# 為站點到站點IPSec VPN配置高可用性功能

## 目錄



## 簡介

本文檔介紹站點到站點IPSec VPN網路的新高可用性功能。熱待命路由器通訊協定(HSRP)通常用於追蹤路由器的介面狀態，以便在路由器之間實現容錯移轉。但是，由於IPSec和HSRP之間不存在內部關聯，因此HSRP不會跟蹤IPSec安全關聯(SA)的狀態，並且IPSec需要一些方案以便在發生故障時與HSRP故障轉移同步。以下是用於在IPSec和HSRP之間提供更緊密耦合的方案的一些要點：

- Internet金鑰交換(IKE)keepalive用於允許IPSec及時檢測HSRP故障切換。
- 應用於特定路由器介面的加密對映與該介面上已配置的HSRP組連結，以使IPSec瞭解HSRP設定。這也允許IPSec使用HSRP虛擬IP地址作為HSRP路由器的網際網路安全關聯和金鑰管理協定(ISAKMP)標識。
- 反向路由注入(RRI)功能用於在HSRP和IPSec故障轉移期間允許動態路由資訊更新。

**注意**：本文檔介紹如何在VPN中使用熱備份路由器協定(HSRP)。HSRP還用於跟蹤出現故障的ISP鏈路。要在路由器上配置冗餘ISP鏈路，請參閱使用ICMP回應操作分析IP服務級別。源裝置是路由器，目的裝置是ISP裝置。

## 必要條件

### 需求

本文件沒有特定先決條件。

### 採用元件

本文中的資訊係根據以下軟體和硬體版本：

- Cisco 7200系列路由器
- Cisco IOS®軟體版本12.3(7)T1,c7200-a3jk9s-mz.123-7.T1

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。如果您在即時網路中工作，請確保在使用任何命令之前瞭解其潛在影響。

## 慣例

如需文件慣例的詳細資訊，請參閱思科技術提示慣例。

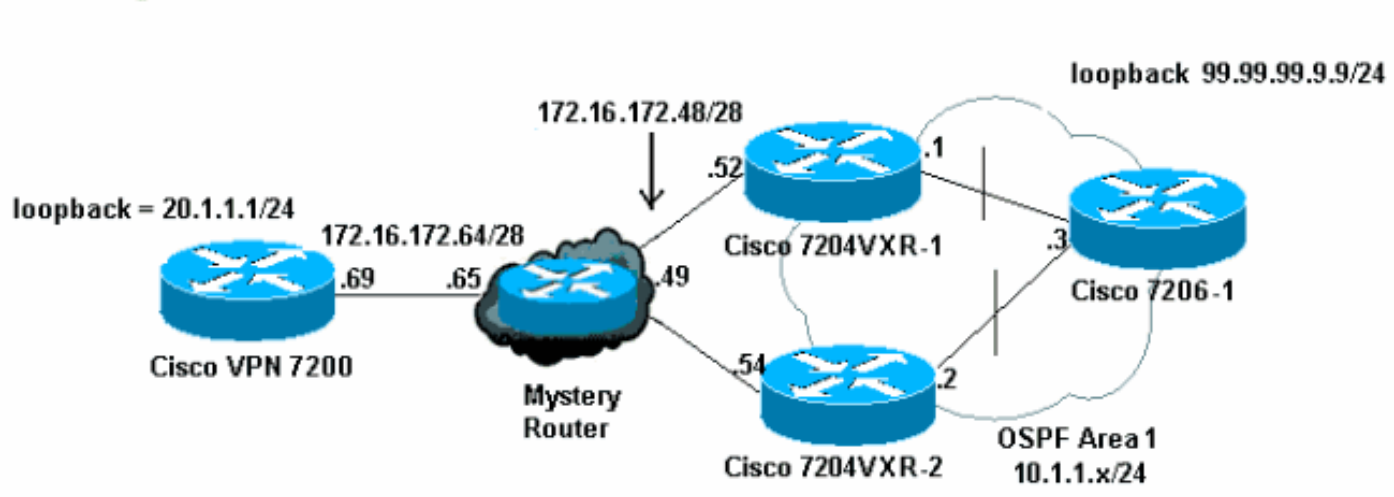
# 設定

本節提供用於設定本文件中所述功能的資訊。

**註：使**用Command Lookup Tool(僅供已註冊客戶使用)可獲取本節中使用的命令的詳細資訊。

## 網路圖表

本檔案會使用以下網路設定：




## 組態

本檔案會使用以下設定：

- Cisco VPN 7200配置
- Cisco 7204VXR-1組態
- Cisco 7204VXR-2組態
- Cisco 7206-1配置

| Cisco VPN 7200配置 |
| --- |
| vpn7200#**show run**<br>Building configuration... |

```
Current configuration : 1854 bytes
!
version 12.2
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname vpn7200
!
!
ip subnet-zero
ip cef
!--- Defines ISAKMP policy and IKE pre-shared key for !-
-- IKE authentication. Note that 172.16.172.53 is the !-
-- HSRP virtual IP address of the remote HSRP routers.
crypto isakmp policy 1 hash md5 authentication pre-share
crypto isakmp key cisco123 address 172.16.172.53 !---
IKE keepalive to detect the IPSec liveness of the remote
!--- VPN router. When HSRP failover happens, IKE
keepalive !--- will detect the HSRP router switchover.
crypto isakmp keepalive 10 ! ! crypto ipsec transform-
set myset esp-des esp-md5-hmac !--- Defines crypto map.
Note that the peer address is the !--- HSRP virtual IP
address of the remote HSRP routers. crypto map vpn 10
ipsec-isakmp set peer 172.16.172.53 set transform-set
myset match address 101 ! interface Loopback0 ip address
20.1.1.1 255.255.255.255 ! interface FastEthernet0/0 ip
address 10.48.66.66 255.255.254.0 duplex full speed 100
! interface FastEthernet0/1 ip address 172.16.172.69
255.255.255.240 duplex full speed 100 crypto map vpn !
ip classless ip route 10.1.1.0 255.255.255.0
172.16.172.65 ip route 99.99.99.99 255.255.255.255
172.16.172.65 ip route 172.16.172.48 255.255.255.240
172.16.172.65 no ip http server ! access-list 101 permit
ip 20.1.1.0 0.0.0.255 10.1.1.0 0.0.0.255 access-list 101
permit ip 20.1.1.0 0.0.0.255 host 99.99.99.99 ! line con
0 exec-timeout 0 0 line aux 0 line vty 0 4 login ! end
```

## Cisco 7204VXR-1組態

```
7204VXR-1#show run
Building configuration...

Current configuration : 1754 bytes
!
version 12.3
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname 7204VXR-1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
ip subnet-zero
!
!
no ip domain lookup
!
!
```

```
ip cef!
!--- Defines ISAKMP policy. crypto isakmp policy 1 hash
md5 authentication pre-share crypto isakmp key cisco123
address 172.16.172.69 crypto isakmp keepalive 10 ! !
crypto ipsec transform-set myset esp-des esp-md5-hmac !-
-- Defines crypto map. Note that "reverse-route" !---
turns on the RRI feature. crypto map vpn 10 ipsec-isakmp
set peer 172.16.172.69 set transform-set myset match
address 101 reverse-route ! ! !--- Define HSRP under the
interface. HSRP will track the !--- internal interface
as well. HSRP group name must be !--- defined here and
will be used for IPSec configuration. !--- The
"redundancy" keyword in the crypto map command !---
specifies the HSRP group to which IPSec will couple. !--
- In normal circumstances, this router will be the HSRP
!--- primary router since it has higher priority than
the !--- other HSRP router. interface FastEthernet0/0 ip
address 172.16.172.52 255.255.255.240 duplex full speed
100 standby 1 ip 172.16.172.53 standby 1 priority 200
standby 1 preempt standby 1 name VPNHA standby 1 track
FastEthernet0/1 150 crypto map vpn redundancy VPNHA !
interface FastEthernet0/1 ip address 10.1.1.1
255.255.255.0 duplex full speed 100 ! interface ATM1/0
no ip address shutdown no atm ilmi-keepalive ! interface
FastEthernet3/0 no ip address shutdown duplex half !
interface ATM6/0 no ip address shutdown no atm ilmi-
keepalive !--- Define dynamic routing protocol and re-
distribute static !--- route. This enables dynamic
routing information update !--- during the HSRP/IPSec
failover. All the "VPN routes" !--- that are injected in
the routing table by RRI as static !--- routes will be
redistributed to internal networks. ! router ospf 1 log-
adjacency-changes redistribute static subnets network
10.1.1.0 0.0.0.255 area 0 ! ip classless ip route
172.16.172.64 255.255.255.240 172.16.172.49 no ip http
server no ip http secure-server ! ! !--- Defines VPN
traffic. The destination IP subnet will be !--- injected
into the routing table as static routes by RRI. access-
list 101 permit ip 10.1.1.0 0.0.0.255 20.1.1.0 0.0.0.255
access-list 101 permit ip host 99.99.99.99 20.1.1.0
0.0.0.255 ! line con 0 exec-timeout 0 0 stopbits 1 line
aux 0 stopbits 1 line vty 0 4 ! ! ! end
```

## Cisco 7204VXR-2組態

```
7204VXR-2#show run
Building configuration...

Current configuration : 2493 bytes
!
version 12.3
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname 7204VXR-2
!
boot-start-marker
boot system flash disk1:c7200-a3jk9s-mz.123-7.T1
boot-end-marker
!
no aaa new-model
ip subnet-zero
```

```
!
!
no ip domain lookup
ip host rund 10.48.92.61
!
!
ip cef
!
crypto isakmp policy 1
hash md5
authentication pre-share
crypto isakmp key cisco123 address 172.16.172.69
crypto isakmp keepalive 10
!
!
crypto ipsec transform-set myset esp-des esp-md5-hmac
!
crypto map vpn 10 ipsec-isakmp
set peer 172.16.172.69
set transform-set myset
match address 101
reverse-route
!
!--- During normal operational conditions this router !-
-- will be the standby router. interface FastEthernet0/0
ip address 172.16.172.54 255.255.255.240 ip directed-
broadcast duplex full standby 1 ip 172.16.172.53 standby
1 preempt standby 1 name VPNHA standby 1 track
FastEthernet1/0 crypto map vpn redundancy VPNHA !
interface FastEthernet1/0 ip address 10.1.1.2
255.255.255.0 ip directed-broadcast duplex full !
interface FastEthernet3/0 ip address 10.48.67.182
255.255.254.0 ip directed-broadcast shutdown duplex full
! router ospf 1 log-adjacency-changes redistribute
static subnets network 10.1.1.0 0.0.0.255 area 0 ! ip
classless ip route 172.16.172.64 255.255.255.240
172.16.172.49 no ip http server no ip http secure-server
! ! ! access-list 101 permit ip 10.1.1.0 0.0.0.255
20.1.1.0 0.0.0.255 access-list 101 permit ip host
99.99.99.99 20.1.1.0 0.0.0.255 ! line con 0 exec-timeout
0 0 transport preferred all transport output all
stopbits 1 line aux 0 transport preferred all transport
output all stopbits 1 line vty 0 4 login transport
preferred all transport input all transport output all !
! ! end
```

## Cisco 7206-1配置

```
7206-1#show run
Building configuration...

Current configuration : 1551 bytes
!
version 12.2
no service pad
service timestamps debug datetime msec localtime
service timestamps log datetime msec localtime
no service password-encryption
!
hostname 7206-1
!
ip subnet-zero
no ip source-route
```

```
ip cef
!
interface Loopback0
ip address 99.99.99.99 255.255.255.255
!
interface FastEthernet0/0
shutdown
duplex full
speed 100
!
!--- Define dynamic routing protocol. All the "VPN
routes" !--- will be learned and updated dynamically
from upstream HSRP !--- routers using the dynamic
routing protocols. interface FastEthernet0/1 ip address
10.1.1.3 255.255.255.0 duplex full speed 100 ! router
ospf 1 log-adjacency-changes passive-interface Loopback0
network 10.1.1.0 0.0.0.255 area 0 network 99.99.99.99
0.0.0.0 area 0 ! ip classless no ip http server ! ! !
line con 0 exec-timeout 0 0 line aux 0 line vty 0 4
login ! end
```

# 如何運作？

此示例演示了如何使用上述設定和配置來使HSRP和IPSec故障切換協同工作。本案例研究強調三個方面：

- 由於介面故障而導致HSRP故障切換。
- HSRP故障切換後如何進行IPSec故障切換。可以看到，這裡的IPSec故障切換將是「無狀態」故障切換。
- 由故障切換引起的路由資訊更改如何動態更新並傳播到內部網路。

**注意：此處的測試流量是**Cisco 7206-1的環回IP地址(99.99.99.99)和Cisco VPN 7200(20.1.1.1)之間的網際網路控制消息協定(ICMP)資料包，並模擬兩個站點之間的VPN流量。

## 正常情況（故障轉移前）

故障轉移前，Cisco 7204VXR-1是主HSRP路由器，Cisco VPN 7200具有Cisco 7204VXR-1的IPSec SA。

在介面上配置加密對映時，RRI功能會注入VPN路由，以匹配加密對映中配置的IPSec訪問控制清單(ACL)和**set peer**命令語句。此路由新增到主HSRP路由器7204VXR-1的路由表中。

**debug crypto ipsec**命令的輸出指示將VPN路由20.1.1/24新增到路由資訊庫(RIB)。

```
IPSEC(rte_mgr): VPN Route Added 20.1.1.0 255.255.255.0
via 172.16.172.69 in IP DEFAULT TABLE
```

主HSRP路由器上的路由表產生到20.1.1/24的靜態路由，該路由通過開放最短路徑優先(OSPF)重新分發到輔助HSRP路由器7204VXR-2和內部路由器7206-1。

VPN路由20.1.1/24作為靜態路由注入路由器7204VXR-1的RIB的下一跳是遠端加密對等體的IP地址。在這種情況下，VPN路由20.1.1/24的下一跳是172.16.172.69。VPN路由下一跳的IP地址通過遞迴路由查詢解析，如此Cisco Express Forwarding表所示：

```
7204VXR-1#show ip route
Codes: 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, 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

Gateway of last resort is not set

    99.0.0.0/32 is subnetted, 1 subnets
O     99.99.99.99 [110/2] via 10.1.1.3, 00:11:21, FastEthernet0/1
    20.0.0.0/24 is subnetted, 1 subnets
S     20.1.1.0 [1/0] via 172.16.172.69
    172.16.0.0/28 is subnetted, 2 subnets
C     172.16.172.48 is directly connected, FastEthernet0/0
S      172.16.172.64 [1/0] via 172.16.172.49
    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C     10.1.1.0/24 is directly connected, FastEthernet0/1
S      10.48.66.0/23 [1/0] via 10.1.1.2


7204VXR-1#show ip cef 20.1.1.0 detail
20.1.1.0/24, version 66, epoch 0, cached adjacency 172.16.172.49
0 packets, 0 bytes
via 172.16.172.69, 0 dependencies, recursive
next hop 172.16.172.49, FastEthernet0/0 via 172.16.172.64/28
valid cached adjacency
```

輔助HSRP路由器和內部路由器7206-1通過OSPF/學習此VPN路由。網路管理員不需要手動輸入靜態路由。更重要的是，由故障切換引起的路由更改會動態更新。

```
7204VXR-2#show ip route
Codes: 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, 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

Gateway of last resort is 10.48.66.1 to network 0.0.0.0

    99.0.0.0/32 is subnetted, 1 subnets
O     99.99.99.99 [110/2] via 10.1.1.3, 00:29:31, FastEthernet1/0
    20.0.0.0/24 is subnetted, 1 subnets
O E2     20.1.1.0 [110/20] via 10.1.1.1, 00:11:06, FastEthernet1/0
    172.16.0.0/28 is subnetted, 2 subnets
C     172.16.172.48 is directly connected, FastEthernet0/0
S      172.16.172.64 [1/0] via 172.16.172.49
    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C      10.1.1.0/24 is directly connected, FastEthernet1/0
C      10.48.66.0/23 is directly connected, FastEthernet3/0
S*     0.0.0.0/0 [1/0] via 10.48.66.1


7206-1#show ip route
Codes: 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, 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

Gateway of last resort is not set

    99.0.0.0/32 is subnetted, 1 subnets
C     99.99.99.99 is directly connected, Loopback0
    20.0.0.0/24 is subnetted, 1 subnets
O E2     20.1.1.0 [110/20] via 10.1.1.1, 00:14:01, FastEthernet0/1
    172.16.0.0/28 is subnetted, 1 subnets
O E2     172.16.172.64 [110/20] via 10.1.1.1, 00:32:21, FastEthernet0/1
                                   [110/20] via 10.1.1.2, 00:32:21, FastEthernet0/1
    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C     10.1.1.0/24 is directly connected, FastEthernet0/1
O E2     10.48.66.0/23 [110/20] via 10.1.1.2, 00:32:22, FastEthernet0/1
```

路由器7204VXR-1是跟蹤內部介面Fa0/1的主要HSRP路由器。

```
7204VXR-1#show standby
FastEthernet0/0 - Group 1
State is Active
2 state changes, last state change 03:21:20
Virtual IP address is 172.16.172.53
Active virtual MAC address is 0000.0c07.ac01
Local virtual MAC address is 0000.0c07.ac01 (v1 default)
Hello time 3 sec, hold time 10 sec
Next hello sent in 0.172 secs
Preemption enabled
Active router is local
Standby router is 172.16.172.54,
   priority 100 (expires in 7.220 sec)
Priority 200 (configured 200)
Track interface FastEthernet0/1 state Up decrement 150
IP redundancy name is "VPNHA" (cfgd)
```

您可以使用**show track**命令檢視HSRP跟蹤的所有對象的清單。

```
7204VXR-1#show track
Track 1 (via HSRP)
Interface FastEthernet0/1 line-protocol
Line protocol is Up
1 change, last change 03:18:22
Tracked by:
HSRP FastEthernet0/0 1
```

路由器7204VXR-2是備用HSRP路由器。在正常操作條件下，該裝置跟蹤內部介面Fa1/0。

```
7204VXR-2#show standby
FastEthernet0/0 - Group 1
State is Standby
1 state change, last state change 02:22:30
Virtual IP address is 172.16.172.53
Active virtual MAC address is 0000.0c07.ac01
Local virtual MAC address is 0000.0c07.ac01 (v1 default)
Hello time 3 sec, hold time 10 sec
Next hello sent in 0.096 secs
Preemption enabled
```

```
Active router is 172.16.172.52,
   priority 200 (expires in 7.040 sec)
Standby router is local
Priority 100 (default 100)
Track interface FastEthernet1/0 state Up decrement 10
IP redundancy name is "VPNHA" (cfgd)
```

這些與IPSec相關的**show**命令在Cisco VPN 7200路由器上生成輸出，展示Cisco VPN 7200與主HSRP路由器(Cisco 7204VXR-1)之間的ISAKMP和IPSec SA。

```
7204VXR-1#show crypto isakmp sa detail
Codes: C - IKE configuration mode, D - Dead Peer Detection
K - Keepalives, N - NAT-traversal
X - IKE Extended Authentication
psk - Preshared key, rsig - RSA signature
renc - RSA encryption

C-id       Local       Remote     I-VRF  Encr  Hash  Auth  DH  Lifetime  Cap.
1    172.16.172.53  172.16.172.69         des   md5   psk   1  23:49:52   K
Connection-id:Engine-id = 1:1(software)


7204VXR-1#show crypto ipsec sa
interface: FastEthernet0/0
Crypto map tag: vpn, local addr. 172.16.172.53

protected vrf:
local ident (addr/mask/prot/port): (99.99.99.99/255.255.255.255/0/0)
remote ident (addr/mask/prot/port): (20.1.1.0/255.255.255.0/0/0)
current_peer: 172.16.172.69:500
PERMIT, flags={origin_is_acl,}
#pkts encaps: 5, #pkts encrypt: 5, #pkts digest: 5
#pkts decaps: 5, #pkts decrypt: 5, #pkts verify: 5
#pkts compressed: 0, #pkts decompressed: 0
#pkts not compressed: 0, #pkts compr. failed: 0
#pkts not decompressed: 0, #pkts decompress failed: 0
#send errors 0, #recv errors 0

local crypto endpt.: 172.16.172.53, remote crypto endpt.: 172.16.172.69
path mtu 1500, media mtu 1500
current outbound spi: 44E0B22B

inbound esp sas:
spi: 0x5B23F22E(1529082414)
transform: esp-des esp-md5-hmac ,
in use settings ={Tunnel, }
slot: 0, conn id: 2000, flow_id: 1, crypto map: vpn
crypto engine type: Software, engine_id: 1
sa timing: remaining key lifetime (k/sec): (4504144/2949)
ike_cookies: B57A9DC9 FA2D627B F70FEDF6 FAAF9E34
IV size: 8 bytes
replay detection support: Y

inbound ah sas:

inbound pcp sas:

outbound esp sas:
spi: 0x44E0B22B(1155576363)
transform: esp-des esp-md5-hmac ,
in use settings ={Tunnel, }
slot: 0, conn id: 2001, flow_id: 2, crypto map: vpn
crypto engine type: Software, engine_id: 1
```

```
sa timing: remaining key lifetime (k/sec): (4504145/2949)
ike_cookies: B57A9DC9 FA2D627B F70FEDF6 FAAF9E34
IV size: 8 bytes
replay detection support: Y

outbound ah sas:

outbound pcp sas:


vpn7200#show crypto isakmp sa
dst             src             state     conn-id    slot
172.16.172.53  172.16.172.69   QM_IDLE   1          0


7204VXR-2#show crypto ipsec sa
interface: FastEthernet0/1
Crypto map tag: vpn, local addr. 172.16.172.69

local ident (addr/mask/prot/port): (20.1.1.0/255.255.255.0/0/0)
remote ident (addr/mask/prot/port): (99.99.99.99/255.255.255.255/0/0)
current_peer: 172.16.172.53
PERMIT, flags={origin_is_acl,}
#pkts encaps: 10, #pkts encrypt: 10, #pkts digest 10
#pkts decaps: 10, #pkts decrypt: 10, #pkts verify 10
#pkts compressed: 0, #pkts decompressed: 0
#pkts not compressed: 0, #pkts compr. failed: 0, #pkts decompress failed: 0
#send errors 5, #recv errors 0

local crypto endpt.: 172.16.172.69, remote crypto endpt.: 172.16.172.53
path mtu 1500, ip mtu 1500
current outbound spi: 5B23F22E

inbound esp sas:
spi: 0x44E0B22B(1155576363)
transform: esp-des esp-md5-hmac ,
in use settings ={Tunnel, }
slot: 0, conn id: 2029, flow_id: 1, crypto map: vpn
sa timing: remaining key lifetime (k/sec): (4607997/2824)
IV size: 8 bytes
replay detection support: Y

inbound ah sas:

inbound pcp sas:

outbound esp sas:
spi: 0x5B23F22E(1529082414)
transform: esp-des esp-md5-hmac ,
in use settings ={Tunnel, }
slot: 0, conn id: 2030, flow_id: 2, crypto map: vpn
sa timing: remaining key lifetime (k/sec): (4607998/2824)
IV size: 8 bytes
replay detection support: Y

outbound ah sas:

outbound pcp sas:
```

## HSRP和IPSec故障轉移後

關閉Cisco 7204VXR-1上的Fa0/0觸發了故障轉移。如果另一個介面Fa0/1關閉，您將看到類似的情況，因為HSRP也會跟蹤該介面的狀態。

當Cisco VPN 7200未收到對傳送到主HSRP路由器的IKE keepalive資料包的響應時，路由器會斷開IPSec SA。

以下**debug crypto isakmp**命令輸出顯示IKE keepalive如何檢測主路由器的中斷：

```
ISAKMP (0:1): received packet from 172.16.172.53 (I) QM_IDLE
ISAKMP (0:1): processing HASH payload. message ID = 1585108592
ISAKMP (0:1): processing NOTIFY ITS_ALIVE protocol 1
spi 0, message ID = 1585108592, sa = 61C3E754
ISAKMP (0:1): sending packet to 172.16.172.53 (I) QM_IDLE
ISAKMP (0:1): purging node -1484552386
ISAKMP (0:1): deleting node 1585108592 error FALSE
   reason "informational (in) state 1"
ISAKMP (0:1): purging node 642343711
ISAKMP (0:1): sending packet to 172.16.172.53 (I) QM_IDLE
ISAKMP (0:1): purging node -523181212
ISAKMP (0:1): purging node -2089541867
ISAKMP (0:1): incrementing error counter on sa: PEERS_ALIVE_TIMER
ISAKMP (0:1): sending packet to 172.16.172.53 (I) QM_IDLE
ISAKMP (0:1): purging node 1671177686
ISAKMP (0:1): incrementing error counter on sa: PEERS_ALIVE_TIMER
ISAKMP (0:1): sending packet to 172.16.172.53 (I) QM_IDLE
ISAKMP (0:1): purging node 1706520344
ISAKMP (0:1): incrementing error counter on sa: PEERS_ALIVE_TIMER
ISAKMP (0:1): sending packet to 172.16.172.53 (I) QM_IDLE
ISAKMP (0:1): purging node 503375209
ISAKMP (0:1): incrementing error counter on sa: PEERS_ALIVE_TIMER
ISAKMP (0:1): sending packet to 172.16.172.53 (I) QM_IDLE
ISAKMP (0:1): purging node 1272270610
ISAKMP (0:1): incrementing error counter on sa: PEERS_ALIVE_TIMER
ISAKMP (0:1): peer not responding!
ISAKMP (0:1): peer does paranoid keepalives.

ISAKMP (0:1): phase 1 going away; let's be paranoid.
ISAKMP (0:1): Bring down phase 2's
ISAKMP (0:1): That phase 1 was the last one of its kind.
   Taking phase 2's with us.
ISAKMP (0:1): peer does paranoid keepalives.

ISAKMP (0:1): deleting SA reason "P1 errcounter exceeded
   (PEERS_ALIVE_TIMER)" state (I)
   QM_IDLE (peer 172.16.172.53) input queue 0
IPSEC(key_engine): got a queue event...
IPSEC(key_engine_delete_sas): rec'd delete notify from ISAKMP
IPSEC(key_engine_delete_sas): delete all SAs shared with 172.16.172.53
IPSEC(delete_sa): deleting SA,
(sa) sa_dest= 172.16.172.69, sa_prot= 50,
sa_spi= 0x44E0B22B(1155576363),
sa_trans= esp-des esp-md5-hmac , sa_conn_id= 2029
IPSEC(delete_sa): deleting SA,
(sa) sa_dest= 172.16.172.53, sa_prot= 50,
sa_spi= 0x5B23F22E(1529082414),
sa_trans= esp-des esp-md5-hmac , sa_conn_id= 2030
ISAKMP (0:1): sending packet to 172.16.172.53 (I) MM_NO_STATE
ISAKMP (0:1): purging node -248155233
ISAKMP (0:1): peer does paranoid keepalives.

IPSEC(key_engine): got a queue event...
IPSEC(key_engine_delete_sas): rec'd delete notify from ISAKMP
IPSEC(key_engine_delete_sas): delete all SAs shared with 172.16.172.53
ISAKMP (0:1): purging node 958118275
```

在Cisco 7204VXR-1主HSRP路由器上進行故障切換時，裝置會成為備用路由器。現有ISAKMP和IPSec SA將被拆除。Cisco 7204VXR-2輔助HSRP路由器變為活動狀態，並與Cisco VPN 7200建立新的IPSec SA。

**debug standby events**命令的輸出顯示與HSRP相關的事件。

```
HSRP: Fa0/0 API Software interface going down
HSRP: Fa0/0 API Software interface going down
HSRP: Fa0/0 Interface down
HSRP: Fa0/0 Grp 1 Active: b/HSRP disabled
HSRP: Fa0/0 Grp 1 Active router is unknown, was local
HSRP: Fa0/0 Grp 1 Standby router is unknown, was 172.16.172.54
HSRP: Fa0/0 Grp 1 Active -> Init
%HSRP-6-STATECHANGE: FastEthernet0/0 Grp 1 state Active -> Init
HSRP: Fa0/0 Grp 1 Redundancy "VPNHA" state Active -> Init
%CRYPTO-5-SESSION_STATUS: Crypto tunnel is DOWN.
   Peer 172.16.172.69:500 Id: 172.16.172.69
HSRP: Fa0/0 Grp 1 Redundancy enquiry for VPNHA succeeded
HSRP: Fa0/0 API Add active HSRP addresses to ARP table
%LINK-5-CHANGED: Interface FastEthernet0/0,
   changed state to administratively down
HSRP: API Hardware state change
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
   changed state to down
```

由於介面關閉，HSRP狀態更改為「Init」。

```
paal#show standby
FastEthernet0/0 - Group 1
State is Init (interface down)
3 state changes, last state change 00:07:29
Virtual IP address is 172.16.172.53
Active virtual MAC address is unknown
Local virtual MAC address is 0000.0c07.ac01 (v1 default)
Hello time 3 sec, hold time 10 sec
Preemption enabled
Active router is unknown
Standby router is unknown
Priority 200 (configured 200)
Track interface FastEthernet0/1 state Up decrement 150
IP redundancy name is "VPNHA" (cfgd)
```

Cisco 7204VXR-2成為活動HSRP路由器，並將其狀態更改為「活動」。

```
HSRP: Fa0/0 Grp 1 Standby: c/Active timer expired (172.16.172.52)
HSRP: Fa0/0 Grp 1 Active router is local, was 172.16.172.52
HSRP: Fa0/0 Grp 1 Standby router is unknown, was local
HSRP: Fa0/0 Grp 1 Standby -> Active (active 0->1, passive 2->1)
%HSRP-6-STATECHANGE: FastEthernet0/0 Grp 1 state Standby -> Active
HSRP: Fa0/0 Grp 1 Redundancy "VPNHA" state Standby -> Active
!--- VPN route 20.1.1.0/24 is added to the routing table. IPSEC(rte_mgr): VPN Route Added
20.1.1.0 255.255.255.0 via 172.16.172.69 in IP DEFAULT TABLE 7204VXR-2#show standby
FastEthernet0/0 - Group 1
State is Active
2 state changes, last state change 00:10:38
Virtual IP address is 172.16.172.53
Active virtual MAC address is 0000.0c07.ac01
Local virtual MAC address is 0000.0c07.ac01 (v1 default)
Hello time 3 sec, hold time 10 sec
Next hello sent in 0.116 secs
```

```
Preemption enabled
Active router is local
Standby router is unknown
Priority 100 (default 100)
Track interface FastEthernet1/0 state Up decrement 10
IP redundancy name is "VPNHA" (cfgd)
```

啟用RRI後，VPN路由將在故障切換期間動態更新。靜態路由20.1.1.0/24被刪除，Cisco 7204VXR-1路由器從Cisco 7204VXR-2路由器獲知該路由。

show ip route命令的輸出演示了此動態更新。

```
7204VXR-1#show ip route
Codes: 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, 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

Gateway of last resort is not set

99.0.0.0/32 is subnetted, 1 subnets
O  99.99.99.99 [110/2] via 10.1.1.3, 02:46:16, FastEthernet0/1
20.0.0.0/24 is subnetted, 1 subnets
O E2  20.1.1.0 [110/20] via 10.1.1.2, 00:08:35, FastEthernet0/1
172.16.0.0/28 is subnetted, 1 subnets
O E2  172.16.172.64 [110/20] via 10.1.1.2, 00:07:56, FastEthernet0/1
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C 10.1.1.0/24 is directly connected, FastEthernet0/1
S  10.48.66.0/23 [1/0] via 10.1.1.2
```

靜態VPN路由被注入到Cisco 7204VXR-2路由器的路由表中。

```
7204VXR-2#show ip route
Codes: 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, 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

Gateway of last resort is not set

99.0.0.0/32 is subnetted, 1 subnets
O  99.99.99.99 [110/2] via 10.1.1.3, 03:04:18, FastEthernet1/0
20.0.0.0/24 is subnetted, 1 subnets
S  20.1.1.0 [1/0] via 172.16.172.69
172.16.0.0/28 is subnetted, 2 subnets
C  172.16.172.48 is directly connected, FastEthernet0/0
S  172.16.172.64 [1/0] via 172.16.172.49
10.0.0.0/24 is subnetted, 1 subnets
C  10.1.1.0 is directly connected, FastEthernet1/0
```

內部路由器7206-1從其OSPF鄰居路由器7204VXR-2獲知到遠端VPN對等路由器的20.1.1/24路由。這些路由變化通過HSRP/RRI和OSPF的組合動態發生。

```
7206-1#show ip route
Codes: 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, 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

Gateway of last resort is not set

    99.0.0.0/32 is subnetted, 1 subnets
C     99.99.99.99 is directly connected, Loopback0
    20.0.0.0/24 is subnetted, 1 subnets
O E2     20.1.1.0 [110/20] via 10.1.1.2, 00:13:55, FastEthernet0/1
    172.16.0.0/28 is subnetted, 1 subnets
O E2     172.16.172.64 [110/20] via 10.1.1.2, 00:13:17, FastEthernet0/1
    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C     10.1.1.0/24 is directly connected, FastEthernet0/1
O E2     10.48.66.0/23 [110/20] via 10.1.1.2, 03:06:08, FastEthernet0/1
```

在HSRP故障切換期間，Cisco 7204VXR-2成為活動路由器後，Cisco 7204VXR-2和Cisco VPN 7200路由器之間的VPN流量會出現ISAKMP和IPSec SA。

VPN 7200路由器上的**show crypto isakmp sa**和**show crypto ipsec sa**命令的輸出如下所示：

```
7204VXR-2#show crypto isakmp sa detail
Codes: C - IKE configuration mode, D - Dead Peer Detection
K - Keepalives, N - NAT-traversal
X - IKE Extended Authentication
psk - Preshared key, rsig - RSA signature
renc - RSA encryption

C-id Local        Remote      I-VRF Encr Hash Auth DH Lifetime Cap.
1   172.16.172.53  172.16.172.69        des  md5   psk  1  23:53:47 K
Connection-id:Engine-id = 1:1(software)


7204VXR-2#show crypto ipsec sa

interface: FastEthernet0/0
Crypto map tag: vpn, local addr. 172.16.172.53


protected vrf:
local ident (addr/mask/prot/port): (99.99.99.99/255.255.255.255/0/0)
remote ident (addr/mask/prot/port): (20.1.1.0/255.255.255.0/0/0)
current_peer: 172.16.172.69:500
PERMIT, flags={origin_is_acl,}
#pkts encaps: 9, #pkts encrypt: 9, #pkts digest: 9
#pkts decaps: 9, #pkts decrypt: 9, #pkts verify: 9
#pkts compressed: 0, #pkts decompressed: 0
#pkts not compressed: 0, #pkts compr. failed: 0
#pkts not decompressed: 0, #pkts decompress failed: 0
#send errors 0, #recv errors 0

local crypto endpt.: 172.16.172.53, remote crypto endpt.: 172.16.172.69
path mtu 1500, media mtu 1500
current outbound spi: 83827275

inbound esp sas:
```

```
spi: 0x8D70E8A3(2372987043)
transform: esp-des esp-md5-hmac ,
in use settings ={Tunnel, }
slot: 0, conn id: 2000, flow_id: 1, crypto map: vpn
crypto engine type: Software, engine_id: 1
sa timing: remaining key lifetime (k/sec): (4453897/3162)
ike_cookies: 95074F89 3FF73F2B F70FEDF6 5998090C
IV size: 8 bytes
replay detection support: Y

inbound ah sas:

inbound pcp sas:

outbound esp sas:
spi: 0x83827275(2206364277)
transform: esp-des esp-md5-hmac ,
in use settings ={Tunnel, }
slot: 0, conn id: 2001, flow_id: 2, crypto map: vpn
crypto engine type: Software, engine_id: 1
sa timing: remaining key lifetime (k/sec): (4453898/3162)
ike_cookies: 95074F89 3FF73F2B F70FEDF6 5998090C
IV size: 8 bytes
replay detection support: Y

outbound ah sas:

outbound pcp sas: vpn7200#show crypto isa sa
dst src state conn-id slot
172.16.172.53   172.16.172.69   QM_IDLE 1       0

vpn7200#show crypto ipsec sa

interface: FastEthernet0/1
Crypto map tag: vpn, local addr. 172.16.172.69


local ident (addr/mask/prot/port): (20.1.1.0/255.255.255.0/0/0)
remote ident (addr/mask/prot/port): (99.99.99.99/255.255.255.255/0/0)
current_peer: 172.16.172.53
PERMIT, flags={origin_is_acl,}
#pkts encaps: 19, #pkts encrypt: 19, #pkts digest 19
#pkts decaps: 19, #pkts decrypt: 19, #pkts verify 19
#pkts compressed: 0, #pkts decompressed: 0
#pkts not compressed: 0, #pkts compr. failed: 0, #pkts decompress failed: 0
#send errors 6, #recv errors 0

local crypto endpt.: 172.16.172.69, remote crypto endpt.: 172.16.172.53
path mtu 1500, ip mtu 1500
current outbound spi: 8D70E8A3

inbound esp sas:
spi: 0x83827275(2206364277)
transform: esp-des esp-md5-hmac ,
in use settings ={Tunnel, }
slot: 0, conn id: 2029, flow_id: 1, crypto map: vpn
sa timing: remaining key lifetime (k/sec): (4607997/3070)
IV size: 8 bytes
replay detection support: Y

inbound ah sas:

inbound pcp sas:
```

```
outbound esp sas:
spi: 0x8D70E8A3(2372987043)
transform: esp-des esp-md5-hmac ,
in use settings ={Tunnel, }
slot: 0, conn id: 2030, flow_id: 2, crypto map: vpn
sa timing: remaining key lifetime (k/sec): (4607998/3070)
IV size: 8 bytes
replay detection support: Y

outbound ah sas:

outbound pcp sas:
```

## 原始HSRP主路由器從中斷中恢復後

在Cisco 7204VXR-1原始HSRP主路由器上恢復服務後，裝置將恢復為活動路由器，因為它具有更高的優先順序，並且已配置HSRP搶佔。

來自不同路由器的**show**和**debug**命令輸出顯示HSRP和IPSec的另一個轉換。自動重新建立ISAKMP和IPSec SA，並動態更新路由資訊更改。

此輸出示例顯示路由器7204VXR-1將其狀態更改為「Active」。

```
HSRP: Fa0/0 API 172.16.172.52 is not an HSRP address
HSRP: Fa0/0 API MAC address update
HSRP: Fa0/0 API Software interface coming up
%LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
HSRP: API Hardware state change
HSRP: Fa0/0 API Software interface coming up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
   changed state to up
HSRP: Fa0/0 Interface up
HSRP: Fa0/0 Starting minimum interface delay (1 secs)
HSRP: Fa0/0 Interface min delay expired
HSRP: Fa0/0 Grp 1 Init: a/HSRP enabled
HSRP: Fa0/0 Grp 1 Init -> Listen
HSRP: Fa0/0 Grp 1 Redundancy "VPNHA" state Init -> Backup
HSRP: Fa0/0 Grp 1 Listen: c/Active timer expired (unknown)
HSRP: Fa0/0 Grp 1 Listen -> Speak
HSRP: Fa0/0 Grp 1 Redundancy "VPNHA" state Backup -> Speak
HSRP: Fa0/0 Grp 1 Speak: d/Standby timer expired (unknown)
HSRP: Fa0/0 Grp 1 Standby router is local
HSRP: Fa0/0 Grp 1 Speak -> Standby
HSRP: Fa0/0 Grp 1 Redundancy "VPNHA" state Speak -> Standby
HSRP: Fa0/0 Grp 1 Redundancy enquiry for VPNHA succeeded
HSRP: Fa0/0 Grp 1 Standby: c/Active timer expired (unknown)
HSRP: Fa0/0 Grp 1 Active router is local
HSRP: Fa0/0 Grp 1 Standby router is unknown, was local
HSRP: Fa0/0 Grp 1 Standby -> Active
%HSRP-6-STATECHANGE: FastEthernet0/0 Grp 1 state Standby -> Active
HSRP: Fa0/0 Grp 1 Redundancy "VPNHA" state Standby -> Active
HSRP: Fa0/0 Grp 1 Active: i/Resign rcvd (100/172.16.172.54)
HSRP: Fa0/0 Grp 1 Redundancy group VPNHA state Active -> Active
HSRP: Fa0/0 Grp 1 Redundancy group VPNHA state Active -> Active
HSRP: Fa0/0 Grp 1 Standby router is 172.16.172.54
```

路由器7204VXR-2將其狀態更改為「備用」。 VPN路由將從路由表中刪除。

```
HSRP: Fa0/0 Grp 1 Standby router is 172.16.172.52
HSRP: Fa0/0 Grp 1 Hello in 172.16.172.52 Active pri 200 vIP 172.16.172.53
```

```
hel 3000 hol 10000 id 0000.0c07.ac01
HSRP: Fa0/0 Grp 1 Active router is 172.16.172.52, was local
HSRP: Fa0/0 Grp 1 Standby router is unknown, was 172.16.172.52
HSRP: Fa0/0 Grp 1 Active: g/Hello rcvd from
   higher pri Active router (200/172.16.172.52)
HSRP: Fa0/0 Grp 1 Active -> Speak (active 1->0, passive 0->1)
%HSRP-6-STATECHANGE: FastEthernet0/0 Grp 1 state Active -> Speak
HSRP: Fa0/0 Grp 1 Redundancy "VPNHA" state Active -> Speak
HSRP: Fa0/0 Grp 1 Speak: d/Standby timer expired (unknown)
HSRP: Fa0/0 Grp 1 Standby router is local
HSRP: Fa0/0 Grp 1 Speak -> Standby (active 0, passive 1)
HSRP: Fa0/0 Grp 1 Redundancy "VPNHA" state Speak -> Standby
HSRP: Fa0/0 Grp 1 Redundancy enquiry for VPNHA succeeded
addr 172.16.172.53 name VPNHA state Speak
active 172.16.172.52 standby 172.16.172.54
 !--- The VPN route is removed. IPSEC(rte_mgr): VPN Route Removed 20.1.1.0 255.255.255.0 via
172.16.172.69 in IP DEFAULT TABLE
```

# 相關資訊

- IPSec協商/IKE通訊協定支援頁面
- 技術支援與文件 - Cisco Systems