result: ALLOW
Elapsed time: 2676 ns
Config:
Additional Information:
Forward Flow based lookup yields rule:
in id=0x1505f1d17940, priority=13, domain=capture, deny=false
hits=105083, user_data=0x1505f2096910, cs_id=0x0, l3_type=0x0
src mac=0000.0000.0000, mask=0000.0000.0000
dst mac=0000.0000.0000, mask=0000.0000.0000
input_ifc=INSIDE, output_ifc=any

Phase: 2
Type: ACCESS-LIST
Subtype:
Result: ALLOW
Elapsed time: 2676 ns
Config:
Implicit Rule
Additional Information:
Forward Flow based lookup yields rule:
in id=0x1502a7ba4d40, priority=1, domain=permit, deny=false
hits=45, user_data=0x0, cs_id=0x0, l3_type=0x8
src mac=0000.0000.0000, mask=0000.0000.0000
dst mac=0000.0000.0000, mask=0100.0000.0000
input_ifc=INSIDE, output_ifc=any

Phase: 3
Type: FLOW-LOOKUP
Subtype:
Result: ALLOW
Elapsed time: 1338 ns
Config:
Additional Information:
Found flow with id 2552, using existing flow
```

```
Module information for forward flow ...
snp_fp_inspect_ip_options
snp_fp_tcp_normalizer
snp_fp_snort
snp_fp_translate
snp_fp_tcp_normalizer
snp_fp_adjacency
snp_fp_fragment
snp_ifc_stat

Module information for reverse flow ...
snp_fp_inspect_ip_options
snp_fp_tcp_normalizer
snp_fp_translate
snp_fp_snort
snp_fp_tcp_normalizer
snp_fp_adjacency
snp_fp_fragment
snp_ifc_stat

Phase: 4
Type: EXTERNAL-INSPECT
Subtype:
Result: ALLOW
Elapsed time: 16502 ns
Config:
Additional Information:
Application: 'SNORT Inspect'

Phase: 5
Type: SNORT
Subtype:
Result: ALLOW
Elapsed time: 12934 ns
Config:
Additional Information:
Snort Trace:
Packet: TCP, ACK, seq 1306692136, ack 1412677785
AppID: service unknown (0), application unknown (0)
Snort id 19, NAP id 1, IPS id 0, Verdict PASS
Snort Verdict: (pass-packet) allow this packet

Result:
input-interface: INSIDE(vrfid:0)
input-status: up
input-line-status: up
Action: allow
Time Taken: 36126 ns

1 packet shown
firepower#
```

浮動超時

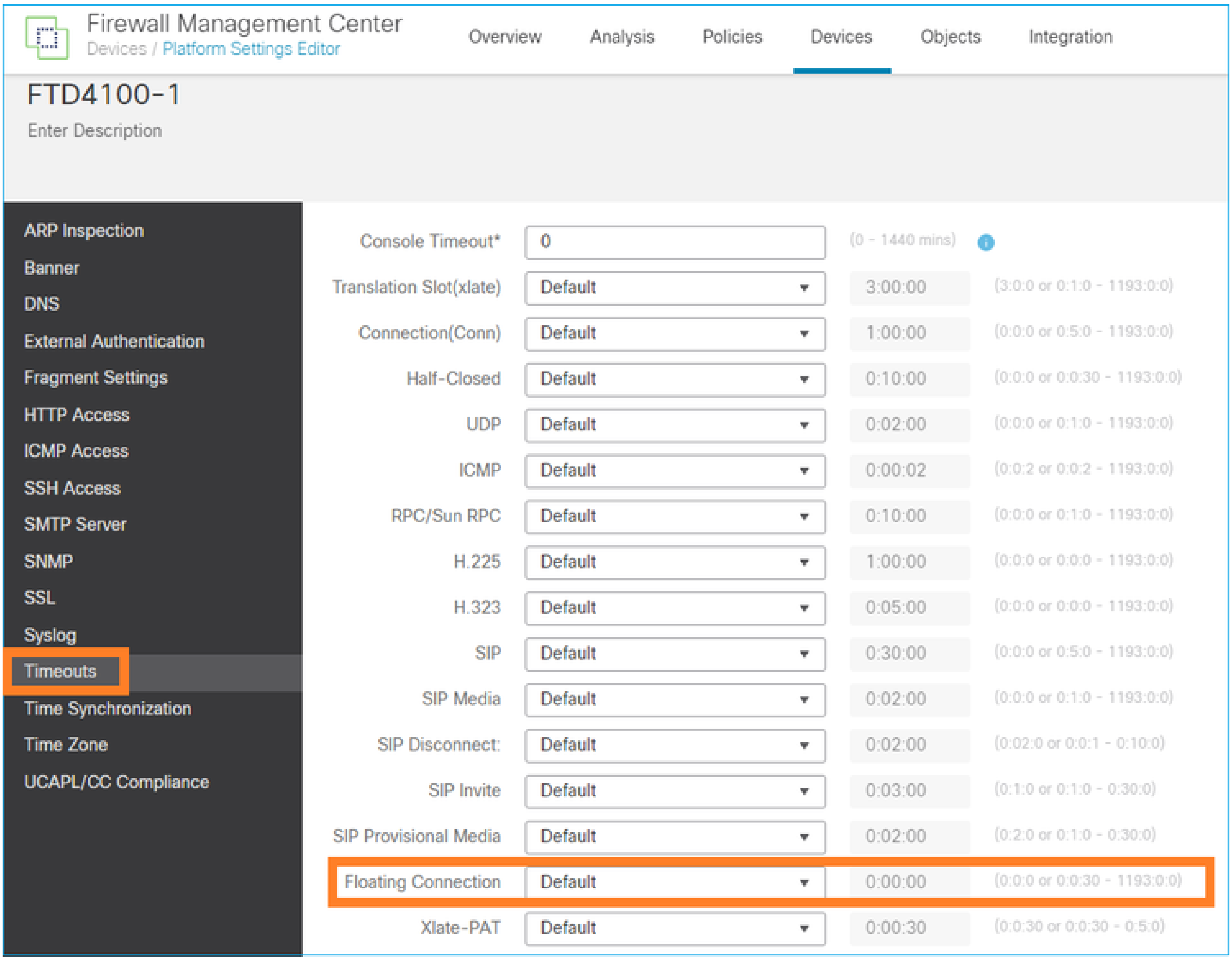
問題

臨時路由不穩定性可能會導致通過FTD建立的長壽命（大象）UDP連線通過不同於預期的FTD介面

建立。

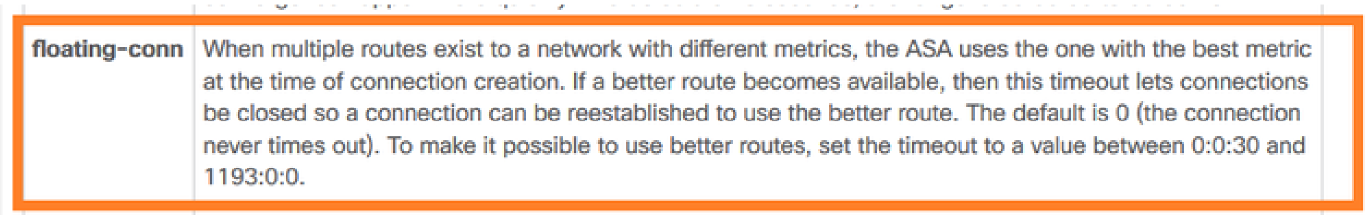
解決方案

要修復此問題，請將timeout floating-conn設定為與預設值不同的值（已禁用）：



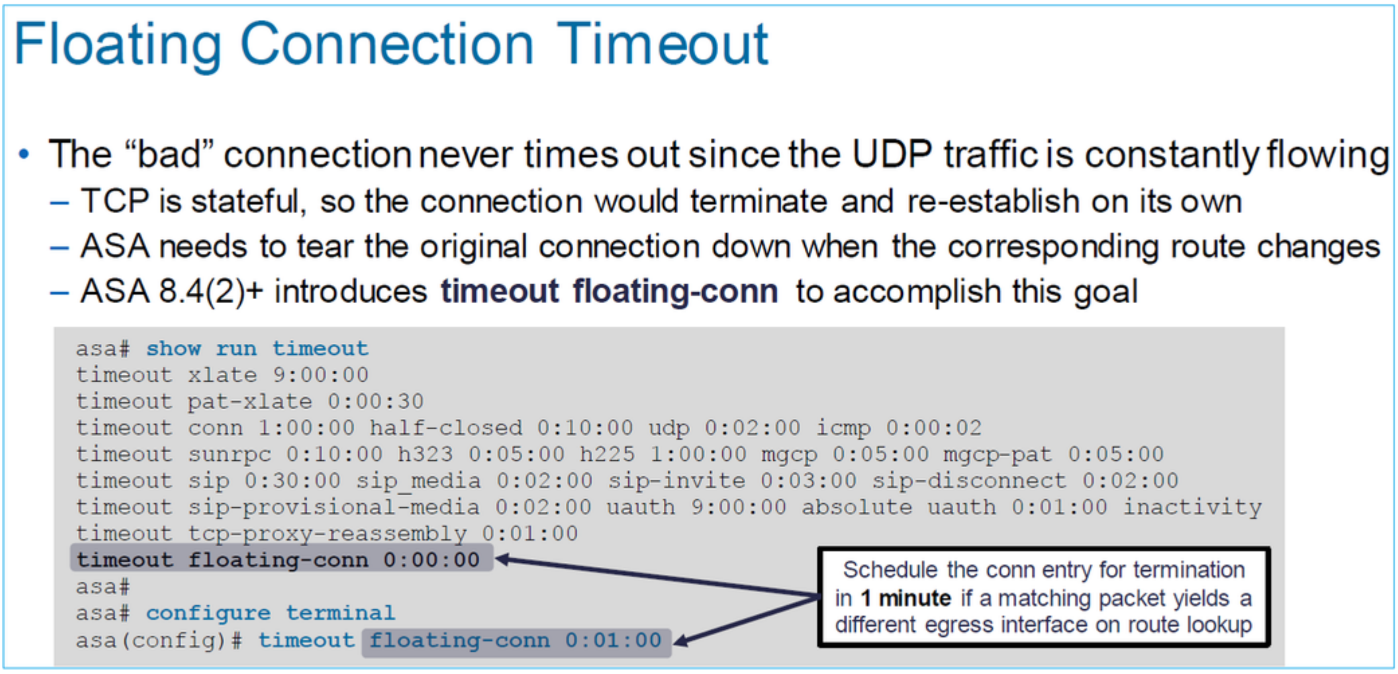
Console Timeout*	0	(0 - 1440 mins)	
Translation Slot(xlate)	Default	3:00:00	(3:0:0 or 0:1:0 - 1193:0:0)
Connection(Conn)	Default	1:00:00	(0:0:0 or 0:5:0 - 1193:0:0)
Half-Closed	Default	0:10:00	(0:0:0 or 0:0:30 - 1193:0:0)
UDP	Default	0:02:00	(0:0:0 or 0:1:0 - 1193:0:0)
ICMP	Default	0:00:02	(0:0:2 or 0:0:2 - 1193:0:0)
RPC/Sun RPC	Default	0:10:00	(0:0:0 or 0:1:0 - 1193:0:0)
H.225	Default	1:00:00	(0:0:0 or 0:0:0 - 1193:0:0)
H.323	Default	0:05:00	(0:0:0 or 0:0:0 - 1193:0:0)
SIP	Default	0:30:00	(0:0:0 or 0:5:0 - 1193:0:0)
SIP Media	Default	0:02:00	(0:0:0 or 0:1:0 - 1193:0:0)
SIP Disconnect:	Default	0:02:00	(0:02:0 or 0:0:1 - 0:10:0)
SIP Invite	Default	0:03:00	(0:1:0 or 0:1:0 - 0:30:0)
SIP Provisional Media	Default	0:02:00	(0:2:0 or 0:1:0 - 0:30:0)
Floating Connection	Default	0:00:00	(0:0:0 or 0:0:30 - 1193:0:0)
Xlate-PAT	Default	0:00:30	(0:0:30 or 0:0:30 - 0:5:0)

在Command Reference（命令參考）中：



floating-conn	When multiple routes exist to a network with different metrics, the ASA uses the one with the best metric at the time of connection creation. If a better route becomes available, then this timeout lets connections be closed so a connection can be reestablished to use the better route. The default is 0 (the connection never times out). To make it possible to use better routes, set the timeout to a value between 0:0:30 and 1193:0:0.

有關詳細資訊，請參閱案例研究：從CiscoLive BRKSEC-3020會話重新載入後UDP連線失敗：



Floating Connection Timeout

- The "bad" connection never times out since the UDP traffic is constantly flowing
  - TCP is stateful, so the connection would terminate and re-establish on its own
  - ASA needs to tear the original connection down when the corresponding route changes
  - ASA 8.4(2)+ introduces **timeout floating-conn** to accomplish this goal

```
asa# show run timeout
timeout xlate 9:00:00
timeout pat-xlate 0:00:30
timeout conn 1:00:00 half-closed 0:10:00 udp 0:02:00 icmp 0:00:02
timeout sunrpc 0:10:00 h323 0:05:00 h225 1:00:00 mgcp 0:05:00 mgcp-pat 0:05:00
timeout sip 0:30:00 sip_media 0:02:00 sip-invite 0:03:00 sip-disconnect 0:02:00
timeout sip-provisional-media 0:02:00 uauth 9:00:00 absolute uauth 0:01:00 inactivity
timeout tcp-proxy-reassembly 0:01:00
timeout floating-conn 0:00:00
asa#
asa# configure terminal
asa(config)# timeout floating-conn 0:01:00
```

Schedule the conn entry for termination in **1 minute** if a matching packet yields a different egress interface on route lookup

連線抑制超時

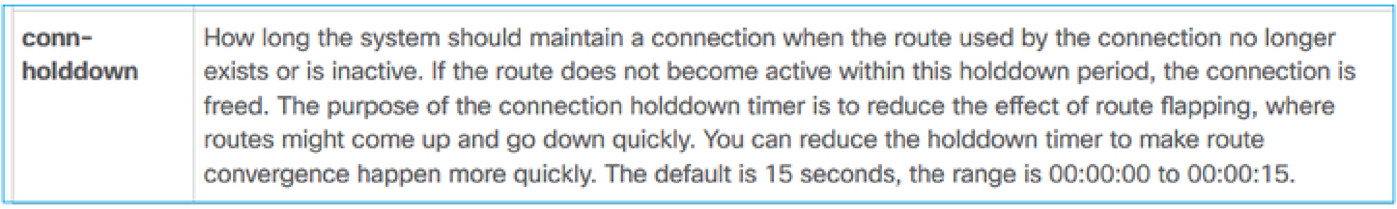
問題

路由關閉（被刪除），但流量匹配已建立的連線。

解決方案

ASA 9.6.2上新增了超時連線抑制功能。預設情況下會啟用該功能，但目前(7.1.x)FMC UI或FlexConfig不支援。相關增強：增強版：超時連線抑制不可用於FMC中的配置

在ASA CLI指南中：



conn-holddown	How long the system should maintain a connection when the route used by the connection no longer exists or is inactive. If the route does not become active within this holddown period, the connection is freed. The purpose of the connection holddown timer is to reduce the effect of route flapping, where routes might come up and go down quickly. You can reduce the holddown timer to make route convergence happen more quickly. The default is 15 seconds, the range is 00:00:00 to 00:00:15.

```
firepower# show run all timeout
timeout xlate 3:00:00
timeout pat-xlate 0:00:30
timeout conn 1:00:00 half-closed 0:10:00 udp 0:02:00 sctp 0:02:00 icmp 0:00:02
timeout sunrpc 0:10:00 h323 0:05:00 h225 1:00:00 mgcp 0:05:00 mgcp-pat 0:05:00
timeout sip 0:30:00 sip_media 0:02:00 sip-invite 0:03:00 sip-disconnect 0:02:00
timeout sip-provisional-media 0:02:00 uauth 0:05:00 absolute
timeout tcp-proxy-reassembly 0:00:30
timeout floating-conn 0:00:00
timeout conn-holddown 0:00:15
timeout igp stale-route 0:01:10
```

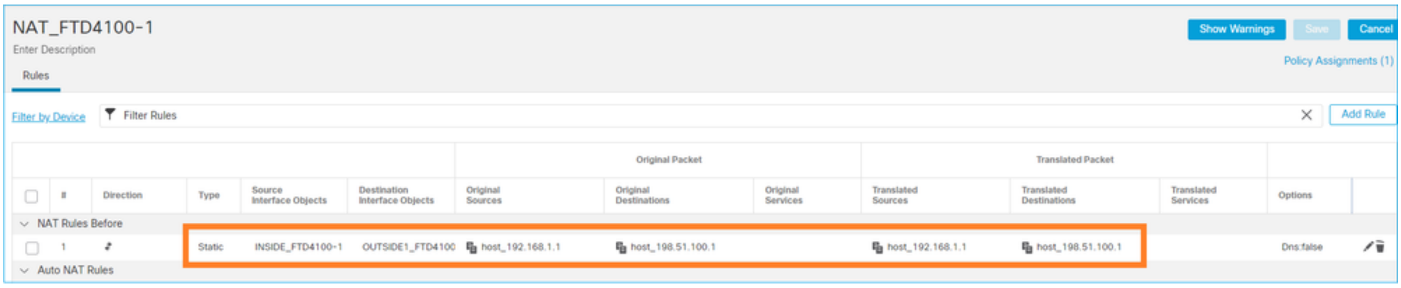
案例2 — 基於NAT查詢的轉發

需求

配置此NAT規則：

- 型別：靜態
- 源介面：INSIDE
- 目標介面：OUTSIDE1
- 原始來源：192.168.1.1
- 原始目標：198.51.100.1
- 轉換後來源：192.168.1.1
- 轉換後的目標：198.51.100.1

解決方案



NAT_FTD4100-1

Enter Description

					Original Packet			Translated Packet				
□	#	Direction	Type	Source Interface Objects	Destination Interface Objects	Original Sources	Original Destinations	Original Services	Translated Sources	Translated Destinations	Translated Services	Options
∨ NAT Rules Before												
□	1	⇄	Static	INSIDE_FTD4100-1	OUTSIDE1_FTD4100	host_192.168.1.1	host_198.51.100.1		host_192.168.1.1	host_198.51.100.1		Dns:false
∨ Auto NAT Rules												

FTD CLI上已部署的NAT規則：

```
firepower# show run nat
nat (INSIDE,OUTSIDE1) source static host_192.168.1.1 host_192.168.1.1 destination static host_198.51.10
firepower# show nat
Manual NAT Policies (Section 1)
1 (INSIDE) to (OUTSIDE1) source static host_192.168.1.1 host_192.168.1.1 destination static host_198.51
translate_hits = 0, untranslate_hits = 0
```

配置3個捕獲：

```
firepower# capture CAPI trace detail interface INSIDE match ip host 192.168.1.1 host 198.51.100.1
firepower# capture CAPO1 interface OUTSIDE1 match ip host 192.168.1.1 any
firepower# capture CAPO2 interface OUTSIDE2 match ip host 192.168.1.1 any
firepower# show capture
capture CAPI type raw-data trace detail interface INSIDE [Capturing - 0 bytes]
match ip host 192.168.1.1 host 198.51.100.1
capture CAPO1 type raw-data interface OUTSIDE1 [Capturing - 0 bytes]
match ip host 192.168.1.1 any
capture CAPO2 type raw-data interface OUTSIDE2 [Capturing - 0 bytes]
```

```
match ip host 192.168.1.1 any
```

起始從192.168.1.1到198.51.100.1的telnet會話：

```
Router1# telnet 198.51.100.1 /vrf VRF-101 /source-interface lo1
Trying 198.51.100.1 ...
% Connection timed out; remote host not responding
```

封包到達FTD，但沒有封包離開OUTSIDE1和OUTSIDE2介面：

```
firepower# show capture
capture CAPI type raw-data trace detail interface INSIDE [Capturing - 156 bytes]
match ip host 192.168.1.1 host 198.51.100.1
capture CAPO1 type raw-data interface OUTSIDE1 [Capturing - 0 bytes]
match ip host 192.168.1.1 any
capture CAPO2 type raw-data interface OUTSIDE2 [Capturing - 0 bytes]
match ip host 192.168.1.1 any
```

追蹤TCP SYN封包。第3階段(UN-NAT)顯示NAT（特定於UN-NAT）將資料包轉移到OUTSIDE1介面以進行下一跳查詢：

```
firepower# show capture CAPI
2 packets captured
1: 11:22:59.179678 802.1Q vlan#101 P0 192.168.1.1.38790 > 198.51.100.1.23: S 1174675193:1174675193(0) w
2: 11:23:01.179632 802.1Q vlan#101 P0 192.168.1.1.38790 > 198.51.100.1.23: S 1174675193:1174675193(0) w
2 packets shown
firepower#
```

```
firepower# show capture CAPI packet-number 1 trace detail

2 packets captured

1: 11:22:59.179678 4c4e.35fc.fcd8 00be.75f6.1dae 0x8100 Length: 62
802.1Q vlan#101 P0 192.168.1.1.38790 > 198.51.100.1.23: S [tcp sum ok] 1174675193:1174675193(0) win 412
...

Phase: 3
Type: UN-NAT
Subtype: static
Result: ALLOW
Elapsed time: 6244 ns
Config:
```

```
nat (INSIDE,OUTSIDE1) source static host_192.168.1.1 host_192.168.1.1 destination static host_198.51.10
Additional Information:
NAT divert to egress interface OUTSIDE1(vrfid:0)
Untranslate 198.51.100.1/23 to 198.51.100.1/23

...
Phase: 12
Type: FLOW-CREATION
Subtype:
Result: ALLOW
Elapsed time: 25422 ns
Config:
Additional Information:
New flow created with id 2614, packet dispatched to next module
Module information for forward flow ...
snp_fp_inspect_ip_options
snp_fp_tcp_normalizer
snp_fp_tcp_proxy
snp_fp_snort
snp_fp_tcp_proxy
snp_fp_translate
snp_fp_tcp_normalizer
snp_fp_adjacency
snp_fp_fragment
snp_ifc_stat


Phase: 15
Type: INPUT-ROUTE-LOOKUP-FROM-OUTPUT-ROUTE-LOOKUP
Subtype: Resolve Preferred Egress interface
Result: ALLOW
Elapsed time: 8028 ns
Config:
Additional Information:
Found next-hop 192.0.2.99 using egress ifc OUTSIDE2(vrfid:0)

Phase: 16
Type: SUBOPTIMAL-LOOKUP
Subtype: suboptimal next-hop
Result: ALLOW
Elapsed time: 446 ns
Config:
Additional Information:
Input route lookup returned ifc OUTSIDE2 is not same as existing ifc OUTSIDE1

Result:
input-interface: INSIDE(vrfid:0)
input-status: up
input-line-status: up
output-interface: OUTSIDE1(vrfid:0)
output-status: up
output-line-status: up
Action: drop
Time Taken: 777375 ns
Drop-reason: (no-adjacency) No valid adjacency, Drop-location: frame 0x00005577204a7287 flow (NA)/NA


1 packet shown
```

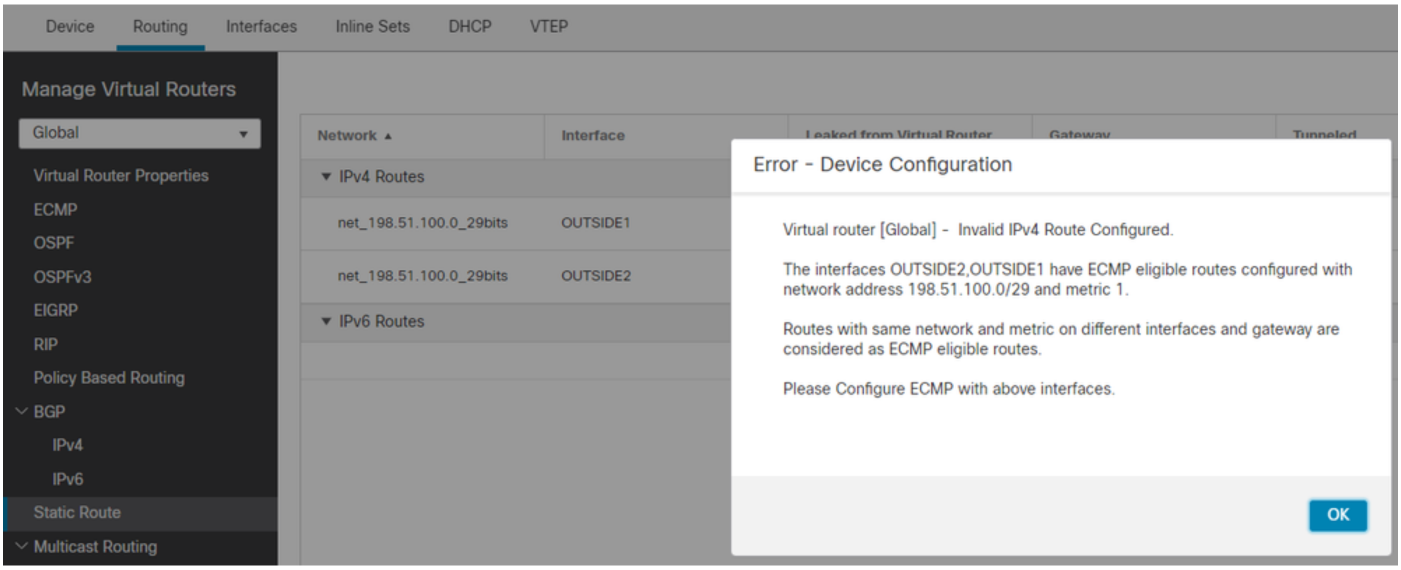
在這種情況下，SUBOPTIMAL-LOOKUP意味著NAT進程(OUTSIDE1)確定的出口介面與ASP輸入表中指定的出口介面不同：

```
firepower# show asp table routing | include 198.51.100.0
in 198.51.100.0 255.255.255.248 via 192.0.2.99, OUTSIDE2
out 198.51.100.0 255.255.255.248 via 192.0.2.99, OUTSIDE2
```

一種可能的解決方法是在OUTSIDE1介面上新增浮動靜態路由：

```
firepower# show run route
route OUTSIDE2 198.51.100.0 255.255.255.248 192.0.2.99 1
route OUTSIDE1 198.51.100.0 255.255.255.248 203.0.113.99 200
```

注意：如果嘗試新增的靜態路由度量與已存在的靜態路由度量相同，則出現以下錯誤：



Error - Device Configuration

Virtual router [Global] - Invalid IPv4 Route Configured.

The interfaces OUTSIDE2,OUTSIDE1 have ECMP eligible routes configured with network address 198.51.100.0/29 and metric 1.

Routes with same network and metric on different interfaces and gateway are considered as ECMP eligible routes.

Please Configure ECMP with above interfaces.

注意：路由表中未安裝距離度量為255的浮動路由。

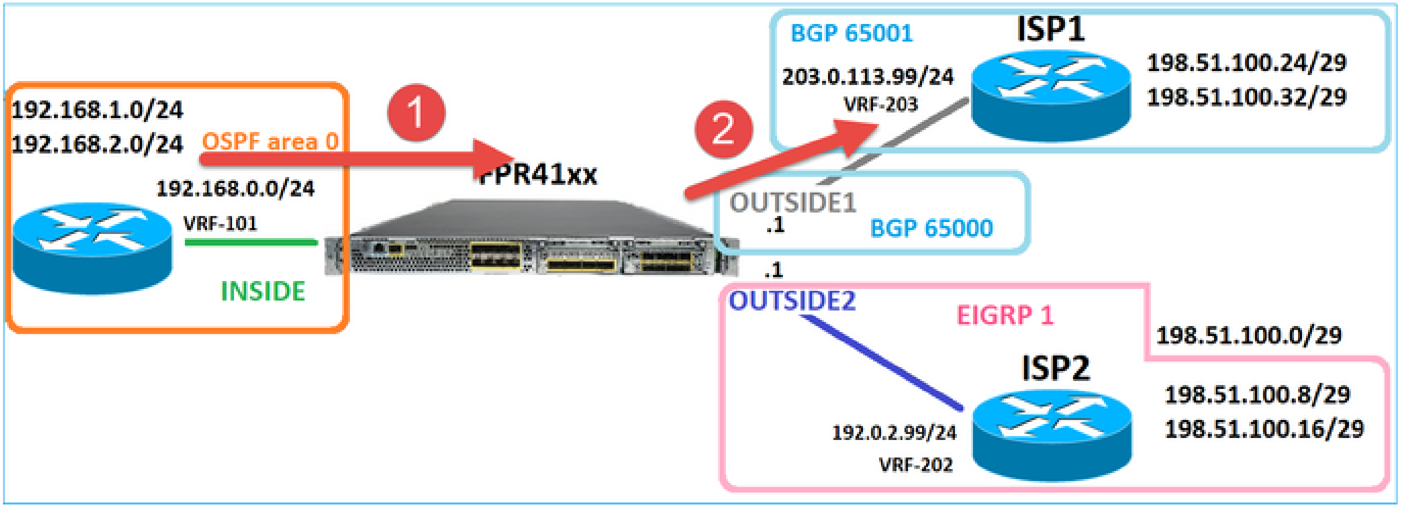
嘗試Telnet以確認有封包是透過FTD傳送的：

```
Router1# telnet 198.51.100.1 /vrf VRF-101 /source-interface lo1
Trying 198.51.100.1 ...
% Connection timed out; remote host not responding
```

```
firepower# show capture
capture CAPI type raw-data trace detail interface INSIDE [Capturing - 156 bytes]
```

```
match ip host 192.168.1.1 host 198.51.100.1
capture CAPO1 type raw-data interface OUTSIDE1 [Capturing - 312 bytes]
match ip host 192.168.1.1 any
capture CAPO2 type raw-data interface OUTSIDE2 [Capturing - 386 bytes]
match ip host 192.168.1.1 any
```

資料包跟蹤顯示，由於NAT查詢，資料包被轉發到ISP1(OUTSIDE1)介面，而不是ISP2:



```
firepower# show capture CAPI packet-number 1 trace

2 packets captured

1: 09:03:02.773962 802.1Q vlan#101 P0 192.168.1.1.16774 > 198.51.100.1.23: S 2910053251:2910053251(0) w
...

Phase: 3
Type: UN-NAT
Subtype: static
Result: ALLOW
Elapsed time: 4460 ns
Config:
nat (INSIDE,OUTSIDE1) source static host_192.168.1.1 host_192.168.1.1 destination static host_198.51.10
Additional Information:
NAT divert to egress interface OUTSIDE1(vrfid:0)
Untranslate 198.51.100.1/23 to 198.51.100.1/23

...

Phase: 12
Type: FLOW-CREATION
Subtype:
Result: ALLOW
Elapsed time: 29436 ns
Config:
Additional Information:
New flow created with id 2658, packet dispatched to next module
Module information for forward flow ...
snp_fp_inspect_ip_options
snp_fp_tcp_normalizer
snp_fp_snort
```

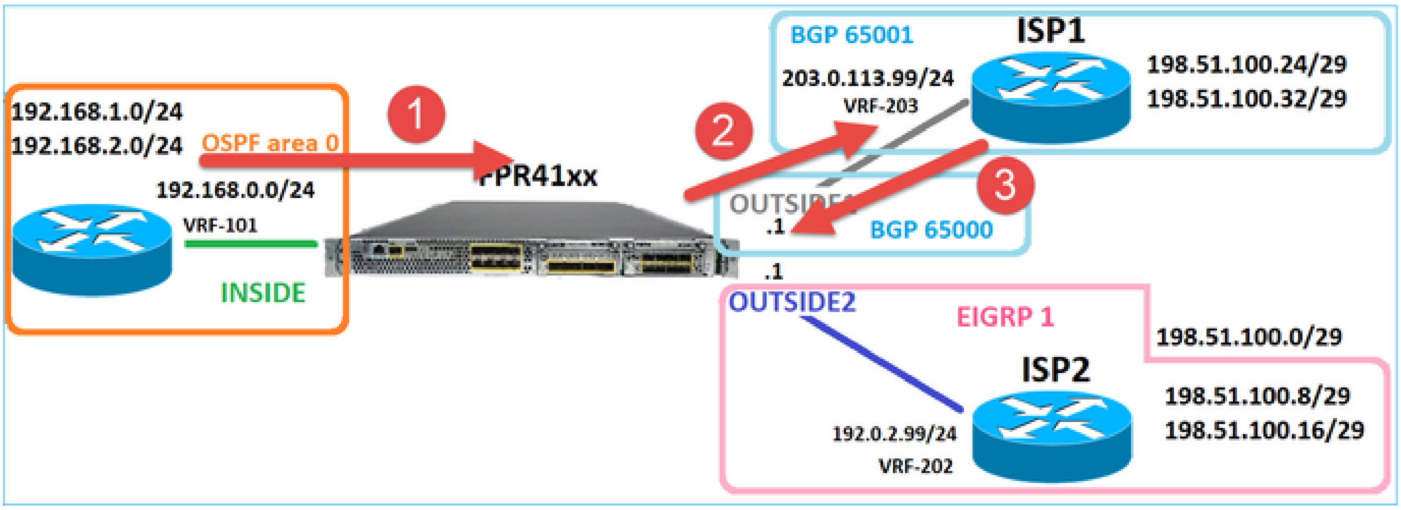
```
snp_fp_translate
snp_fp_tcp_normalizer
snp_fp_adjacency
snp_fp_fragment
snp_ifc_stat

Phase: 15
Type: INPUT-ROUTE-LOOKUP-FROM-OUTPUT-ROUTE-LOOKUP
Subtype: Resolve Preferred Egress interface
Result: ALLOW
Elapsed time: 5798 ns
Config:
Additional Information:
Found next-hop 192.0.2.99 using egress ifc OUTSIDE2(vrfid:0)

Phase: 16
Type: SUBOPTIMAL-LOOKUP
Subtype: suboptimal next-hop
Result: ALLOW
Elapsed time: 446 ns
Config:
Additional Information:
Input route lookup returned ifc OUTSIDE2 is not same as existing ifc OUTSIDE1

Phase: 17
Type: NEXTHOP-LOOKUP-FROM-OUTPUT-ROUTE-LOOKUP
Subtype: Lookup Nexthop on interface
Result: ALLOW
Elapsed time: 1784 ns
Config:
Additional Information:
Found next-hop 203.0.113.99 using egress ifc OUTSIDE1(vrfid:0)

Phase: 18
Type: ADJACENCY-LOOKUP
Subtype: Resolve Nexthop IP address to MAC
Result: ALLOW
Elapsed time: 1338 ns
Config:
Additional Information:
Found adjacency entry for Next-hop 203.0.113.99 on interface OUTSIDE1
Adjacency :Active
MAC address 4c4e.35fc.fcd8 hits 106 reference 2
...

Result:
input-interface: INSIDE(vrfid:0)
input-status: up
input-line-status: up
output-interface: OUTSIDE1(vrfid:0)
output-status: up
output-line-status: up
Action: allow
Time Taken: 723409 ns


1 packet shown
firepower#
```

有趣的是，在這種情況下，INSIDE和兩個輸出介面上均顯示資料包：

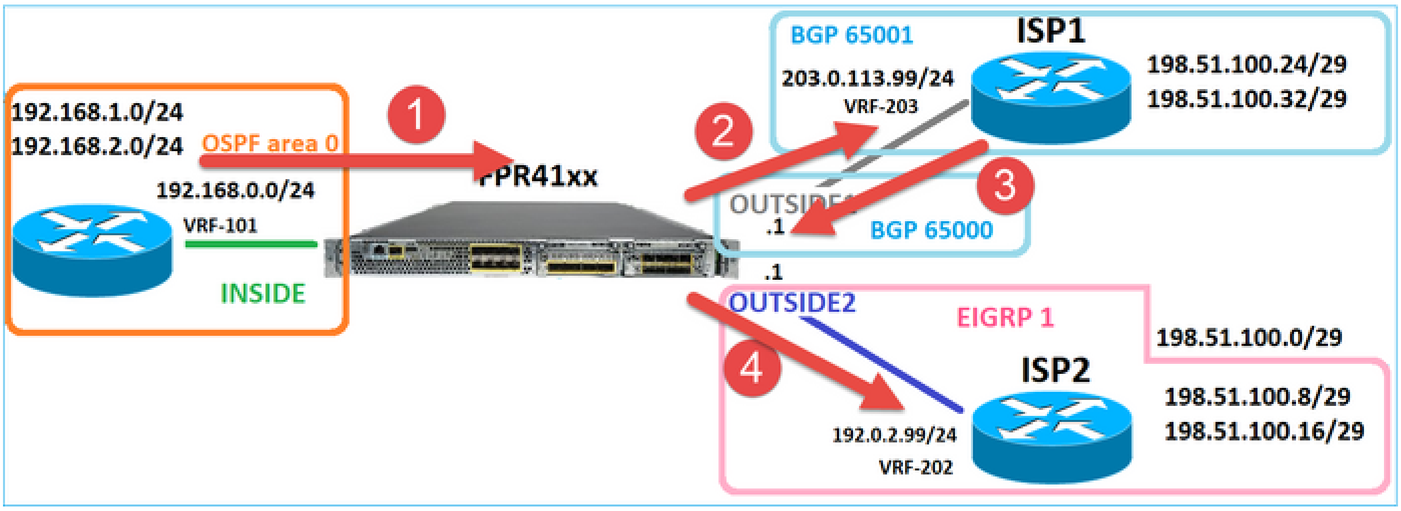
```
firepower# show capture CAPI

2 packets captured

1: 09:03:02.773962 802.1Q vlan#101 P0 192.168.1.1.32134 > 198.51.100.1.23: S 3031010184:3031010184(0) w
2: 09:03:05.176565 802.1Q vlan#101 P0 192.168.1.1.32134 > 198.51.100.1.23: S 3031010184:3031010184(0) w
2 packets shown
firepower# show capture CAPO1

4 packets captured

1: 09:03:02.774358 802.1Q vlan#203 P0 192.168.1.1.32134 > 198.51.100.1.23: S 3249840142:3249840142(0) w
2: 09:03:02.774557 802.1Q vlan#203 P0 192.168.1.1.32134 > 198.51.100.1.23: S 3249840142:3249840142(0) w
3: 09:03:05.176702 802.1Q vlan#203 P0 192.168.1.1.32134 > 198.51.100.1.23: S 3249840142:3249840142(0) w
4: 09:03:05.176870 802.1Q vlan#203 P0 192.168.1.1.32134 > 198.51.100.1.23: S 3249840142:3249840142(0) w
4 packets shown
firepower# show capture CAPO2

5 packets captured

1: 09:03:02.774679 802.1Q vlan#202 P0 192.168.1.1.32134 > 198.51.100.1.23: S 194652172:194652172(0) win
2: 09:03:02.775457 802.1Q vlan#202 P0 198.51.100.1.23 > 192.168.1.1.32134: S 4075003210:4075003210(0) a
3: 09:03:05.176931 802.1Q vlan#202 P0 192.168.1.1.32134 > 198.51.100.1.23: S 194652172:194652172(0) win
4: 09:03:05.177282 802.1Q vlan#202 P0 198.51.100.1.23 > 192.168.1.1.32134: . ack 194652173 win 4128
5: 09:03:05.180517 802.1Q vlan#202 P0 198.51.100.1.23 > 192.168.1.1.32134: S 4075003210:4075003210(0) a
```

封包詳細資訊包括MAC位址資訊，而OUTSIDE1和OUTSIDE2介面上的封包追蹤軌跡顯示封包的路徑：

```
firepower# show capture CAPO1 detail

4 packets captured

1: 09:03:02.774358 00be.75f6.1dae 4c4e.35fc.fcd8 0x8100 Length: 62
802.1Q vlan#203 P0 192.168.1.1.32134 > 198.51.100.1.23: S [tcp sum ok] 3249840142:3249840142(0) win 412
2: 09:03:02.774557 4c4e.35fc.fcd8 00be.75f6.1dae 0x8100 Length: 62
802.1Q vlan#203 P0 192.168.1.1.32134 > 198.51.100.1.23: S [tcp sum ok] 3249840142:3249840142(0) win 412
3: 09:03:05.176702 00be.75f6.1dae 4c4e.35fc.fcd8 0x8100 Length: 62
802.1Q vlan#203 P0 192.168.1.1.32134 > 198.51.100.1.23: S [tcp sum ok] 3249840142:3249840142(0) win 412
4: 09:03:05.176870 4c4e.35fc.fcd8 00be.75f6.1dae 0x8100 Length: 62
802.1Q vlan#203 P0 192.168.1.1.32134 > 198.51.100.1.23: S [tcp sum ok] 3249840142:3249840142(0) win 412
4 packets shown
```



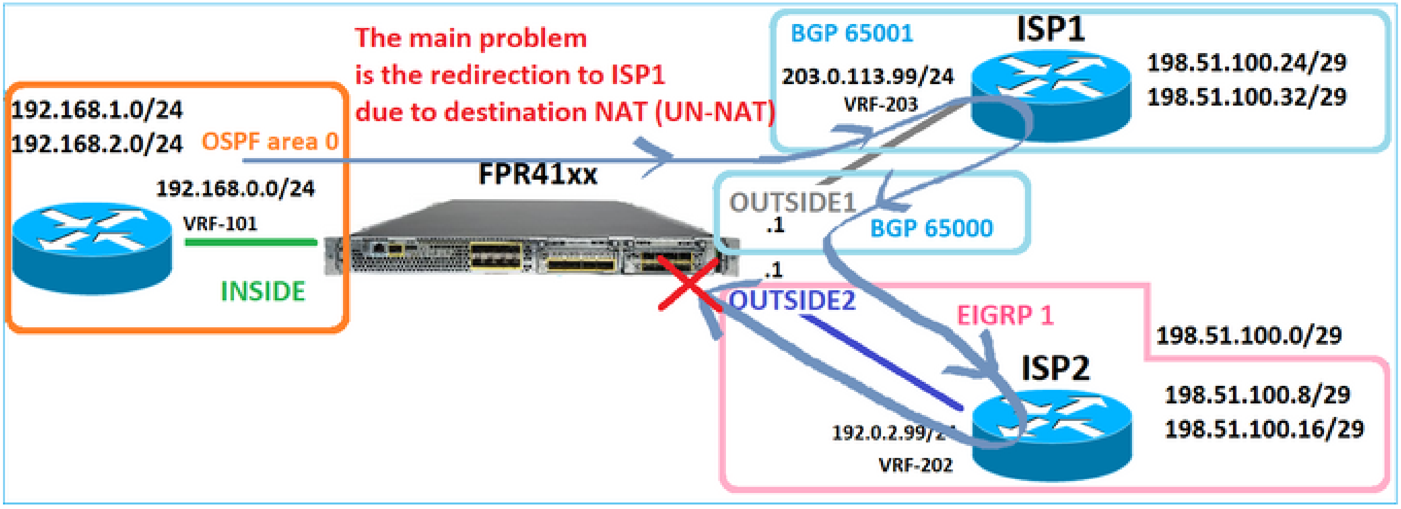
返回的資料包跟蹤顯示由於全域性路由表查詢而重定向到OUTSIDE2介面：



```
firepower# show capture CAP01 packet-number 2 trace

4 packets captured

2: 09:03:02.774557 802.1Q vlan#203 P0 192.168.1.1.32134 > 198.51.100.1.23: S 3249840142:3249840142(0) w
...

Phase: 3
Type: INPUT-ROUTE-LOOKUP
Subtype: Resolve Egress Interface
Result: ALLOW
Elapsed time: 7136 ns
Config:
Additional Information:
Found next-hop 192.0.2.99 using egress ifc OUTSIDE2(vrfid:0)

...

Phase: 10
Type: FLOW-CREATION
Subtype:
Result: ALLOW
Elapsed time: 12488 ns
Config:
```

```
Additional Information:
New flow created with id 13156, packet dispatched to next module

...

Phase: 13
Type: INPUT-ROUTE-LOOKUP-FROM-OUTPUT-ROUTE-LOOKUP
Subtype: Resolve Preferred Egress interface
Result: ALLOW
Elapsed time: 3568 ns
Config:
Additional Information:
Found next-hop 192.0.2.99 using egress ifc OUTSIDE2(vrfid:0)

Phase: 14
Type: ADJACENCY-LOOKUP
Subtype: Resolve Nexthop IP address to MAC
Result: ALLOW
Elapsed time: 1338 ns
Config:
Additional Information:
Found adjacency entry for Next-hop 192.0.2.99 on interface OUTSIDE2
Adjacency :Active
MAC address 4c4e.35fc.fcd8 hits 0 reference 1

...

Result:
input-interface: OUTSIDE1(vrfid:0)
input-status: up
input-line-status: up
output-interface: OUTSIDE2(vrfid:0)
output-status: up
output-line-status: up
Action: allow
Time Taken: 111946 ns


1 packet shown
firepower#
```

ISP2路由器傳送應答(SYN/ACK)，但此資料包被重定向到ISP1，因為它與建立的連線匹配。由於ASP輸出表中沒有第2層鄰接關係，FTD捨棄該封包：



```
firepower# show capture CAPO2 packet-number 2 trace

5 packets captured

2: 09:03:02.775457 802.1Q vlan#202 P0 198.51.100.1.23 > 192.168.1.1.32134: S 4075003210:4075003210(0) a
...

Phase: 3
Type: FLOW-LOOKUP
Subtype:
Result: ALLOW
Elapsed time: 2230 ns
Config:
Additional Information:
Found flow with id 13156, using existing flow

...

Phase: 7
Type: SUBOPTIMAL-LOOKUP
Subtype: suboptimal next-hop
Result: ALLOW
Elapsed time: 0 ns
Config:
Additional Information:
Input route lookup returned ifc INSIDE is not same as existing ifc OUTSIDE1

Result:
input-interface: OUTSIDE2(vrfid:0)
input-status: up
input-line-status: up
output-interface: INSIDE(vrfid:0)
output-status: up
output-line-status: up
Action: drop
Time Taken: 52628 ns
Drop-reason: (no-adjacency) No valid adjacency, Drop-location: frame 0x00005577204a7287 flow (NA)/NA
```

案例3 — 根據原則型路由(PBR)轉送

在連線流查詢和目標NAT查詢之後，PBR是可能影響輸出介面確定的下一項。PBR記錄在： Policy Based Routing(基於策略的路由)

對於FMC上的PBR配置，務必注意以下準則：
FlexConfig用於在FMC中為低於7.1的FTD版本設定PBR。您仍然可以使用FlexConfig在所有版本中配置PBR。但是，對於入口介面，不能同時使用FlexConfig和FMC的Policy Based Routing頁面配置PBR。

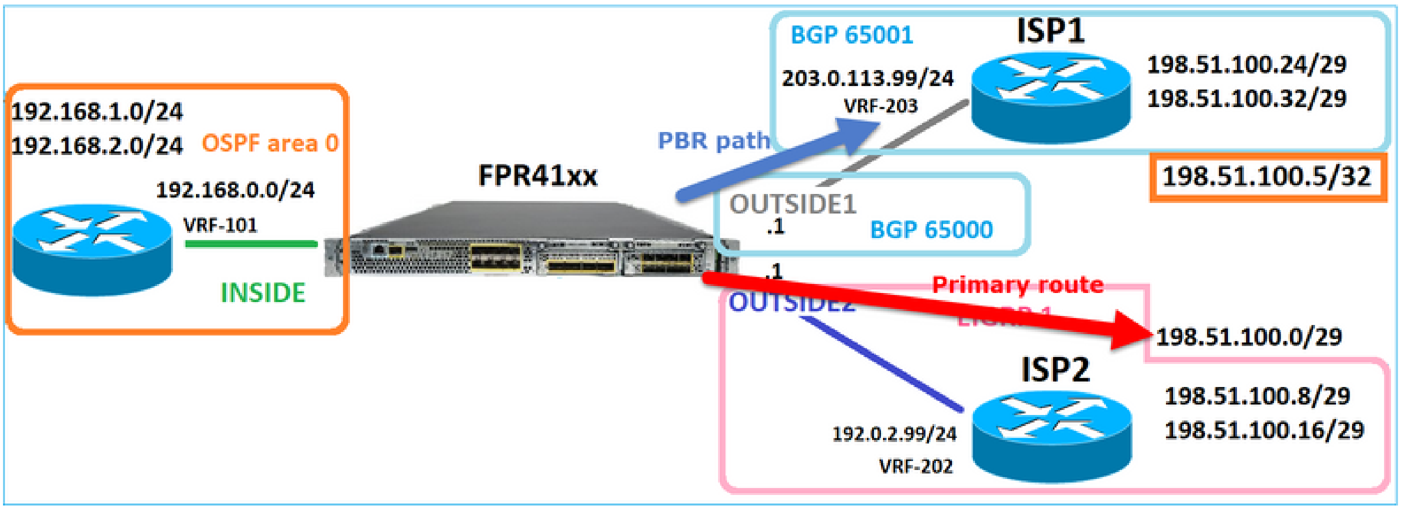
在本案例研究中，FTD具有指向198.51.100.0/24的路由，該路由指向ISP2:

```
firepower# show route | begin Gate
Gateway of last resort is not set

C 192.0.2.0 255.255.255.0 is directly connected, OUTSIDE2
L 192.0.2.1 255.255.255.255 is directly connected, OUTSIDE2
C 192.168.0.0 255.255.255.0 is directly connected, INSIDE
L 192.168.0.1 255.255.255.255 is directly connected, INSIDE
O 192.168.1.1 255.255.255.255 [110/11] via 192.168.0.99, 5d01h, INSIDE
O 192.168.2.1 255.255.255.255 [110/11] via 192.168.0.99, 5d01h, INSIDE
S 198.51.100.0 255.255.255.248 [1/0] via 192.0.2.99, OUTSIDE2
D 198.51.100.8 255.255.255.248
[90/130816] via 192.0.2.99, 5d01h, OUTSIDE2
D 198.51.100.16 255.255.255.248
[90/130816] via 192.0.2.99, 5d01h, OUTSIDE2
B 198.51.100.24 255.255.255.248 [20/0] via 203.0.113.99, 5d00h
B 198.51.100.32 255.255.255.248 [20/0] via 203.0.113.99, 5d00h
C 203.0.113.0 255.255.255.0 is directly connected, OUTSIDE1
L 203.0.113.1 255.255.255.255 is directly connected, OUTSIDE1
```

需求

使用以下特徵配置PBR策略：

- 從IP 192.168.2.0/24發往198.51.100.5的流量必須傳送到ISP1（下一跳203.0.113.99），而其它源必須使用OUTSIDE2介面。



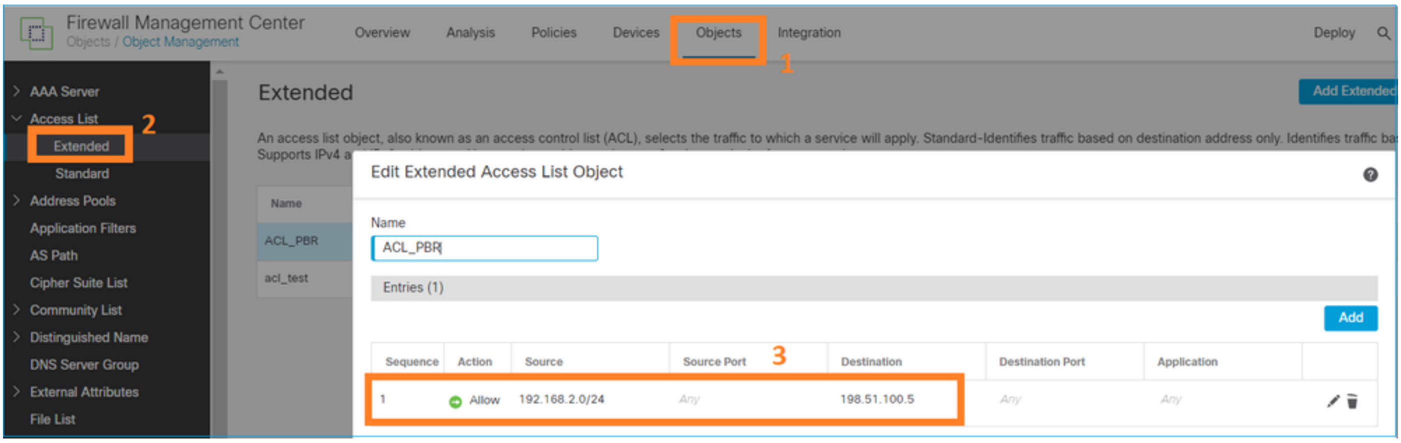
解決方案

在7.1之前的版本中，要配置PBR:
1.建立與感興趣的流量（例如PBR_ACL）匹配的擴展ACL。
2.建立與步驟1中建立的ACL匹配的路由對映，然後設定所需的下一跳。
3.使用步驟2中建立的路由對映建立一個FlexConfig對象，以在入口介面上啟用PBR。

在7.1以前的版本中，可以使用7.1以前版本的方法配置PBR，也可以使用Device > Routing部分下的新的基於策略的路由選項：
1.建立與感興趣的流量（例如PBR_ACL）匹配的擴展ACL。
2.新增PBR策略並指定：
a.匹配的流量
b.輸入介面
c.下一跳

配置PBR（新方式）

第1步 — 為匹配流量定義訪問清單。



An access list object, also known as an access control list (ACL), selects the traffic to which a service will apply. Standard-Identifies traffic based on destination address only. Identifies traffic ba
Supports IPv4 a

Edit Extended Access List Object

Name: ACL_PBR

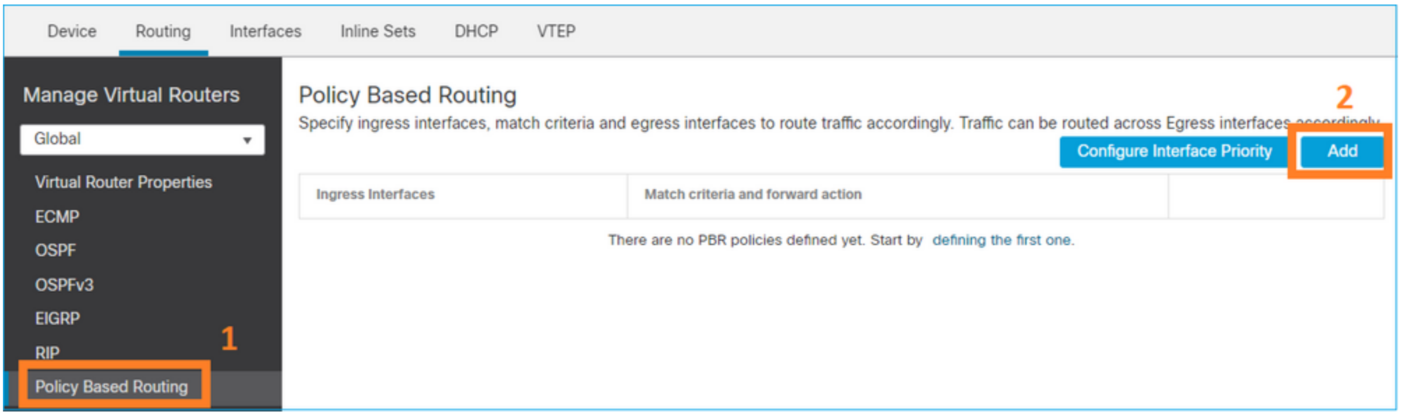
Entries (1)

Add

Sequence	Action	Source	Source Port	Destination	Destination Port	Application
1	Allow	192.168.2.0/24	Any	198.51.100.5	Any	Any

第2步 — 新增PBR策略

導覽至Devices > Device Management，然後編輯FTD裝置。選擇Routing > Policy Based Routing，然後在Policy Based Routing頁面上選擇Add。

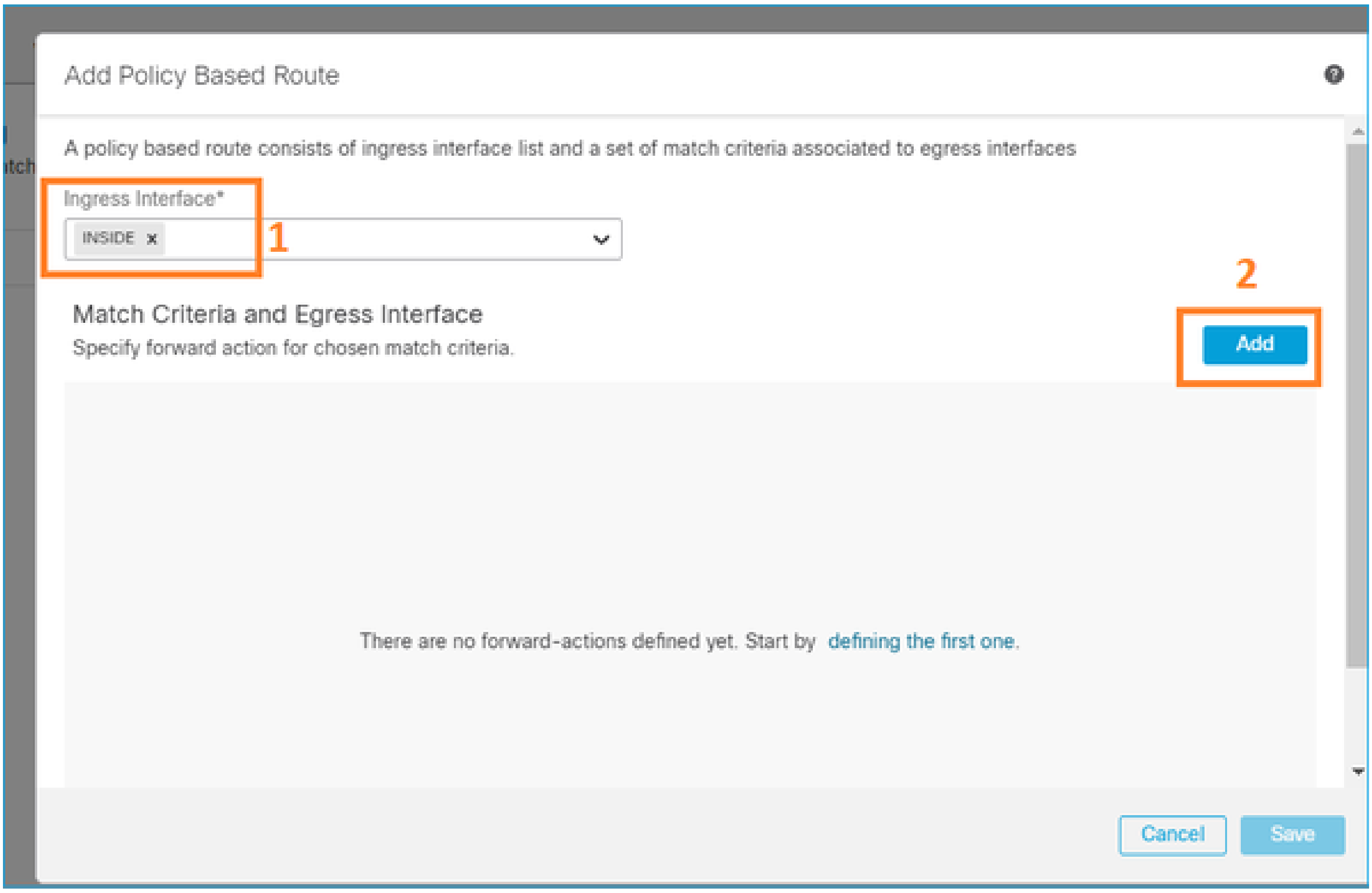


Policy Based Routing

Specify ingress interfaces, match criteria and egress interfaces to route traffic accordingly. Traffic can be routed across Egress interfaces accordingly.

There are no PBR policies defined yet. Start by defining the first one.

指定輸入介面：



A policy based route consists of ingress interface list and a set of match criteria associated to egress interfaces

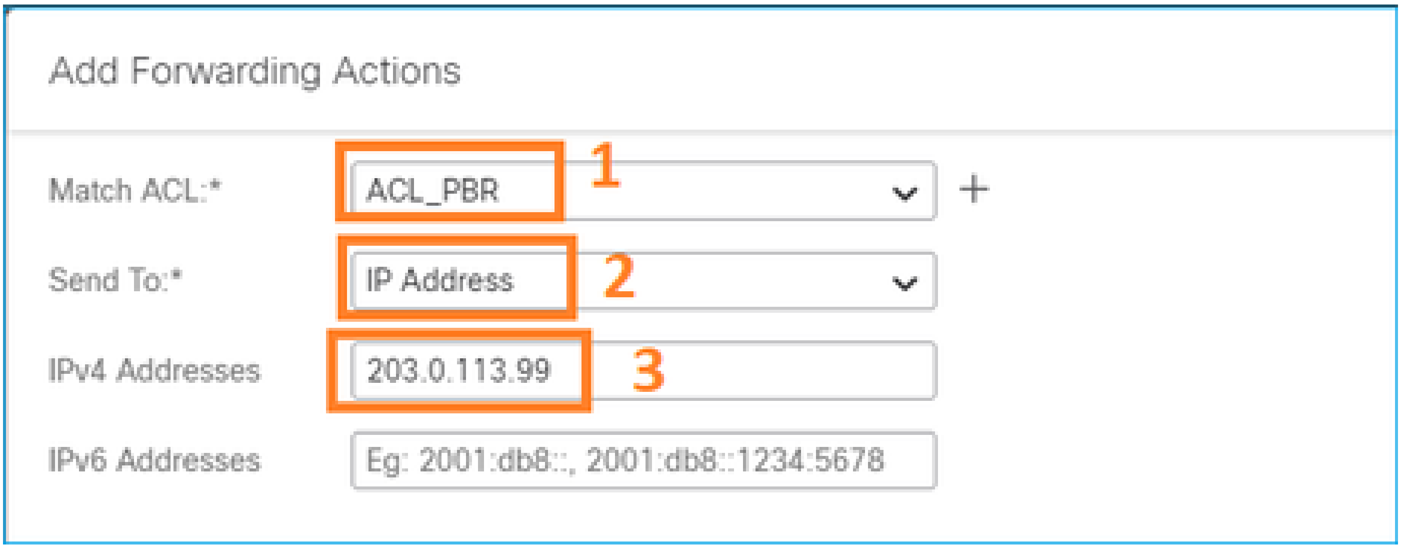
Ingress Interface*: INSIDE

Match Criteria and Egress Interface

Specify forward action for chosen match criteria.

There are no forward-actions defined yet. Start by defining the first one.

指定轉發操作：



Add Forwarding Actions

Match ACL:* ACL_PBR

Send To:* IP Address

IPv4 Addresses 203.0.113.99

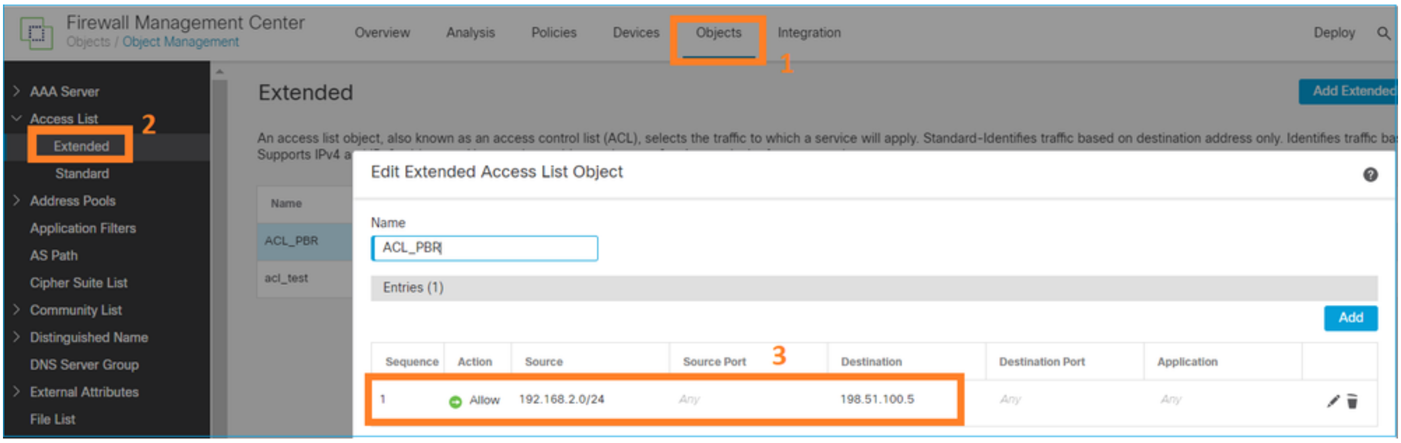
IPv6 Addresses Eg: 2001:db8::, 2001:db8::1234:5678

儲存和部署

注意：如果要配置多個輸出介面，必須在「傳送到」欄位中設定「輸出介面」選項（從7.0+版可用）。有關更多詳細資訊，請檢查：基於策略的路由的配置示例

配置PBR（傳統方式）

第1步 — 為匹配流量定義訪問清單。



Firewall Management Center
Objects / Object Management

Extended

An access list object, also known as an access control list (ACL), selects the traffic to which a service will apply. Standard-Identifies traffic based on destination address only. Identifies traffic ba
Supports IPv4 a

Edit Extended Access List Object

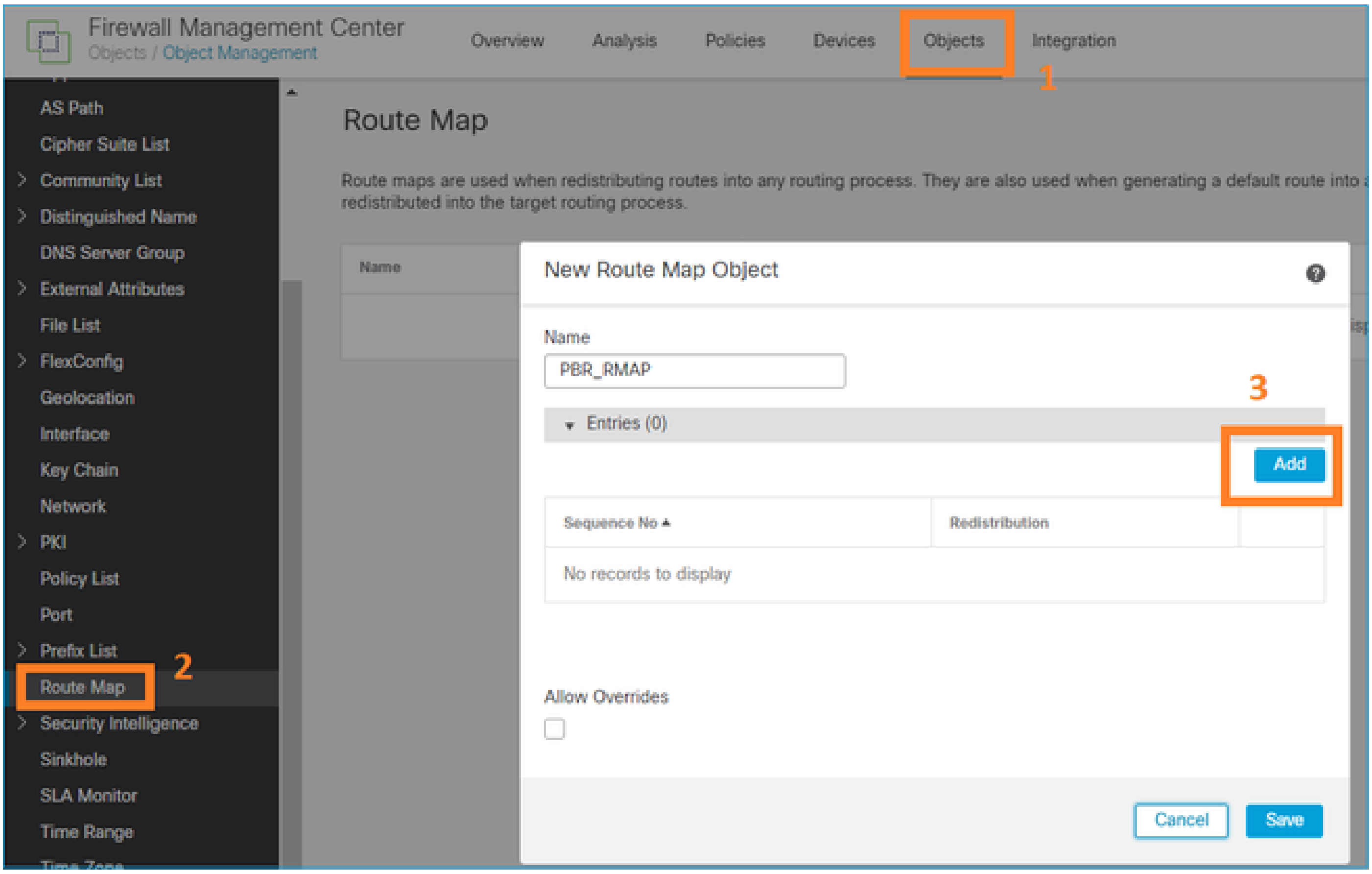
Name: ACL_PBR

Entries (1)

Sequence	Action	Source	Source Port	Destination	Destination Port	Application
1	Allow	192.168.2.0/24	Any	198.51.100.5	Any	Any

第2步 — 定義與ACL匹配的路由對映並設定下一跳。

首先，定義Match子句：



Route Map

Route maps are used when redistributing routes into any routing process. They are also used when generating a default route into a
redistributed into the target routing process.

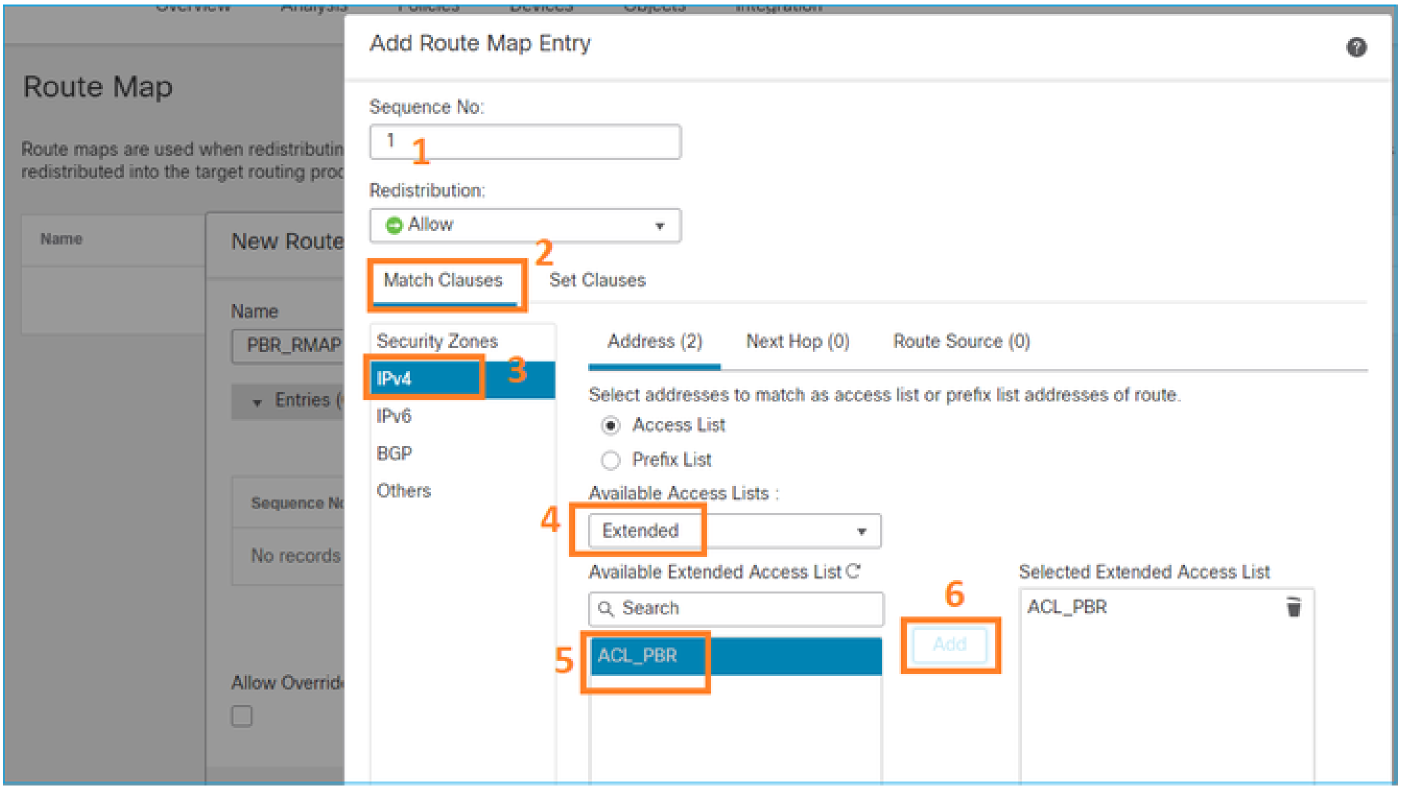
New Route Map Object

Name: PBR_RMAP

Entries (0)

Sequence No ▲	Redistribution
No records to display	

Allow Overrides ☐



Add Route Map Entry

Sequence No: 1

Redistribution: Allow

Select addresses to match as access list or prefix list addresses of route.

● Access List

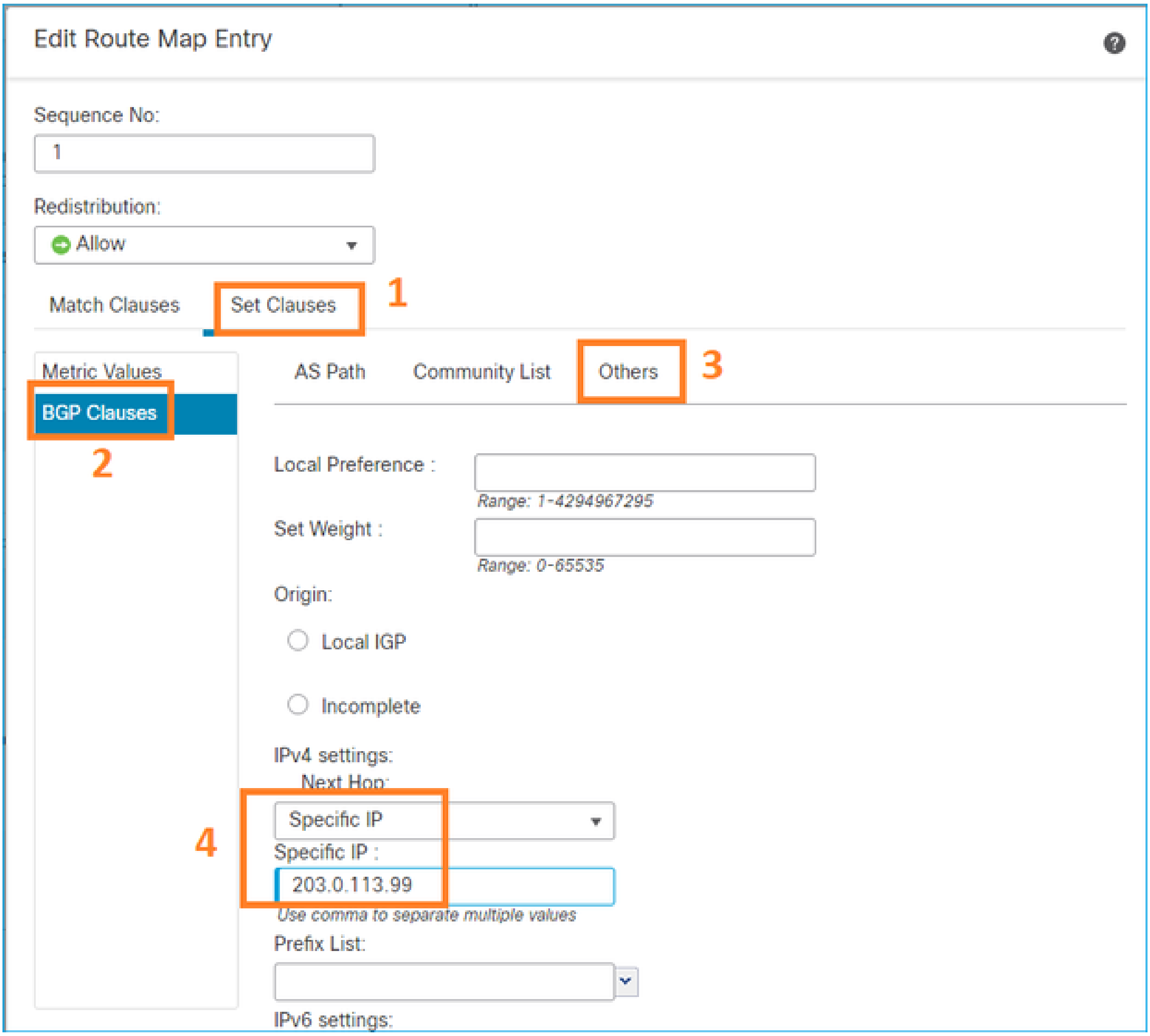
○ Prefix List

Available Access Lists : Extended

Available Extended Access List: ACL_PBR

Selected Extended Access List: ACL_PBR

定義Set子句：



Edit Route Map Entry

Sequence No: 1

Redistribution: Allow

Match Clauses | Set Clauses

Metric Values | BGP Clauses

AS Path | Community List | Others

Local Preference :

Range: 1-4294967295

Set Weight :

Range: 0-65535

Origin:

○ Local IGP

○ Incomplete

IPv4 settings:

Next Hop:

Specific IP

Specific IP : 203.0.113.99

Use comma to separate multiple values

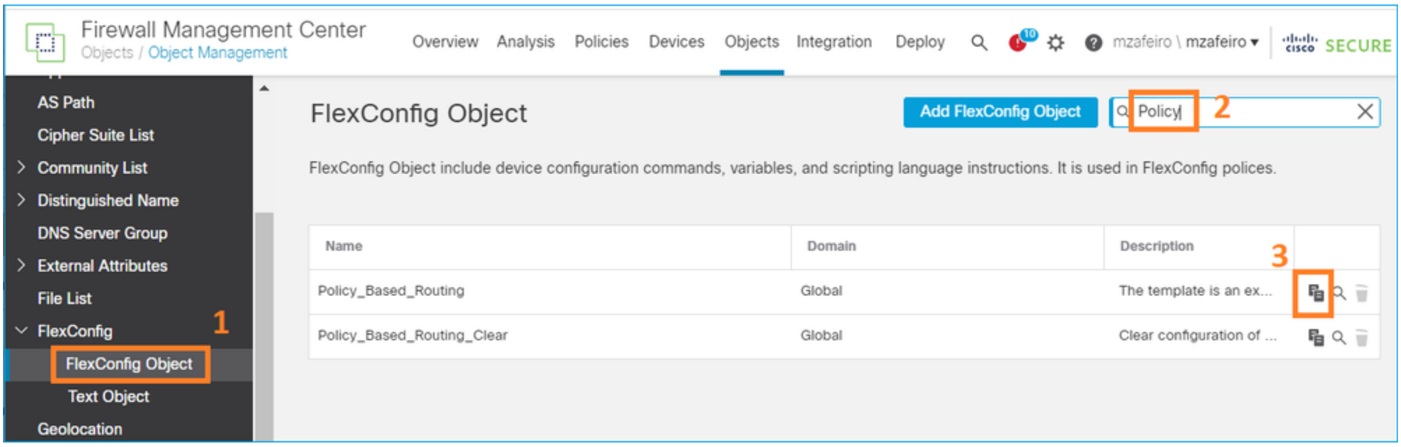
Prefix List:

IPv6 settings:

新增並儲存。

第3步 — 配置FlexConfig PBR對象。

首先，複製（複製）現有的PBR對象：



Firewall Management Center

Objects / Object Management

Overview Analysis Policies Devices Objects Integration Deploy

mzafeiro \ mzafeiro

AS Path
Cipher Suite List
Community List
Distinguished Name
DNS Server Group
External Attributes
File List
FlexConfig
FlexConfig Object
Text Object
Geolocation

FlexConfig Object

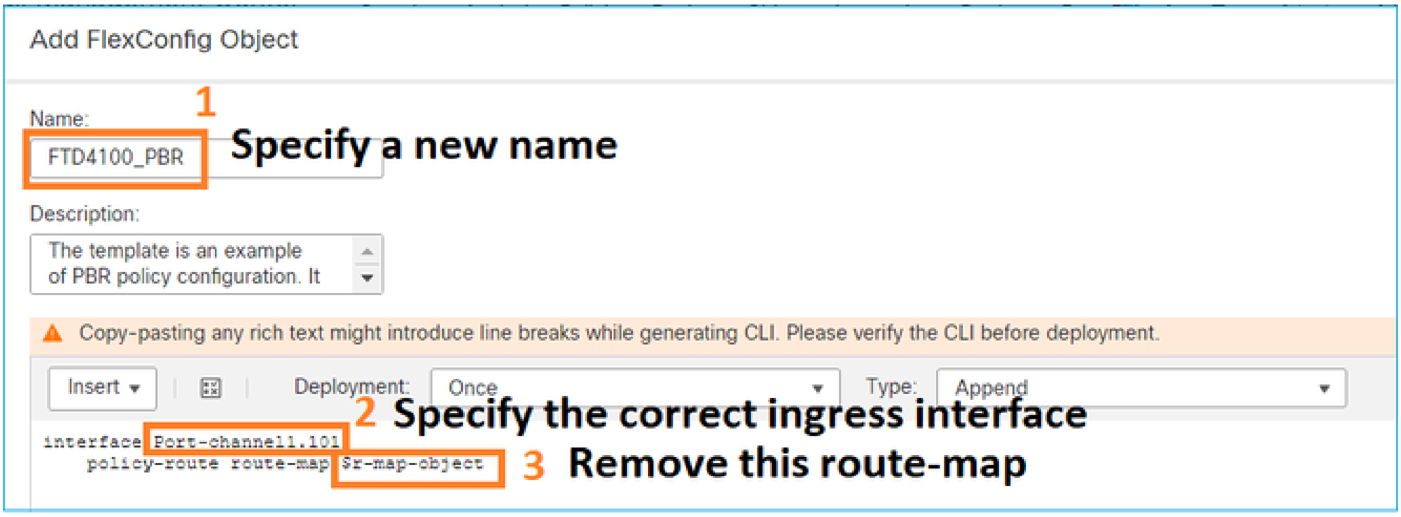
Add FlexConfig Object

Policy

FlexConfig Object include device configuration commands, variables, and scripting language instructions. It is used in FlexConfig polices.

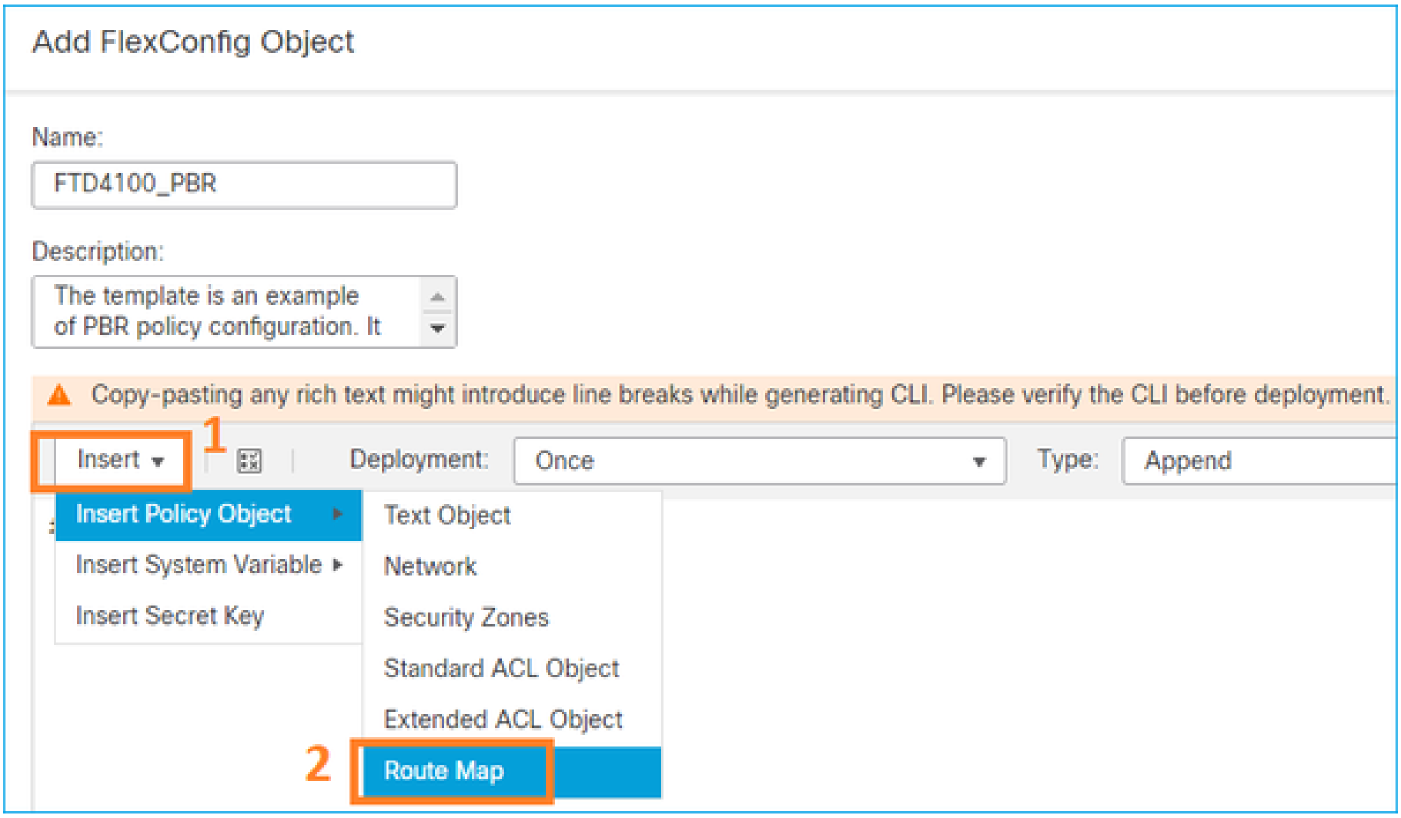
Name	Domain	Description
Policy_Based_Routing	Global	The template is an ex...
Policy_Based_Routing_Clear	Global	Clear configuration of ...

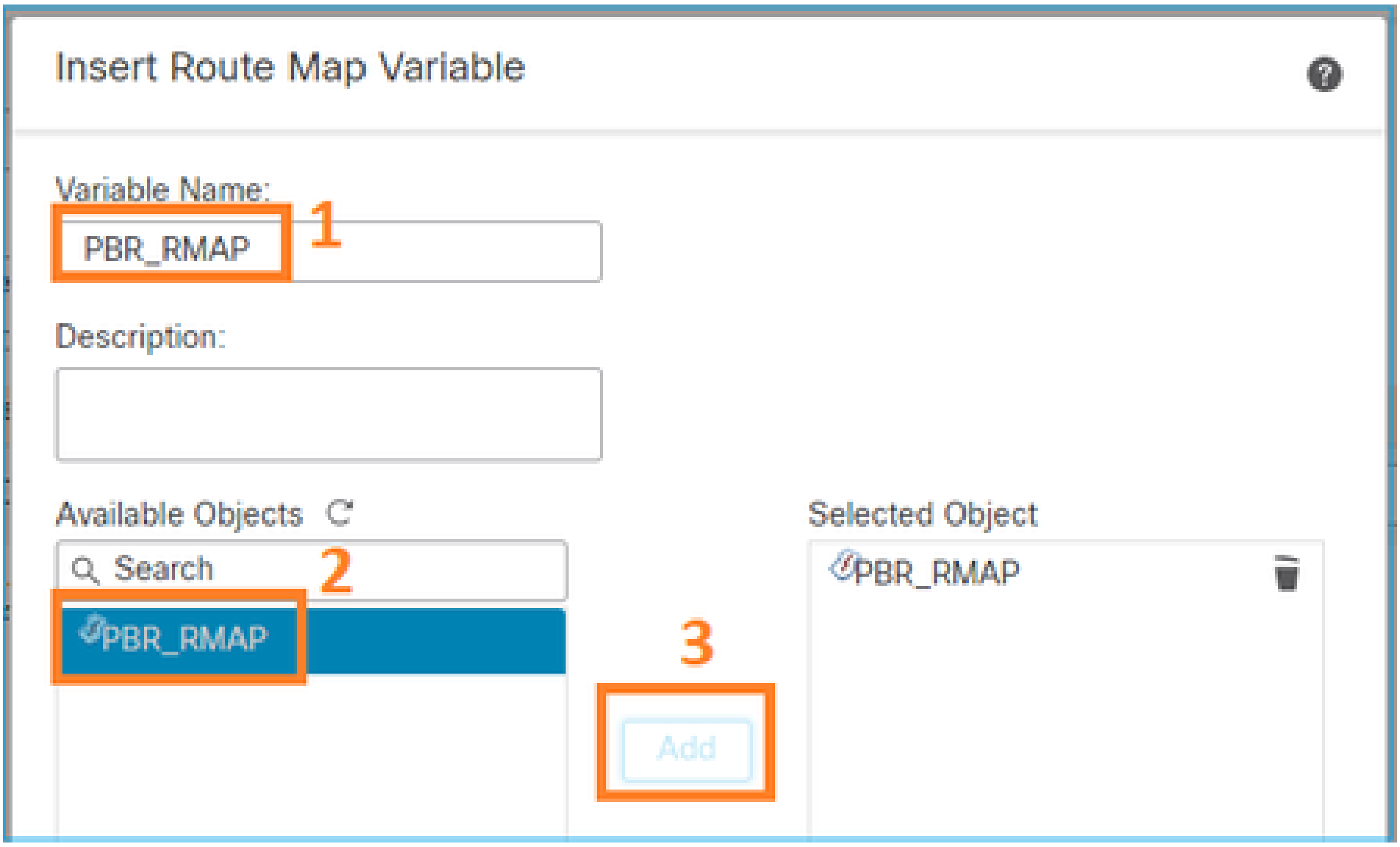
指定對象名稱並刪除預定義的路由對映對象：


Add FlexConfig Object
Name:
FTD4100_PBR
1
Specify a new name
Description:
The template is an example of PBR policy configuration. It
Copy-pasting any rich text might introduce line breaks while generating CLI. Please verify the CLI before deployment.
Insert
Deployment:
Once
Type:
Append
2
Specify the correct ingress interface
3
Remove this route-map

```
interface Port-channel1.101
    policy-route route-map $r-map-object
```

指定新的路由對映：





Insert Route Map Variable

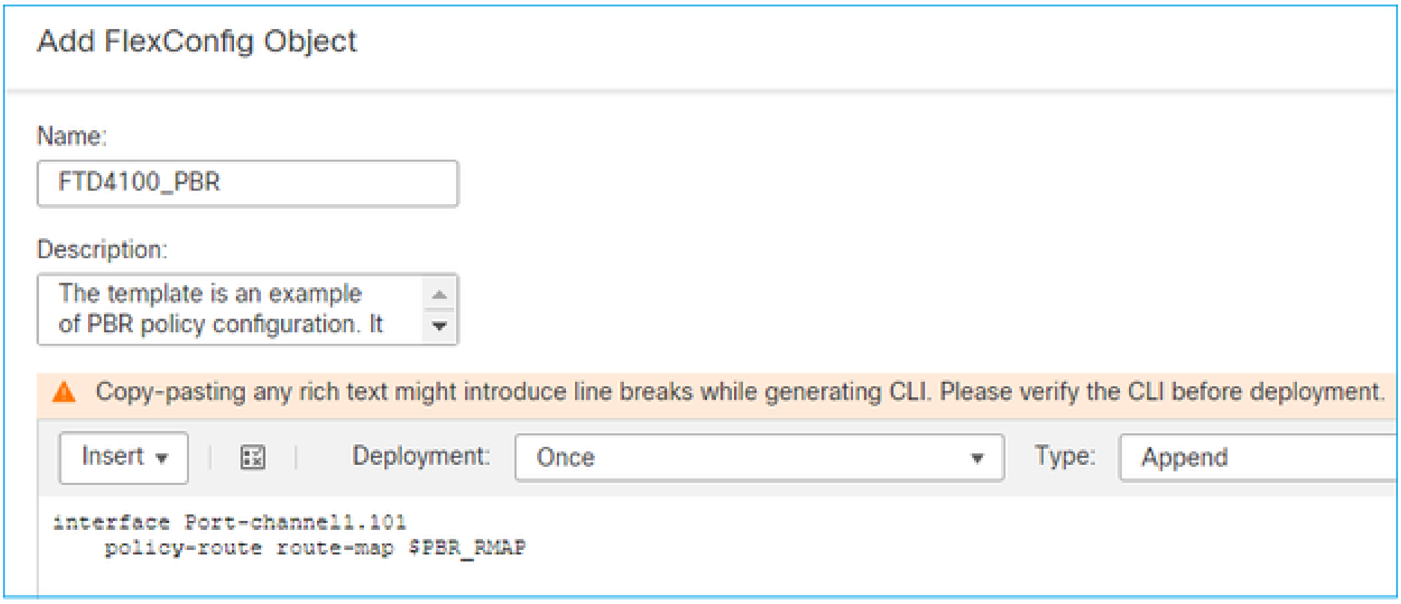
Variable Name: PBR_RMAP

Description:

Available Objects

Selected Object: PBR_RMAP

這就是最終結果：



Add FlexConfig Object

Name: FTD4100_PBR

Description: The template is an example of PBR policy configuration. It

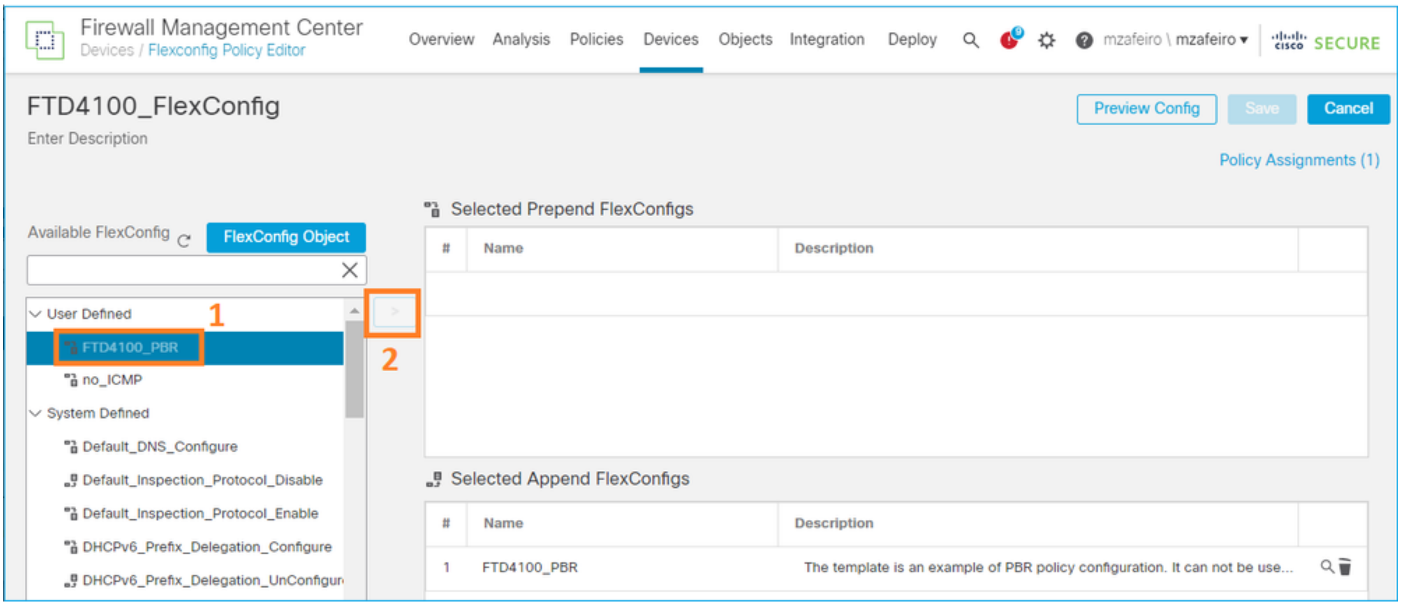
⚠ Copy-pasting any rich text might introduce line breaks while generating CLI. Please verify the CLI before deployment.

Deployment: Once

Type: Append

```
interface Port-channel1.101
    policy-route route-map $PBR_RMAP
```

第4步 — 將PBR對象新增到FTD FlexConfig策略。



FTD4100_FlexConfig

Enter Description

- User Defined
  - FTD4100_PBR
  - no_ICMP
- System Defined
  - Default_DNS_Configure
  - Default_Inspection_Protocol_Disable
  - Default_Inspection_Protocol_Enable
  - DHCPv6_Prefix_Delegation_Configure
  - DHCPv6_Prefix_Delegation_UnConfigur

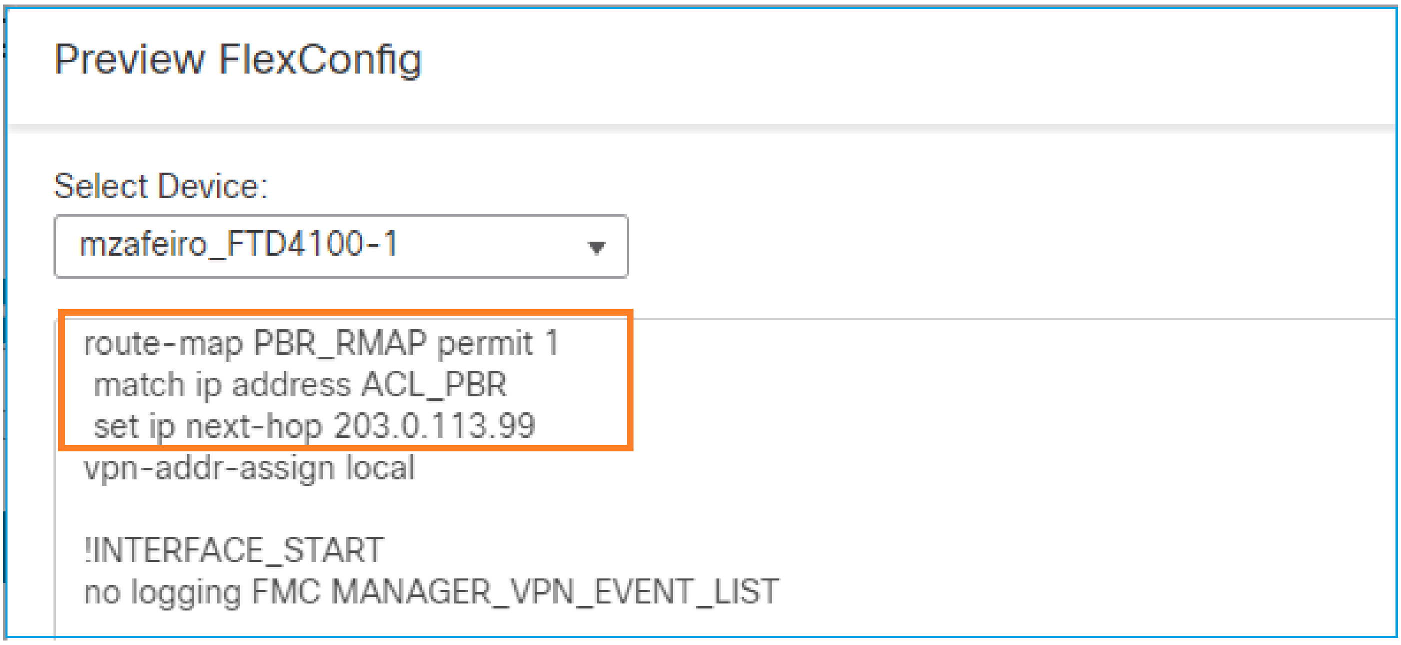
Selected Prepend FlexConfigs

#	Name	Description

Selected Append FlexConfigs

#	Name	Description
1	FTD4100_PBR	The template is an example of PBR policy configuration. It can not be use...

儲存並選擇預覽配置：

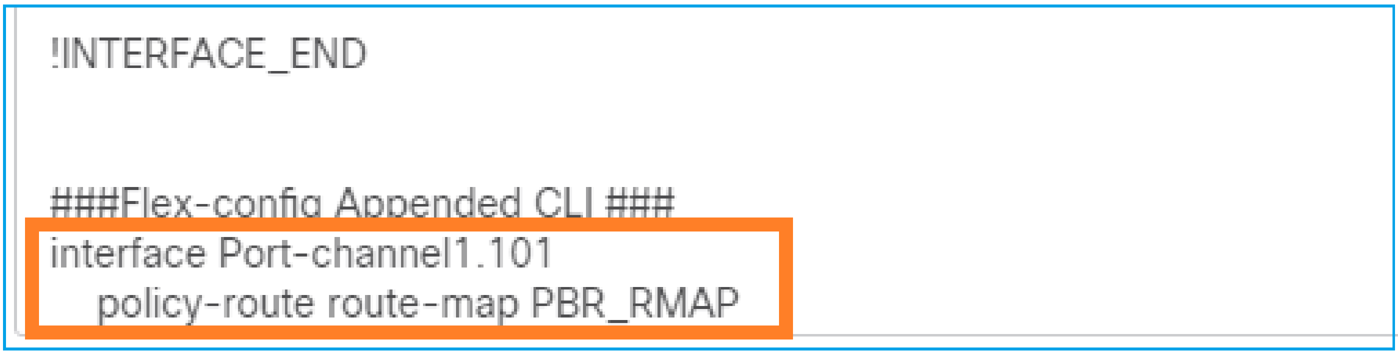


Preview FlexConfig

Select Device:

mzafeiro_FTD4100-1

```
route-map PBR_RMAP permit 1
 match ip address ACL_PBR
 set ip next-hop 203.0.113.99
vpn-addr-assign local

!INTERFACE_START
no logging FMC MANAGER_VPN_EVENT_LIST
```



```
!INTERFACE_END


###Flex-config Appended CLI ###
interface Port-channel1.101
    policy-route route-map PBR_RMAP
```

最後，部署策略。

注意：不能使用FlexConfig和FMC UI為同一入口介面配置PBR。

有關PBR SLA配置，請查閱以下文檔：為FMC管理的FTD上的雙ISP配置PBR（使用IP SLA配置）

PBR驗證

輸入介面驗證：

```
firepower# show run interface Po1.101
!
interface Port-channel1.101
vlan 101
nameif INSIDE
cts manual
propagate sgt preserve-untag
policy static sgt disabled trusted
security-level 0
ip address 192.168.0.1 255.255.255.0
policy-route route-map FMC_GENERATED_PBR_1649228271478
ospf authentication null
```

路由對映驗證：

```
firepower# show run route-map
!
route-map FMC_GENERATED_PBR_1649228271478 permit 5
 match ip address ACL_PBR
 set ip next-hop 203.0.113.99
```

```
firepower# show route-map
route-map FMC_GENERATED_PBR_1649228271478, permit, sequence 5
Match clauses:
ip address (access-lists): ACL_PBR

Set clauses:
adaptive-interface cost OUTSIDE1 (0)
```

策略路由驗證：

```
firepower# show policy-route
Interface Route map
Port-channel1.101 FMC_GENERATED_PBR_1649228271478
```

更改前後Packet Tracer:

不使用PBR	使用PBR

```
firepower# packet-tracer input INSIDE tcp 192.168.2.100 1111 198.51.100.5 23

....


Phase: 3
Type: INPUT-ROUTE-LOOKUP
Subtype: Resolve Egress Interface
Result: ALLOW
Elapsed time: 11596 ns
Config:
Additional Information:
Found next-hop 192.0.2.99 using egress ifc OUTSIDE2(vrfid:0)

...



Phase: 13
Type: INPUT-ROUTE-LOOKUP-FROM-OUTPUT-ROUTE-LOOKUP
Subtype: Resolve Preferred Egress interface
Result: ALLOW
Elapsed time: 6244 ns
Config:
Additional Information:
Found next-hop 192.0.2.99 using egress ifc OUTSIDE2(vrfid:0)


Phase: 14
Type: ADJACENCY-LOOKUP
Subtype: Resolve Nexthop IP address to MAC
Result: ALLOW
Elapsed time: 2230 ns
Config:
Additional Information:
Found adjacency entry for Next-hop 192.0.2.99 on interface OUTSIDE2
Adjacency :Active
MAC address 4c4e.35fc.fcd8 hits 0 reference 1


Result:
input-interface: INSIDE(vrfid:0)
input-status: up
input-line-status: up
output-interface: OUTSIDE2(vrfid:0)
output-status: up
output-line-status: up
Action: allow
Time Taken: 272058 ns
```

```
firepower# packet-tracer i

...
Phase: 3
Type: SUBOPTIMAL-LOOKUP
Subtype: suboptimal next-h
Result: ALLOW
Elapsed time: 39694 ns
Config:
Additional Information:
Input route lookup returne

Phase: 4
Type: ECMP load balancing
Subtype:
Result: ALLOW
Elapsed time: 2230 ns
Config:
Additional Information:
ECMP load balancing
Found next-hop 203.0.113.9

Phase: 5
Type: PBR-LOOKUP
Subtype: policy-route
Result: ALLOW
Elapsed time: 446 ns
Config:
route-map FMC_GENERATED_PB
match ip address ACL_PBR
set adaptive-interface cos
Additional Information:
Matched route-map FMC_GENE
Found next-hop 203.0.113.9

...

Phase: 15
Type: ADJACENCY-LOOKUP
Subtype: Resolve Nexthop I
Result: ALLOW
Elapsed time: 5352 ns
Config:
Additional Information:
Found adjacency entry for
Adjacency :Active
MAC address 4c4e.35fc.fcd8

Result:
input-interface: INSIDE(vr
input-status: up
input-line-status: up
output-interface: OUTSIDE1
output-status: up
output-line-status: up
Action: allow
Time Taken: 825100 ns
```

使用實際流量進行測試

使用跟蹤配置資料包捕獲：

```
firepower# capture CAPI trace interface INSIDE match ip host 192.168.2.1 host 198.51.100.5
firepower# capture CAPO1 trace interface OUTSIDE1 match ip host 192.168.2.1 host 198.51.100.5
firepower# capture CAPO2 trace interface OUTSIDE2 match ip host 192.168.2.1 host 198.51.100.5
```

```
Router1# telnet 198.51.100.5 /vrf VRF-101 /source-interface lo2
Trying 198.51.100.5 ... Open
```

捕獲顯示：

```
firepower# show capture
capture CAPI type raw-data trace interface INSIDE [Capturing - 4389 bytes]
match ip host 192.168.2.1 host 198.51.100.5
capture CAPO1 type raw-data trace interface OUTSIDE1 [Capturing - 4389 bytes]
match ip host 192.168.2.1 host 198.51.100.5
capture CAPO2 type raw-data trace interface OUTSIDE2 [Capturing - 0 bytes]
match ip host 192.168.2.1 host 198.51.100.5
```

TCP SYN封包的追蹤軌跡：

```
firepower# show capture CAPI packet-number 1 trace

44 packets captured

1: 13:26:38.485585 802.1Q vlan#101 P0 192.168.2.1.49032 > 198.51.100.5.23: S 571152066:571152066(0) win
...

Phase: 3
Type: SUBOPTIMAL-LOOKUP
Subtype: suboptimal next-hop
Result: ALLOW
Elapsed time: 13826 ns
Config:
Additional Information:
Input route lookup returned ifc OUTSIDE2 is not same as existing ifc OUTSIDE1

Phase: 4
Type: ECMP load balancing
Subtype:
Result: ALLOW
Elapsed time: 1784 ns
Config:
Additional Information:
ECMP load balancing
```

```
Found next-hop 203.0.113.99 using egress ifc OUTSIDE1(vrfid:0)

Phase: 5
Type: PBR-LOOKUP
Subtype: policy-route
Result: ALLOW
Elapsed time: 446 ns
Config:
route-map FMC_GENERATED_PBR_1649228271478 permit 5
match ip address ACL_PBR
set adaptive-interface cost OUTSIDE1
Additional Information:
Matched route-map FMC_GENERATED_PBR_1649228271478, sequence 5, permit
Found next-hop 203.0.113.99 using egress ifc OUTSIDE1

...

Phase: 15
Type: ADJACENCY-LOOKUP
Subtype: Resolve Nexthop IP address to MAC
Result: ALLOW
Elapsed time: 4906 ns
Config:
Additional Information:
Found adjacency entry for Next-hop 203.0.113.99 on interface OUTSIDE1
Adjacency :Active
MAC address 4c4e.35fc.fcd8 hits 348 reference 2

...

Result:
input-interface: INSIDE(vrfid:0)
input-status: up
input-line-status: up
output-interface: OUTSIDE1(vrfid:0)
output-status: up
output-line-status: up
Action: allow
Time Taken: 222106 ns
```

ASP PBR表顯示策略命中計數：

```
firepower# show asp table classify domain pbr

Input Table
in id=0x1505f26d3420, priority=2147483642, domain=pbr, deny=false
hits=7, user_data=0x1505f26e7590, cs_id=0x0, use_real_addr, flags=0x0, protocol=0
src ip/id=192.168.2.0, mask=255.255.255.0, port=0, tag=any
dst ip/id=198.51.100.5, mask=255.255.255.255, port=0, tag=any, dscp=0x0, nsg_id=none
input_ifc=INSIDE(vrfid:0), output_ifc=any

Output Table:

L2 - Output Table:

L2 - Input Table:

Last clearing of hits counters: Never
```

注意：Packet Tracer還會增加命中計數器。

PBR偵錯

警告：在生產環境中，調試可以生成大量消息。

啟用此調試：

```
firepower# debug policy-route
debug policy-route enabled at level 1
```

傳送實際流量：

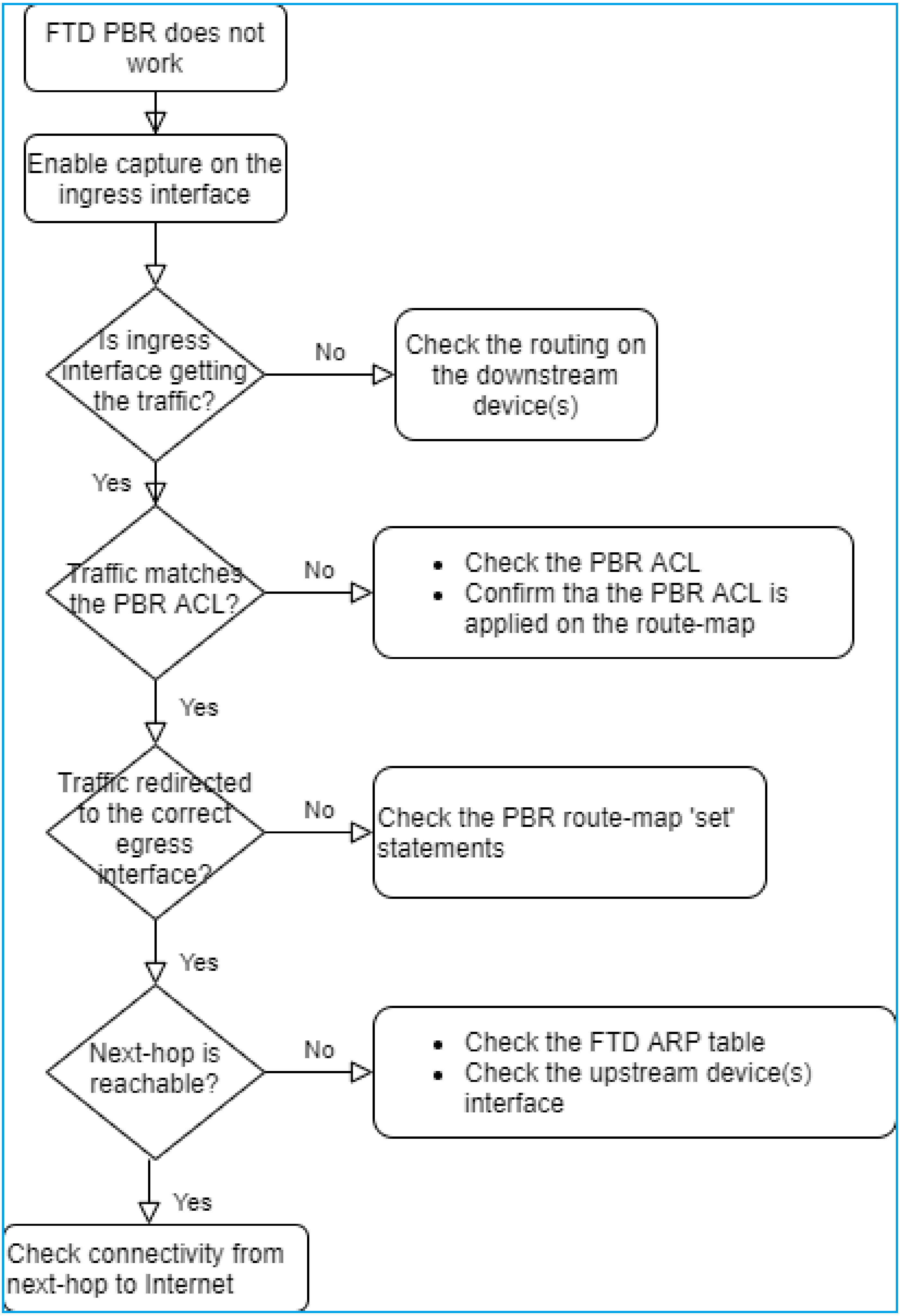
```
Router1# telnet 198.51.100.5 /vrf VRF-101 /source-interface lo2
Trying 198.51.100.5 ... Open
```

偵錯顯示：

```
firepower#

pbr: policy based route lookup called for 192.168.2.1/37256 to 198.51.100.5/23 proto 6 sub_proto 0 rece
pbr: First matching rule from ACL(2)
pbr: route map FMC_GENERATED_PBR_1649228271478, sequence 5, permit; proceed with policy routing
pbr: policy based routing applied; egress_ifc = OUTSIDE1 : next_hop = 203.0.113.99
```

注意：Packet Tracer還會生成調試輸出。

此流程圖可用於對PBR進行故障排除：


FTD PBR does not work
Enable capture on the ingress interface
Is ingress interface getting the traffic?
No
Check the routing on the downstream device(s)
Yes
Traffic matches the PBR ACL?
No
• Check the PBR ACL
• Confirm tha the PBR ACL is applied on the route-map
Yes
Traffic redirected to the correct egress interface?
No
Check the PBR route-map 'set' statements
Yes
Next-hop is reachable?
No
• Check the FTD ARP table
• Check the upstream device(s) interface
Yes
Check connectivity from next-hop to Internet

PBR命令摘要

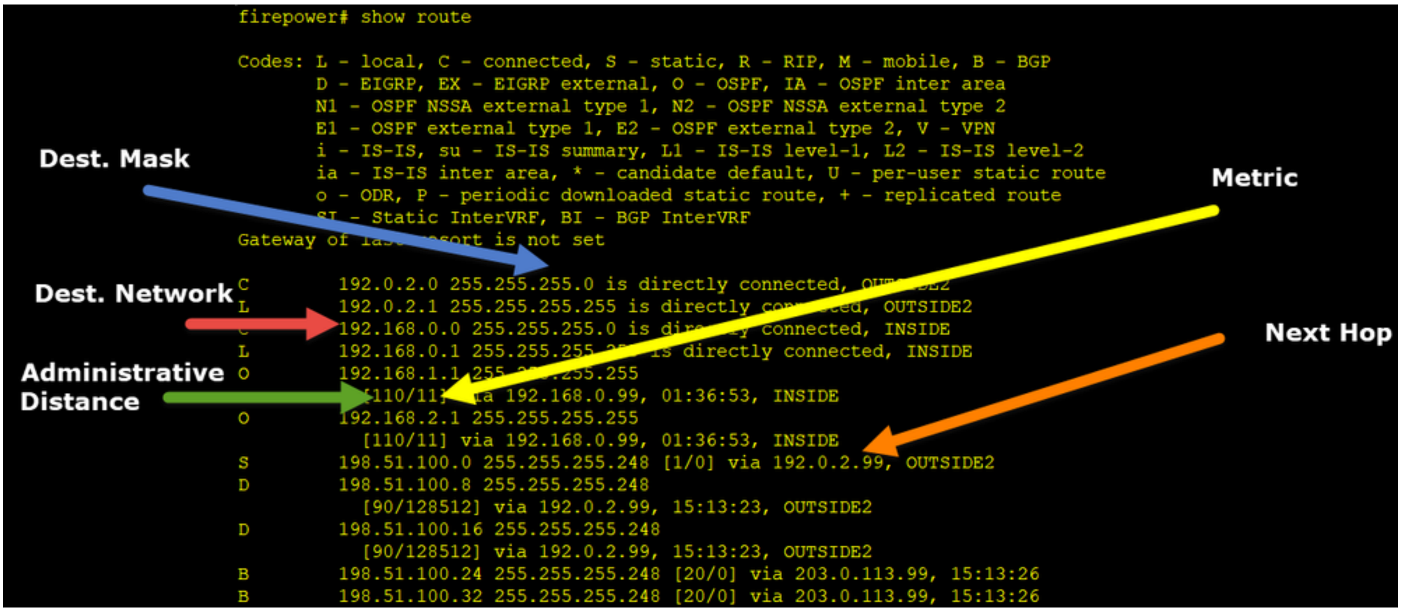
```
show asp drop
```

案例4 — 基於全域性路由查詢的轉發

在連線查詢、NAT查詢和PBR之後，最後檢查以確定輸出介面的專案是全域性路由表。

路由表驗證

現在來檢查FTD路由表輸出：



```
firepower# show route

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, V - VPN
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, + - replicated route
       SI - Static InterVRF, BI - BGP InterVRF
Gateway of last resort is not set

C        192.0.2.0 255.255.255.0 is directly connected, OUTSIDE2
L        192.0.2.1 255.255.255.255 is directly connected, OUTSIDE2
C        192.168.0.0 255.255.255.0 is directly connected, INSIDE
L        192.168.0.1 255.255.255.255 is directly connected, INSIDE
O        192.168.1.1 255.255.255.255
           [110/11] via 192.168.0.99, 01:36:53, INSIDE
O        192.168.2.1 255.255.255.255
           [110/11] via 192.168.0.99, 01:36:53, INSIDE
S        198.51.100.0 255.255.255.248 [1/0] via 192.0.2.99, OUTSIDE2
D        198.51.100.8 255.255.255.248
           [90/128512] via 192.0.2.99, 15:13:23, OUTSIDE2
D        198.51.100.16 255.255.255.248
           [90/128512] via 192.0.2.99, 15:13:23, OUTSIDE2
B        198.51.100.24 255.255.255.248 [20/0] via 203.0.113.99, 15:13:26
B        198.51.100.32 255.255.255.248 [20/0] via 203.0.113.99, 15:13:26
```

路由過程的主要目標是找到下一跳。路由選擇順序如下：

1. 最長的匹配獲勝
2. 最小AD（在不同的路由協定源之間）
3. 最低度量（如果路由是從同一源獲知的 — 路由協定）

路由表的填充方式：

- IGP(R、D、EX、O、IA、N1、N2、E1、E2、i、su、L1、L2、ia、o)

- BGP(B)

- BGP InterVRF(BI)

— 靜態

— 靜態InterVRF(SI)

— 已連線(C)

— 本地IP(L)

- VPN(V)

— 重新分發

— 預設

要檢視路由表摘要，請使用以下命令：

<#root>

```
firepower#

show route summary



IP routing table maximum-paths is 8
Route Source   Networks Subnets Replicates Overhead Memory (bytes)
connected      0        8       0          704      2368
static         0        1       0          88       296
ospf 1         0        2       0          176      600
Intra-area: 2 Inter-area: 0 External-1: 0 External-2: 0
NSSA External-1: 0 NSSA External-2: 0
bgp 65000      0        2       0          176      592
External: 2 Internal: 0 Local: 0
eigrp 1        0        2       0          216      592
internal       7                                    3112

Total          7        15      0          1360     7560
```

您可以使用以下命令跟蹤路由表更新：

<#root>

```
firepower#

debug ip routing


IP routing debugging is on
```

例如，從全域性路由表中刪除OSPF路由192.168.1.0/24時，調試會顯示以下內容：

<#root>

```
firepower#

RT: ip_route_delete 192.168.1.0 255.255.255.0 via 192.0.2.99, INSIDE


ha_cluster_synced 0 routetype 0
RT: del 192.168.1.0 via 192.0.2.99, ospf metric [110/11]NP-route: Delete-Output 192.168.1.0/24 hop_coun
RT: delete network route to 192.168.1.0 255.255.255.0NP-route: Delete-Output 192.168.1.0/24 hop_count:1
```

```
NP-route: Delete-Input 192.168.1.0/24 hop_count:1 Distance:110 Flags:0X0 , via 0.0.0.0, INSIDE
```

新增回時：

<#root>

```
firepower#
```

RT: NP-route: Add-Output 192.168.1.0/24 hop_count:1 , via 192.0.2.99, INSIDE

```
NP-route: Add-Input 192.168.1.0/24 hop_count:1 Distance:110 Flags:0X0 , via 192.0.2.99, INSIDE
```

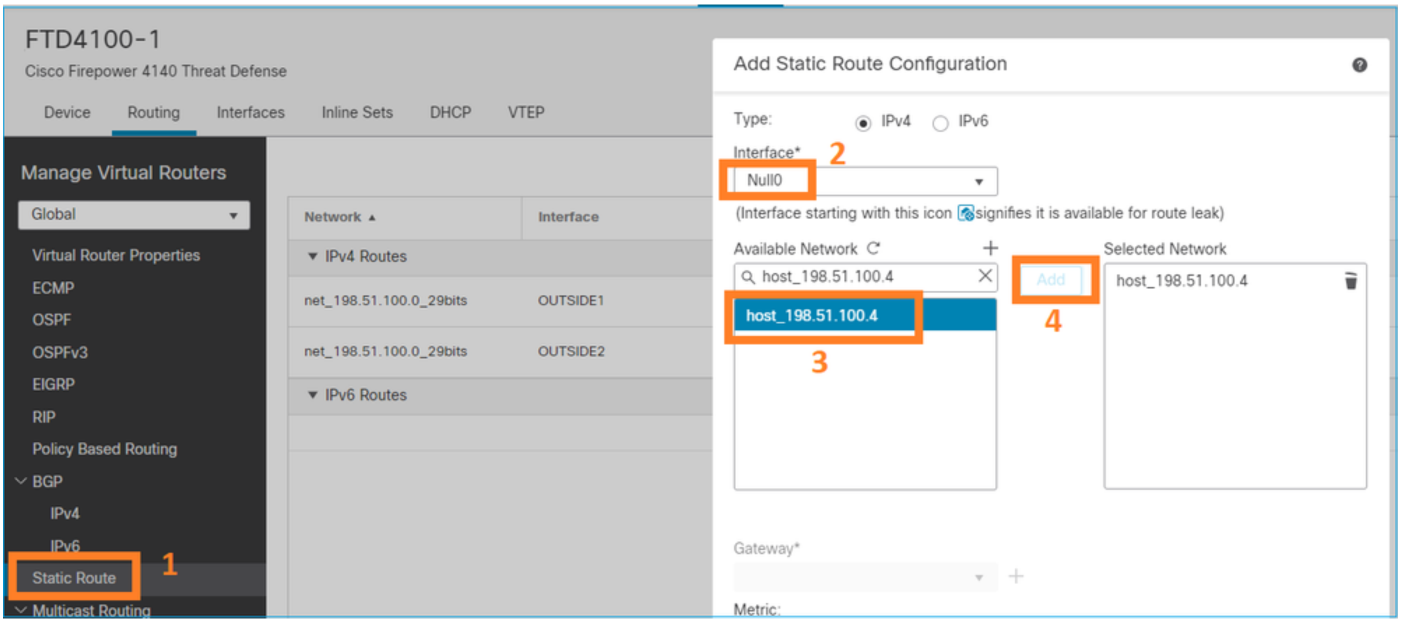
Null0介面

Null0介面可用於丟棄不需要的流量。此捨棄比使用存取控制原則(ACL)規則的流量捨棄對效能的影響較小。

需求

為198.51.100.4/32主機配置Null0路由。

解決方案



Network ▲	Interface
net_198.51.100.0_29bits	OUTSIDE1
net_198.51.100.0_29bits	OUTSIDE2

Type: ● IPv4 ○ IPv6

Interface*: Null0

(Interface starting with this icon signifies it is available for route leak)

Available Network: host_198.51.100.4

Selected Network: host_198.51.100.4

儲存並部署。

驗證：

<#root>

```
firepower#

show run route


route OUTSIDE2 198.51.100.0 255.255.255.248 192.0.2.99 1
route OUTSIDE1 198.51.100.0 255.255.255.248 203.0.113.99 200

route Null0 198.51.100.4 255.255.255.255 1
```

<#root>

```
firepower#

show route | include 198.51.100.4


S 198.51.100.4 255.255.255.255 [1/0] is directly connected, Null0
```

嘗試訪問遠端主機：

<#root>

```
Router1#

ping vrf VRF-101 198.51.100.4


Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 198.51.100.4, timeout is 2 seconds:

.....


Success rate is 0 percent (0/5)
```

FTD 記錄顯示：

<#root>

```
firepower#

show log | include 198.51.100.4


Apr 12 2022 12:35:28:

%FTD-6-110002: Failed to locate egress interface for ICMP from INSIDE:192.168.0.99/0 to 198.51.100.4/0
```

ASP丟棄顯示：

```
<#root>

firepower#

show asp drop


Frame drop:

No route to host (no-route)                1920
```

等價多重路徑(ECMP)

流量區域

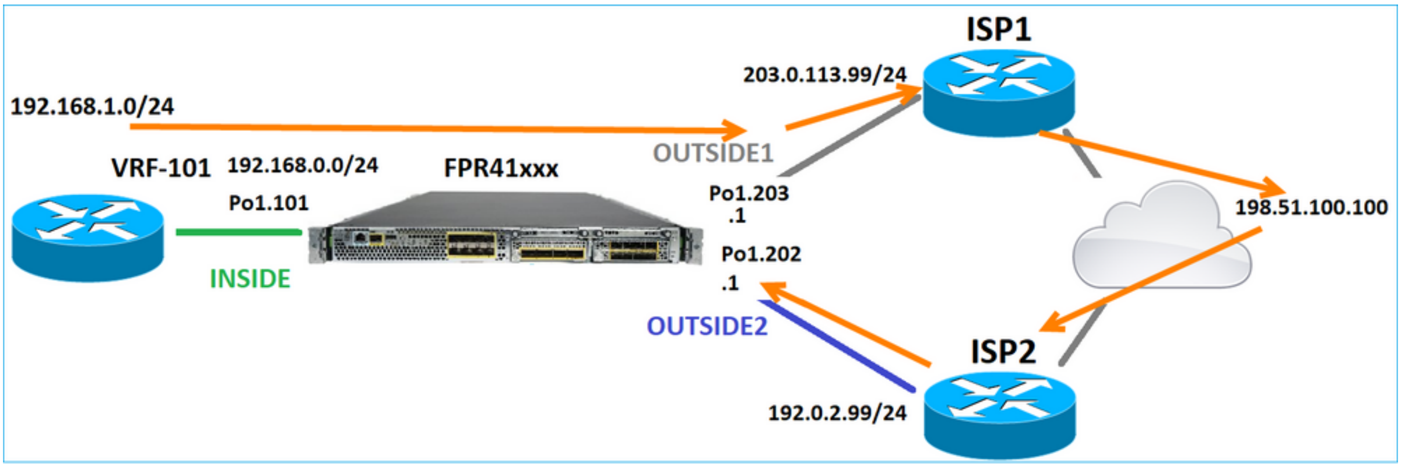
- ECMP流量區域允許使用者將介面組合在一起（稱為ECMP區域）。
- 這允許ECMP路由以及跨多個介面的流量負載均衡。
- 當介面與ECMP Traffic Zone關聯時，使用者能夠在介面上建立等價靜態路由。等價靜態路由是到具有相同度量值的同一目標網路的路由。

在7.1版本之前，Firepower威脅防禦支持通過FlexConfig策略的ECMP路由。從7.1版本起，您可以將介面分組到流量區域，並在Firepower管理中心中配置ECMP路由。

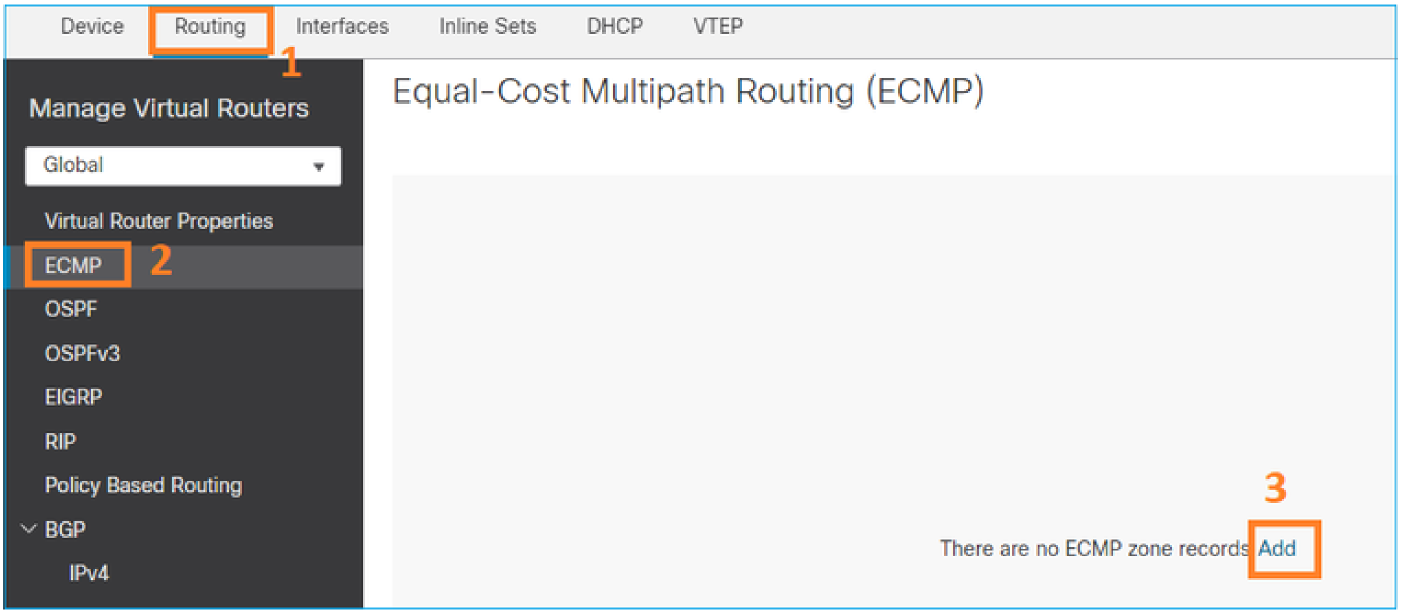
EMCP記錄在：ECMP

在本範例中，發生非對稱路由，且傳回流量遭捨棄：

```
<#root>

firepower#

show log


Apr 13 2022 07:20:48: %FTD-6-302013:

B

uilt inbound TCP connection 4046 for INSIDE:192.168.1.1/23943 (192.168.1.1/23943) to OUTSIDE1:198.51.10


Apr 13 2022 07:20:48: %FTD-6-106015:

Deny TCP (no connection) from 198.51.100.100/23 to 192.168.1.1/23943 flags SYN ACK on interface OUTSIDE2
```



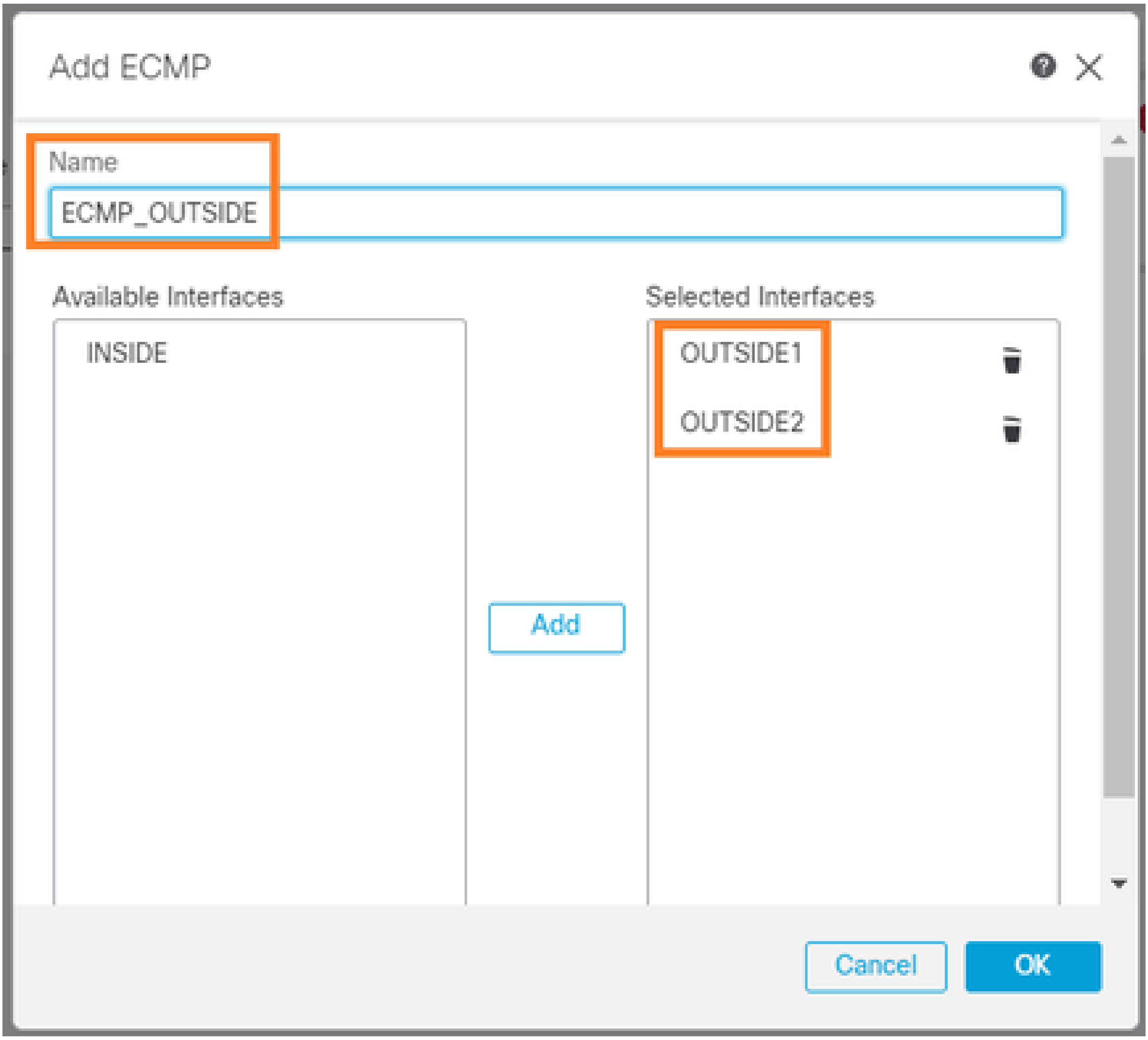
從FMC UI配置ECMP:



Equal-Cost Multipath Routing (ECMP)

There are no ECMP zone records Add

在ECMP組中新增2個介面：

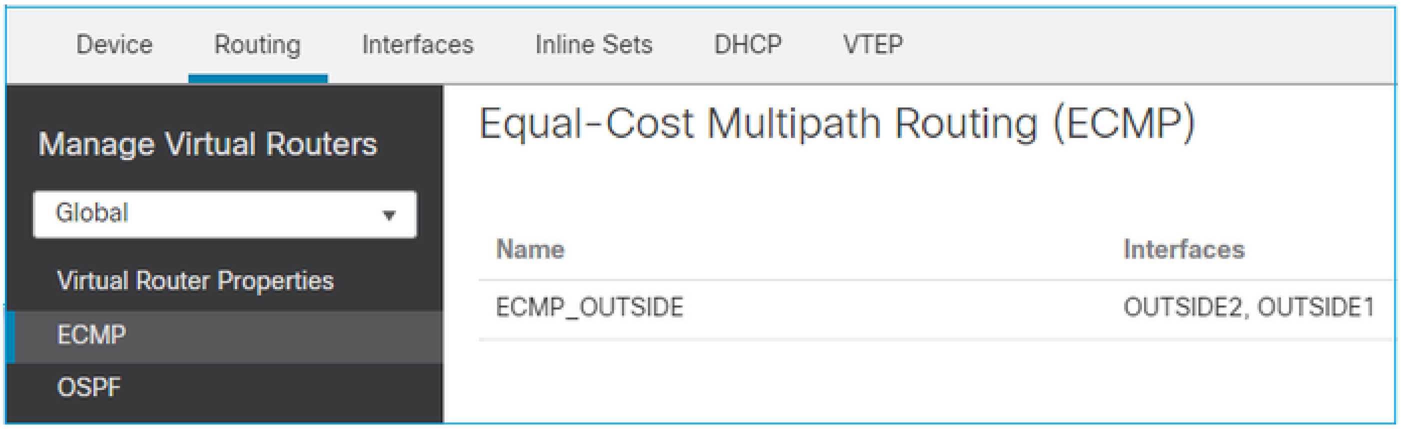


Name: ECMP_OUTSIDE

Available Interfaces: INSIDE

Selected Interfaces: OUTSIDE1, OUTSIDE2

結果是：



Equal-Cost Multipath Routing (ECMP)

Name	Interfaces
ECMP_OUTSIDE	OUTSIDE2, OUTSIDE1

儲存並部署。

ECMP區域驗證：

<#root>

```
firepower#

show run zone


zone ECMP_OUTSIDE ecmp


firepower#

show zone


Zone: ECMP_OUTSIDE ecmp


Security-level: 0


Zone member(s): 2


OUTSIDE1 Port-channel1.203


OUTSIDE2 Port-channel1.202
```

介面驗證：

<#root>

```
firepower#

show run int po1.202


!
interface Port-channel1.202
vlan 202
nameif OUTSIDE2
cts manual
propagate sgt preserve-untag
policy static sgt disabled trusted
security-level 0

zone-member ECMP_OUTSIDE


ip address 192.0.2.1 255.255.255.0

firepower#

show run int po1.203
```

```
!
interface Port-channel1.203
vlan 203
nameif OUTSIDE1
cts manual
propagate sgt preserve-untag
policy static sgt disabled trusted
security-level 0
```

```
zone-member ECMP_OUTSIDE


ip address 203.0.113.1 255.255.255.0
```

現在，允許傳回流量，且連線為UP:

<#root>

```
Router1#

telnet 198.51.100.100 /vrf VRF-101 /source-interface lo1


Trying 198.51.100.100 ... Open
```

Capture on ISP1 interface（ISP1介面上的捕獲）顯示輸出流量：

<#root>

```
firepower#

show capture CAP1



5 packets captured

1: 10:03:52.620115 802.1Q vlan#203 P0 192.168.1.1.56199 > 198.51.100.100.23: S 1782458734:1782458734(0)
2: 10:03:52.621992 802.1Q vlan#203 P0 192.168.1.1.56199 > 198.51.100.100.23: . ack 2000807246 win 4128
3: 10:03:52.622114 802.1Q vlan#203 P0 192.168.1.1.56199 > 198.51.100.100.23: . ack 2000807246 win 4128
4: 10:03:52.622465 802.1Q vlan#203 P0 192.168.1.1.56199 > 198.51.100.100.23: P 1782458735:1782458753(18
5: 10:03:52.622556 802.1Q vlan#203 P0 192.168.1.1.56199 > 198.51.100.100.23: . ack 2000807246 win 4128
```

ISP2介面上的捕獲顯示返回流量：

<#root>

```
firepower#

show capture CAP2
```

```
6 packets captured

1: 10:03:52.621305 802.1Q vlan#202 P0 198.51.100.100.23 > 192.168.1.1.56199:
```

S

```
 2000807245:2000807245(0)
```

ack

```
 1782458735 win 64240 <mss 1460>
3: 10:03:52.623808 802.1Q vlan#202 P0 198.51.100.100.23 > 192.168.1.1.56199: . ack 1782458753 win 64222
```

FTD管理平面

FTD有2個管理平面：

- Management0介面 — 提供對Firepower子系統的訪問
- LINA診斷介面 — 提供對FTD LINA子系統的存取許可權

要配置和驗證Management0介面，請分別使用configure network和show network命令。

另一方面，LINA介面提供對LINA本身的存取。FTD RIB中的FTD介面專案可以視為本機路由：

<#root>

```
firepower#
```

show route | include L

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
L 192.0.2.1 255.255.255.255 is directly connected, OUTSIDE2
L 192.168.0.1 255.255.255.255 is directly connected, INSIDE
L 203.0.113.1 255.255.255.255 is directly connected, OUTSIDE1
```

同樣，它們也可以被視為ASP路由表中的身份條目：

<#root>

```
firepower#
```

show asp table routing | include identity

```
in 169.254.1.1 255.255.255.255 identity
in
```

192.0.2.1 255.255.255.255 identity

```
in

203.0.113.1 255.255.255.255 identity


in

192.168.0.1 255.255.255.255 identity


in ff02::1 ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff identity
in ff02::1:ff01:3 ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff identity
in ff02::1:ff00:1 ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff identity
in fe80::200:ff:fe01:3 ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff identity
in fd00:0:0:1::1 ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff identity
out 0.0.0.0 0.0.0.0 via 0.0.0.0, identity
out :: :: via 0.0.0.0, identity
```

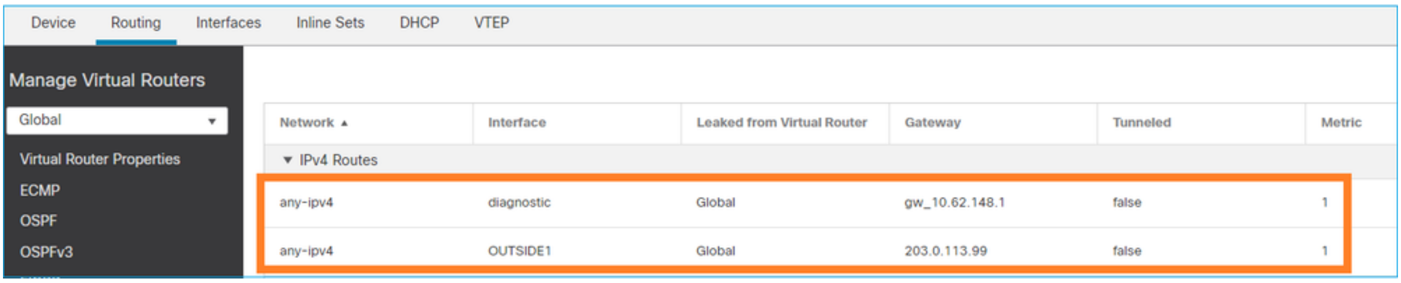
要點

當封包到達FTD時，且目的地IP與其中一種身分IP相符時，FTD知道必須使用該封包。

FTD LINA診斷介面路由

FTD（與執行9.5後代碼的ASA類似）為配置為僅管理的任何介面維護類似VRF的路由表。診斷介面就是一個此類介面的示例。

雖然FMC不允許您（不帶ECMP）使用相同的度量在2個不同介面上配置2條預設路由，但是您可以在FTD資料介面上配置1條預設路由，並在診斷介面上配置另一條預設路由：



Network ▲	Interface	Leaked from Virtual Router	Gateway	Tunneled	Metric
▼ IPv4 Routes					
any-ipv4	diagnostic	Global	gw_10.62.148.1	false	1
any-ipv4	OUTSIDE1	Global	203.0.113.99	false	1

資料平面流量使用全域性表預設網關，而管理平面流量使用診斷預設GW:

<#root>

```
firepower#

show route management-only



Routing Table: mgmt-only


Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, V - VPN
```

```
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route, + - replicated route
SI - Static InterVRF, BI - BGP InterVRF

Gateway of last resort is 10.62.148.1 to network 0.0.0.0



S* 0.0.0.0 0.0.0.0 [1/0] via 10.62.148.1, diagnostic
```

全域性路由表網關：

<#root>

```
firepower#

show route | include S\*|Gateway


Gateway of last resort is 203.0.113.99 to network 0.0.0.0


S* 0.0.0.0 0.0.0.0 [1/0] via 203.0.113.99, OUTSIDE1
```

當您從FTD傳送流量（框內流量）時，會根據以下條件選擇輸出介面：

1. 全域性路由表
2. 僅管理路由表

如果手動指定輸出介面，可以覆寫輸出介面選項。

嘗試ping診斷介面網關。如果不指定來源介面，ping就會失敗，因為FTD首先使用全域路由表，此全域路由表包含預設路由。如果全域性表中沒有路由，FTD會在僅管理路由表上執行路由查詢：

<#root>

```
firepower#

ping 10.62.148.1


Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.62.148.1, timeout is 2 seconds:

?????


Success rate is 0 percent (0/5)
firepower#

show capture CAP1 | include 10.62.148.1
```

```
1: 10:31:22.970607 802.1Q vlan#203 P0

203.0.113.1 > 10.62.148.1 icmp: echo request


2: 10:31:22.971431 802.1Q vlan#203 P0

10.1.1.2 > 203.0.113.1 icmp: host 10.62.148.1 unreachable
```

<#root>

```
firepower#

ping diagnostic 10.62.148.1


Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.62.148.1, timeout is 2 seconds:

!!!!!


Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

這同樣適用於嘗試使用copy指令從LINA CLI複製檔案的情況。

雙向轉送偵測(BFD)

在傳統ASA 9.6版上新增了BFD支援，並且僅對BGP協定：雙向轉發檢測路由

在FTD上：

- 支援BGP IPv4和BGP IPv6協定（軟體6.4）。
- 不支援OSPFv2、OSPFv3和EIGRP協定。
- 不支援靜態路由的BFD。

虛擬路由器(VRF)

6.6版本中新增了VRF支援。有關詳細資訊，請檢視以下文檔：虛擬路由器的配置示例

相關資訊

- FTD靜態路由和預設路由

關於此翻譯

思科已使用電腦和人工技術翻譯本文件，讓全世界的使用者能夠以自己的語言理解支援內容。請注意，即使是最佳機器翻譯，也不如專業譯者翻譯的內容準確。Cisco Systems, Inc. 對這些翻譯的準確度概不負責，並建議一律查看原始英文文件（提供連結）。