스포크 간 통신을 사용하여 IPSec 라우터 간 허브 및 스포크 구성

목차

소개

이 샘플 컨피그레이션에서는 세 라우터 간의 허브 및 스포크 IPsec 설계를 보여줍니다. 이 예에서는 허브를 통해 스포크 사이트 간에 통신이 활성화되므로 이 컨피그레이션은 다른 허브 및 스포크 컨피그레이션과 다릅니다. 즉, 두 스포크 라우터 사이에 직접 IPsec 터널이 없습니다. 모든 패킷은 터널을 통해 허브 라우터로 전송됩니다. 이 라우터는 다른 스포크 라우터와 공유된 IPsec 터널을 재배포합니다. 이 컨피그레이션은 Cisco 버그 ID CSCdp09904를 확인한 결과 가능합니다(등록된 고객만 해당). 이 수정은 Cisco IOS® Software Release 12.2(5)에 통합되었으며 이 릴리스는 이 컨피그레이션의 최소 요구 사항입니다.

OSPF를 사용하여 IPSec을 통한 GRE(Generic Routing Encapsulation) 터널을 구성하려면 OSPF를 사용하여 IPSec을 통한 GRE 터널 구성을 참조하십시오.

NAT(Network Address Translation)를 사용하여 GRE 터널에서 기본 Cisco IOS® 방화벽 컨피그레이션을 구성하려면 IOS 방화벽 및 NAT를 사용하여 GRE 터널에서 라우터 간 IPSec(사전 공유 키) 구성을 참조하십시오.

사전 요구 사항

요구 사항

이 문서에서는 IPsec 프로토콜에 대한 기본적인 이해가 필요합니다. IPsec에 대한 자세한 내용은 IPSec(IP Security) 암호화 소개를 참조하십시오.

이 문서의 목적은 다음 라우터 간에 암호화를 수행하는 것입니다.

- 172.16.1.0/24(스포크 1)에서 10.1.1.0/24(허브)
- 192.168.1.0/24(스포크 2)에서 10.1.1.0/24(허브)
- 172.16.1.0/24(스포크 1)에서 192.168.1.0/24(스포크 2)

사용되는 구성 요소

이 문서의 정보는 이러한 소프트웨어 및 하드웨어 버전을 기반으로 합니다.

- Cisco IOS 소프트웨어 릴리스 12.2(24a) (c2500-ik8s-l.122-24a.bin)
- Cisco 2500 라우터

이 문서의 정보는 특정 랩 환경의 디바이스를 토대로 작성되었습니다. 이 문서에 사용된 모든 디바이스는 초기화된(기본) 컨피그레이션으로 시작되었습니다. 현재 네트워크가 작동 중인 경우, 모든 명령어의 잠재적인 영향을 미리 숙지하시기 바랍니다.

표기 규칙

문서 규칙에 대한 자세한 내용은 Cisco 기술 팁 표기 규칙을 참고하십시오.

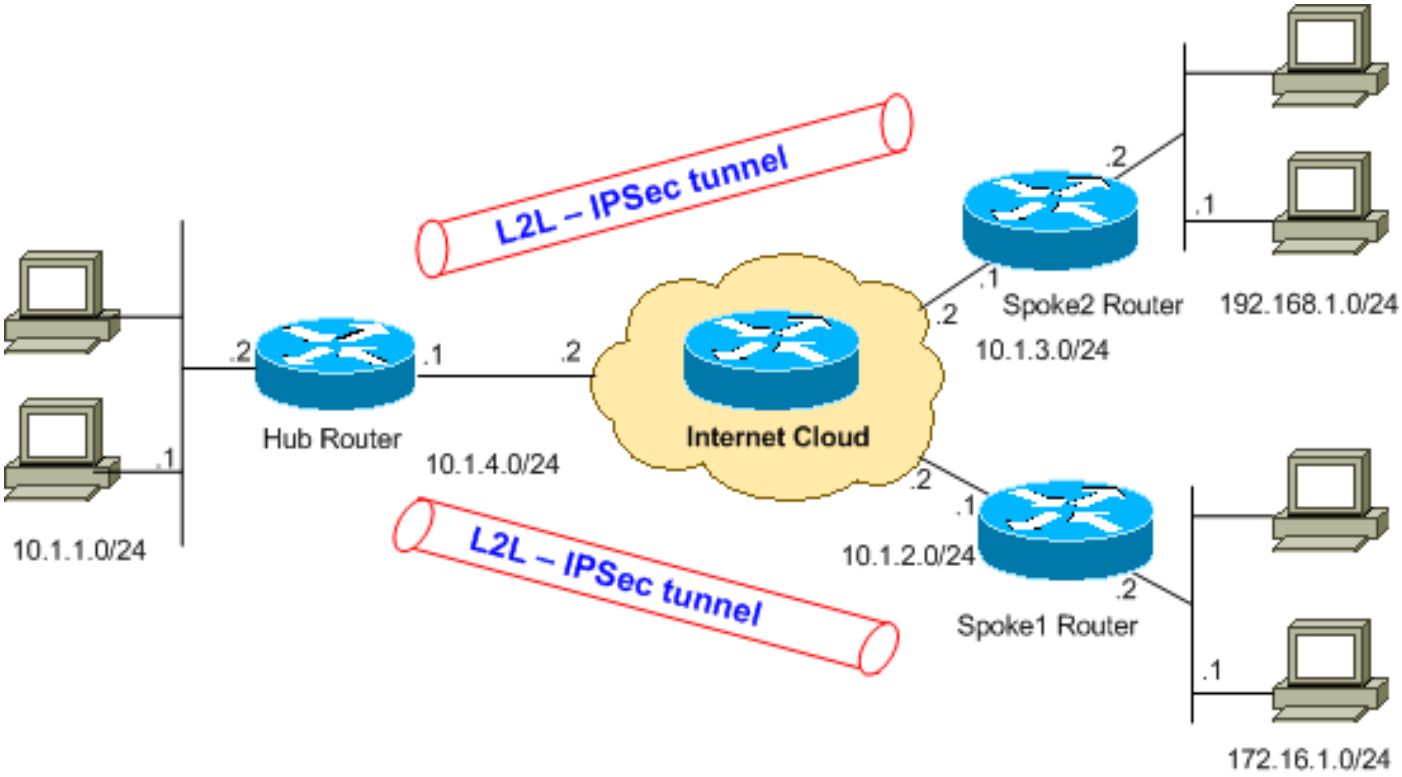
구성

이 섹션에는 이 문서에서 설명하는 기능을 구성하기 위한 정보가 표시됩니다.

참고: 명령 조회 도구(등록된 고객만 해당)를 사용하여 이 문서에 사용된 명령에 대한 자세한 내용을 확인하십시오.

네트워크 다이어그램

이 문서에서는 이 다이어그램에 표시된 네트워크 설정을 사용합니다.



참고: 이 구성에 사용된 IP 주소 지정 체계는 인터넷에서 합법적으로 라우팅할 수 없습니다. 이는 실습 환경에서 사용된 RFC 1918 주소입니다.

구성

이 문서에서는 이러한 구성을 사용합니다.

show running-config 명령은 라우터에서 실행 중인 컨피그레이션을 표시합니다.

- 허브 라우터
- 스포크 1 라우터
- 스포크 2 라우터

허브 라우터

```
Hub#show running-config
Building configuration...
Current configuration : 1466 bytes
!
version 12.2

service timestamps debug datetime msec
service timestamps log uptime
no service password-encryption
!
hostname Hub
!


!
ip subnet-zero
!

!
```

```
!--- Configuration for IKE policies. crypto isakmp
policy 10
!--- Enables the IKE policy configuration (config-
isakmp) !--- command mode, where you can specify the
parameters that !--- are used during an IKE negotiation.
hash md5
authentication pre-share
crypto isakmp key cisco123 address 10.1.2.1
crypto isakmp key cisco123 address 10.1.3.1
!--- Specifies the preshared key "cisco123" which should
!--- be identical at both peers. This is a global !---
configuration mode command. ! !--- Configuration for
IPsec policies. crypto ipsec transform-set myset esp-des
esp-md5-hmac
!--- Enables the crypto transform configuration mode, !-
-- where you can specify the transform sets that are
used !--- during an IPsec negotiation. ! crypto map
mymap 10 ipsec-isakmp
!--- Indicates that IKE is used to establish !--- the
IPsec security association for protecting the !---
traffic specified by this crypto map entry. set peer
10.1.2.1
!--- Sets the IP address of the remote end. set
transform-set myset
!--- Configures IPsec to use the transform-set !---
"myset" defined earlier in this configuration. match
address 110
!--- Specifies the traffic to be encrypted. crypto map
mymap 20 ipsec-isakmp
set peer 10.1.3.1
set transform-set myset
match address 120
!
!
!
!
interface Ethernet0
ip address 10.1.1.1 255.255.255.0
!
interface Ethernet1
ip address 10.1.4.1 255.255.255.0
no ip route-cache
!--- You must enable process switching for IPsec !--- to
encrypt outgoing packets. This command disables fast
switching. no ip mroute-cache crypto map mymap
!--- Configures the interface to use the !--- crypto map
"mymap" for IPsec. ! !--- Output suppressed. ip
classless ip route 172.16.1.0 255.255.255.0 Ethernet1
ip route 192.168.1.0 255.255.255.0 Ethernet1
ip route 10.1.0.0 255.255.0.0 Ethernet1
ip http server

!
access-list 110 permit ip 10.1.1.0 0.0.0.255 172.16.1.0
0.0.0.255
access-list 110 permit ip 192.168.1.0 0.0.0.255
172.16.1.0 0.0.0.255
access-list 120 permit ip 10.1.1.0 0.0.0.255 192.168.1.0
0.0.0.255
access-list 120 permit ip 172.16.1.0 0.0.0.255
192.168.1.0 0.0.0.255
!--- This crypto ACL-permit identifies the !--- matching
traffic flows to be protected via encryption.
```

스포크 1 라우터

```
Spoke1#show running-config
Building configuration...
Current configuration : 1203 bytes
!
version 12.2

service timestamps debug datetime msec
service timestamps log uptime
no service password-encryption
!
hostname Spoke1
!
enable secret 5 $1$DOX3$rIrxEnTVTw/7LNbxi.akz0

!
ip subnet-zero
no ip domain-lookup
!

!
crypto isakmp policy 10
hash md5
authentication pre-share
crypto isakmp key cisco123 address 10.1.4.1
!
!
crypto ipsec transform-set myset esp-des esp-md5-hmac
!
crypto map mymap 10 ipsec-isakmp
set peer 10.1.4.1
set transform-set myset
match address 110
!
!
!
!
interface Ethernet0
ip address 172.16.1.1 255.255.255.0
!
interface Ethernet1
ip address 10.1.2.1 255.255.255.0
no ip route-cache
no ip mroute-cache
crypto map mymap
!

.
.
!--- Output suppressed. . . ip classless
ip route 192.168.1.0 255.255.255.0 Ethernet1
ip route 10.1.0.0 255.255.0.0 Ethernet1
no ip http server

!
access-list 110 permit ip 172.16.1.0 0.0.0.255 10.1.1.0
0.0.0.255
access-list 110 permit ip 172.16.1.0 0.0.0.255
192.168.1.0 0.0.0.255
!

end
```

```
2509a#
```

스포크 2 라우터

```
Spoke2#show running-config
Building configuration...
Current configuration : 1117 bytes
!
version 12.2

service timestamps debug datetime msec
service timestamps log uptime
service password-encryption
!
hostname Spoke2
!

!
ip subnet-zero
no ip domain-lookup
!

!
crypto isakmp policy 10
hash md5
authentication pre-share
crypto isakmp key cisco123 address 10.1.4.1
!
!
crypto ipsec transform-set myset esp-des esp-md5-hmac
!
crypto map mymap 10 ipsec-isakmp
set peer 10.1.4.1
set transform-set myset
match address 120
!
!
!
!
interface Ethernet0
ip address 192.168.1.1 255.255.255.0
!
interface Ethernet1
ip address 10.1.3.1 255.255.255.0
!--- No ip route-cache. no ip mroute-cache crypto map
mymap
!


.
.
!--- Output suppressed. . . ip classless
ip route 172.16.0.0 255.255.0.0 Ethernet1
ip route 10.1.0.0 255.255.0.0 Ethernet1
no ip http server

!
access-list 120 permit ip 192.168.1.0 0.0.0.255
172.16.1.0 0.0.0.255
access-list 120 permit ip 192.168.1.0 0.0.0.255 10.1.1.0
0.0.0.255
!

end
```

```
VPN2509#
```

다른 스포크 추가

spoke1 및 spoke2 외에 다른 스포크 라우터(spoke3)를 기존 허브 라우터에 추가해야 하는 경우, 필요한 것은 허브에서 spoke3로 새로운 LAN-to-LAN(L2L) 터널을 생성하는 것입니다. 그러나 물리적 인터페이스당 하나의 암호화 맵만 구성할 수 있으므로 이 터널을 추가할 때 동일한 암호화 맵 이름을 사용해야 합니다. 이는 각 원격 사이트에 대해 서로 다른 회선 번호를 사용하는 경우에 가능합니다.

참고: 새 터널 엔트리를 추가할 때 암호화 맵을 제거하고 인터페이스에 다시 적용해야 할 수 있습니다. 암호화 맵을 제거하면 모든 활성 터널이 지워집니다.

허브 라우터

```
Hub#show running-config
Building configuration...
Current configuration : 1466 bytes
!
version 12.2

service timestamps debug datetime msec
service timestamps log uptime
no service password-encryption
!
hostname Hub
!



!
ip subnet-zero
!

!
crypto isakmp policy 10

hash md5
authentication pre-share
crypto isakmp key cisco123 address 10.1.2.1
crypto isakmp key cisco123 address 10.1.3.1
crypto isakmp key cisco123 address 10.1.5.1
!

crypto ipsec transform-set myset esp-des esp-md5-hmac
!
crypto map mymap 10 ipsec-isakmp
set peer 10.1.2.1
set transform-set myset
match address 110

crypto map mymap 20 ipsec-isakmp
set peer 10.1.3.1
set transform-set myset
match address 120

!--- It is important to specify crypto map line number
30 for !--- the Spoke 3 router with the same crypto map
name "mymap" crypto map mymap 30 ipsec-isakmp
set peer 10.1.5.1
set transform-set myset
```

```
match address 130
!
!
!
!
interface Ethernet0
ip address 10.1.1.1 255.255.255.0
!
interface Ethernet1
ip address 10.1.4.1 255.255.255.0
no ip route-cache
no ip mroute-cache

!--- It is important to remove and re-apply the crypto
!--- map to this interface if it is used for the
termination of other !--- spoke VPN tunnels. crypto map
mymap
!

!--- Output suppressed. ip classless ip route 172.16.1.0
255.255.255.0 Ethernet1 ip route 192.168.1.0
255.255.255.0 Ethernet1 ip route 10.1.0.0 255.255.0.0
Ethernet1 ip route 172.16.2.0 255.255.255.0 Ethernet1 ip
http server ! access-list 110 permit ip 10.1.1.0
0.0.0.255 172.16.1.0 0.0.0.255 access-list 110 permit ip
192.168.1.0 0.0.0.255 172.16.1.0 0.0.0.255 access-list
110 permit ip 172.16.2.0 0.0.0.255 172.16.1.0 0.0.0.255
access-list 120 permit ip 10.1.1.0 0.0.0.255 192.168.1.0
0.0.0.255 access-list 120 permit ip 172.16.2.0 0.0.0.255
192.168.1.0 0.0.0.255 access-list 120 permit ip
172.16.1.0 0.0.0.255 192.168.1.0 0.0.0.255 access-list
130 permit ip 10.1.1.0 0.0.0.255 172.16.2.0 0.0.0.255
access-list 130 permit ip 192.168.1.0 0.0.0.255
172.16.2.0 0.0.0.255
access-list 130 permit ip 172.16.1.0 0.0.0.255
172.16.2.0 0.0.0.255
```

스포크 3 라우터

```
Spoke3#show running-config
Building configuration...
Current configuration : 1117 bytes
!
version 12.2

service timestamps debug datetime msec
service timestamps log uptime
service password-encryption
!
hostname Spoke3
!

!
ip subnet-zero
no ip domain-lookup
!

!
crypto isakmp policy 10
hash md5
authentication pre-share
crypto isakmp key cisco123 address 10.1.4.1
!
```

```
!
crypto ipsec transform-set myset esp-des esp-md5-hmac
!
crypto map mymap 10 ipsec-isakmp
set peer 10.1.4.1
set transform-set myset
match address 130
!
!
!
!
interface Ethernet0
ip address 172.16.2.1 255.255.255.0
!
interface Ethernet1
ip address 10.1.5.1 255.255.255.0
no ip mroute-cache
crypto map mymap
!


.
.
!--- Output suppressed. . . ip classless
ip route 172.16.0.0 255.255.0.0 Ethernet1
ip route 10.1.0.0 255.255.0.0 Ethernet1
no ip http server

!
access-list 130 permit ip 172.168.2.0 0.0.0.255
172.16.1.0 0.0.0.255
access-list 130 permit ip 172.168.2.0 0.0.0.255 10.1.1.0
0.0.0.255
access-list 130 permit ip 172.168.2.0 0.0.0.255
192.168.1.0 0.0.0.255
!

end
VPN2509#
```

다음을 확인합니다.

이 섹션을 사용하여 컨피그레이션이 제대로 작동하는지 확인합니다.

Output Interpreter 도구(등록된 고객만 해당)(OIT)는 특정 **show** 명령을 지원합니다. OIT를 사용하여 **show** 명령 출력의 분석을 봅니다.

이 컨피그레이션을 확인하려면 Spoke 2의 ethernet1 인터페이스 주소로 향하는 Spoke 1의 ethernet1 인터페이스 주소에서 제공된 확장 ping **명령**을 시도합니다.

- **ping** - 기본 네트워크 연결을 진단하는 데 사용됩니다.

```
Spoke1#ping
Protocol [ip]:
Target IP address: 192.168.1.1
Repeat count [5]:
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Source address or interface: 172.16.1.1
Type of service [0]:
Set DF bit in IP header? [no]:
```

```
Validate reply data? [no]:
Data pattern [0xABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]:
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 64/64/68 ms
```

- show crypto ipsec sa - 현재(IPSec) SA에서 사용하는 설정을 표시합니다.
- show crypto isakmp sa - 피어의 현재 모든 IKE SA를 표시합니다.
- show crypto engine **connections active** - 각 IPSec SA에서 전송된 패킷 수를 표시합니다.

샘플 show 출력

이 출력은 허브 라우터에서 실행된 **show crypto engine connections active** 명령의 출력입니다.

```
Hub#show crypto engine connections active

ID Interface IP-Address State Algorithm Encrypt Decrypt
5 Ethernet0 10.1.4.1 set HMAC_MD5+DES_56_CB 0 0
6 <none> <none>  set HMAC_MD5+DES_56_CB 0 0
2000 Ethernet0 10.1.4.1 set HMAC_MD5+DES_56_CB 0 10
2001 Ethernet0 10.1.4.1 set HMAC_MD5+DES_56_CB 10 0
2002 Ethernet0 10.1.4.1 set HMAC_MD5+DES_56_CB 0 10
2003 Ethernet0 10.1.4.1 set HMAC_MD5+DES_56_CB 10 0
```

이 예에서는 각 터널이 10개의 패킷을 암호화하고 해독했음을 확인할 수 있습니다. 이는 트래픽이 Hub 라우터를 통과했음을 나타냅니다.

참고: 각 피어에 대해 두 개의 IPsec SA가 생성됩니다(각 방향마다 하나씩). 예를 들어 허브 라우터에는 두 개의 피어에 대해 생성된 IPsec SA가 4개 있습니다.

문제 해결

이 섹션에서는 컨피그레이션 문제를 해결하는 데 사용할 수 있는 정보를 제공합니다.

문제 해결 명령

참고: debug **명령**을 사용하기 전에 디버그 명령에 대한 중요 정보를 참조하십시오.

- debug crypto ipsec - 2단계의 IPsec 협상을 표시합니다.
- debug crypto isakmp - 1단계의 ISAKMP 협상을 표시합니다.
- debug crypto engine - 암호화된 트래픽을 표시합니다.
- clear crypto isakmp - 1단계와 관련된 SA를 지웁니다.
- clear crypto sa - 2단계와 관련된 SA를 지웁니다.

디버그 출력 샘플

debug crypto ipsec 및 **debug crypto isakmp** 명령의 허브 라우터 출력입니다.

```
*Mar  1 00:03:46.887: ISAKMP (0:0): received packet
  from 10.1.2.1 (N) NEW SA
```

*Mar 1 00:03:46.887: ISAKMP: local port 500, remote port 500
*Mar 1 00:03:46.899: ISAKMP (0:1): processing SA payload. message ID = 0
*Mar 1 00:03:46.899: ISAKMP (0:1): found peer pre-shared key matching 10.1.2.1
*Mar 1 00:03:46.903: ISAKMP (0:1): Checking ISAKMP transform 1 against priority
 10 policy
*Mar 1 00:03:46.903: ISAKMP: encryption DES-CBC
*Mar 1 00:03:46.907: ISAKMP: hash MD5
*Mar 1 00:03:46.907: ISAKMP: default group 1
*Mar 1 00:03:46.911: ISAKMP: auth pre-share
*Mar 1 00:03:46.911: ISAKMP: life type in seconds
*Mar 1 00:03:46.911: ISAKMP: life duration (VPI) of 0x0 0x1 0x51 0x80
*Mar 1 00:03:46.915: ISAKMP (0:1): **atts are acceptable**. Next payload is 0
!--- The initial IKE parameters have been !--- successfully exchanged between Spoke 1 and Hub.
*Mar 1 00:03:48.367: ISAKMP (0:1): SA is doing pre-shared key authentication using id type
ID_IPV4_ADDR *Mar 1 00:03:48.371: ISAKMP (0:1): sending packet to 10.1.2.1 (R) MM_SA_SETUP *Mar
1 00:03:56.895: ISAKMP (0:1): received packet from 10.1.2.1 (R) MM_SA_SETUP *Mar 1 00:03:56.899:
ISAKMP (0:1): phase 1 packet is a duplicate of a previous packet. *Mar 1 00:03:56.899: ISAKMP
(0:1): retransmitting due to retransmit phase 1 *Mar 1 00:03:56.903: ISAKMP (0:1):
retransmitting phase 1 MM_SA_SETUP... *Mar 1 00:03:57.403: ISAKMP (0:1): retransmitting phase 1
MM_SA_SETUP... *Mar 1 00:03:57.403: ISAKMP (0:1): incrementing error counter on sa: retransmit
phase 1 *Mar 1 00:03:57.407: ISAKMP (0:1): retransmitting phase 1 MM_SA_SETUP *Mar 1
00:03:57.407: ISAKMP (0:1): sending packet to 10.1.2.1 (R) MM_SA_SETUP *Mar 1 00:03:58.923:
ISAKMP (0:1): received packet from 10.1.2.1 (R) MM_SA_SET UP *Mar 1 00:03:58.931: ISAKMP (0:1):
processing KE payload. message ID = 0 *Mar 1 00:04:00.775: ISAKMP (0:1): processing NONCE
payload. message ID = 0 *Mar 1 00:04:00.783: ISAKMP (0:1): found peer pre-shared key matching
10.1.2.1 *Mar 1 00:04:00.795: ISAKMP (0:1): SKEYID state generated *Mar 1 00:04:00.799: ISAKMP
(0:1): processing vendor id payload *Mar 1 00:04:00.803: ISAKMP (0:1): speaking to another IOS
box! *Mar 1 00:04:00.811: ISAKMP (0:1): sending packet to 10.1.2.1 (R) MM_KEY_EXCH *Mar 1
00:04:02.751: ISAKMP (0:1): received packet from 10.1.2.1 (R) MM_KEY_EXCH *Mar 1 00:04:02.759:
ISAKMP (0:1): processing ID payload. message ID = 0 *Mar 1 00:04:02.759: ISAKMP (0:1):
processing HASH payload. message ID = 0 *Mar 1 00:04:02.767: ISAKMP (0:1): SA has been
authenticated with 10.1.2.1 *Mar 1 00:04:02.771: ISAKMP (1): ID payload next-payload : 8 type :
1 protocol : 17 port : 500 length : 8 *Mar 1 00:04:02.775: ISAKMP (1): Total payload length: 12
*Mar 1 00:04:02.783: ISAKMP (0:1): sending packet to 10.1.2.1 (R) QM_IDLE *Mar 1 00:04:02.871:
ISAKMP (0:1): received packet from 10.1.2.1 (R) **QM_IDLE**
!--- IKE phase 1 SA has been sucessfully negotiated !--- between Spoke 1 and Hub. *Mar 1
00:04:02.891: ISAKMP (0:1): processing HASH payload. message ID = 581713929 *Mar 1 00:04:02.891:
ISAKMP (0:1): processing SA payload. message ID = 581713929 *Mar 1 00:04:02.895: ISAKMP (0:1):
Checking IPSec proposal 1
!--- IKE exchanges IPsec phase 2 parameters !--- between Spoke 1 and Hub. *Mar 1 00:04:02.895:
ISAKMP: transform 1, ESP_DES *Mar 1 00:04:02.899: ISAKMP: attributes in transform: *Mar 1
00:04:02.899: ISAKMP: encaps is 1 *Mar 1 00:04:02.899: ISAKMP: SA life type in seconds *Mar 1
00:04:02.903: ISAKMP: SA life duration (basic) of 3600 *Mar 1 00:04:02.903: ISAKMP: SA life type
in kilobytes *Mar 1 00:04:02.907: ISAKMP: SA life duration (VPI) of 0x0 0x46 0x50 0x0 *Mar 1
00:04:02.911: ISAKMP: authenticator is HMAC-MD5 *Mar 1 00:04:02.915: ISAKMP (0:1): **atts are
acceptable.**
!--- IPsec phase 2 parameters have been !--- successfully exchanged between Spoke 1 and Hub.
*Mar 1 00:04:02.915: IPSEC(validate_proposal_request): proposal part #1, (key eng. msg.) INBOUND
local= 10.1.4.1, remote= 10.1.2.1, local_proxy= 192.168.1.0/255.255.255.0/0/0 (type=4),
remote_proxy= 172.16.1.0/255.255.255.0/0/0 (type=4), protocol= ESP, transform= esp-des esp-md5-
hmac , lifedur= 0s and 0kb, spi= 0x0(0), conn_id= 0, keysize= 0, flags= 0x4 *Mar 1 00:04:02.931:
ISAKMP (0:1): processing NONCE payload. message ID = 581713929 *Mar 1 00:04:02.935: ISAKMP
(0:1): processing ID payload. message ID = 581713929 *Mar 1 00:04:02.935: ISAKMP (0:1):
processing ID payload. message ID = 581713929 *Mar 1 00:04:02.939: ISAKMP (0:1): asking for 1
spis from ipsec *Mar 1 00:04:02.943: IPSEC(key_engine): got a queue event... *Mar 1
00:04:02.951: IPSEC(spi_response): getting spi 4208568169 for SA from 10.1.4.1 to 10.1.2.1 for
prot 3 *Mar 1 00:04:02.955: ISAKMP: received ke message (2/1) *Mar 1 00:04:03.207: ISAKMP (0:1):
sending packet to 10.1.2.1 (R) QM_IDLE *Mar 1 00:04:03.351: ISAKMP (0:1): received packet from
10.1.2.1 (R) QM_IDLE *Mar 1 00:04:03.387: ISAKMP (0:1): Creating IPSec SAs *Mar 1 00:04:03.387:
inbound SA from 10.1.2.1 to 10.1.4.1 (proxy 172.16.1.0 to 192.168.1.0) *Mar 1 00:04:03.391: has
spi 0xFAD9A769 and conn_id 2000 and flags 4 *Mar 1 00:04:03.395: lifetime of 3600 seconds *Mar 1
00:04:03.395: lifetime of 4608000 kilobytes *Mar 1 00:04:03.399: outbound SA from 10.1.4.1 to
10.1.2.1 (proxy 192.168.1.0 to 172.16.1.0) *Mar 1 00:04:03.403: has spi -732960388 and conn_id
2001 and flags C *Mar 1 00:04:03.407: lifetime of 3600 seconds *Mar 1 00:04:03.407: lifetime of

4608000 kilobytes *Mar 1 00:04:03.411: ISAKMP (0:1): deleting node 581713929 error FALSE reason " quick mode done (await()" *Mar 1 00:04:03.415: IPSEC(key_engine): got a queue event... *Mar 1 00:04:03.415: IPSEC(initialize_sas): , (key eng. msg.) INBOUND local= 10.1.4.1, remote= 10.1.2.1, local_proxy= 192.168.1.0/255.255.255.0/0/0 (type=4), remote_proxy= 172.16.1.0/255.255.255.0/0/0 (type=4), protocol= ESP, transform= esp-des esp-md5-hmac , lifedur= 3600s and 4608000kb, spi= 0xFAD9A769(4208568169), conn_id= 2000, keysize= 0, flags= 0x4 *Mar 1 00:04:03.427: IPSEC(initialize_sas): , (key eng. msg.) OUTBOUND local= 10.1.4.1, remote= 10.1.2.1, local_proxy= 192.168.1.0/255.255.255.0/0/0 (type=4), remote_proxy= 172.16.1.0/255.255.255.0/0/0 (type=4), protocol= ESP, transform= esp-des esp-md5-hmac , lifedur= 3600s and 4608000kb, spi= 0xD44FE97C(3562006908), conn_id= 2001, keysize= 0, flags= 0xC *Mar 1 00:04:03.443: **IPSEC(create_sa): sa created,**
  (sa) **sa_dest= 10.1.4.1**, sa_prot= 50,
    sa_spi= 0xFAD9A769(4208568169),
    sa_trans= esp-des esp-md5-hmac , sa_conn_id= 2000
*Mar 1 00:04:03.447: **IPSEC(create_sa): sa created,**
  (sa) **sa_dest= 10.1.2.1**, sa_prot= 50,
    sa_spi= 0xD44FE97C(3562006908),
    sa_trans= esp-des esp-md5-hmac , sa_conn_id= 2001
!--- IPsec tunnel has been created between !--- routers Spoke 1 and Hub. *Mar 1 00:05:02.387: IPSEC(sa_request): , *!--- Since an IPsec tunnel is created between Spoke 1 !--- and Spoke 2 through the Hub, the Hub router !--- initializes a new IPsec tunnel between itself and Spoke 2.* (key eng. msg.) OUTBOUND local= 10.1.4.1, remote= 10.1.3.1, local_proxy= 172.16.1.0/255.255.255.0/0/0 (type=4), remote_proxy= 192.168.1.0/255.255.255.0/0/0 (type=4), protocol= ESP, transform= esp-des esp-md5-hmac , lifedur= 3600s and 4608000kb, spi= 0x1B7A414E(460996942), conn_id= 0, keysize= 0, flags= 0x400C *Mar 1 00:05:02.399: ISAKMP: received ke message (1/1) *Mar 1 00:05:02.403: ISAKMP: local port 500, remote port 500 *Mar 1 00:05:02.411: ISAKMP (0:2): beginning Main Mode exchange *Mar 1 00:05:02.415: ISAKMP (0:2): sending packet to 10.1.3.1 (I) MM_NO_STATE *Mar 1 00:05:12.419: ISAKMP (0:2): retransmitting phase 1 MM_NO_STATE... *Mar 1 00:05:12.419: ISAKMP (0:2): incrementing error counter on sa: retransmit phase 1 *Mar 1 00:05:12.423: ISAKMP (0:2): retransmitting phase 1 MM_NO_STATE *Mar 1 00:05:12.423: ISAKMP (0:2): sending packet to 10.1.3.1 (I) MM_NO_STATE *Mar 1 00:05:22.427: ISAKMP (0:2): retransmitting phase 1 MM_NO_STATE... *Mar 1 00:05:22.427: ISAKMP (0:2): incrementing error counter on sa: retransmit phase 1 *Mar 1 00:05:22.431: ISAKMP (0:2): retransmitting phase 1 MM_NO_STATE *Mar 1 00:05:22.431: ISAKMP (0:2): sending packet to 10.1.3.1 (I) MM_NO_STATE *Mar 1 00:05:22.967: ISAKMP (0:2): received packet from 10.1.3.1 (I) MM_NO_STATE *Mar 1 00:05:22.975: ISAKMP (0:2): processing SA payload. message ID = 0 *Mar 1 00:05:22.975: ISAKMP (0:2): found peer pre-shared key matching 10.1.3.1 *Mar 1 00:05:22.979: ISAKMP (0:2): Checking ISAKMP transform 1 against priority 10 policy *Mar 1 00:05:22.979: ISAKMP: encryption DES-CBC *Mar 1 00:05:22.983: ISAKMP: hash MD5 *Mar 1 00:05:22.983: ISAKMP: default group 1 *Mar 1 00:05:22.987: ISAKMP: auth pre-share *Mar 1 00:05:22.987: ISAKMP: life type in seconds *Mar 1 00:05:22.987: ISAKMP: life duration (VPI) of 0x0 0x1 0x51 0x80 *Mar 1 00:05:22.991: ISAKMP (0:2): **atts are acceptable.**
 Next payload is 0
!--- IKE phase 1 parameters have been successfully !--- exchanged between Hub and Spoke 2. *Mar 1 00:05:24.447: ISAKMP (0:2): SA is doing pre-shared key authentication using id type ID_IPV4_ADDR *Mar 1 00:05:24.455: ISAKMP (0:2): sending packet to 10.1.3.1 (I) MM_SA_SETUP *Mar 1 00:05:26.463: ISAKMP (0:2): received packet from 10.1.3.1 (I) MM_SA_SETUP *Mar 1 00:05:26.471: ISAKMP (0:2): processing KE payload. message ID = 0 *Mar 1 00:05:28.303: ISAKMP (0:2): processing NONCE payload. message ID = 0 *Mar 1 00:05:28.307: ISAKMP (0:2): found peer pre-shared key matching 10.1.3.1 *Mar 1 00:05:28.319: ISAKMP (0:2): SKEYID state generated *Mar 1 00:05:28.323: ISAKMP (0:2): processing vendor id payload *Mar 1 00:05:28.327: ISAKMP (0:2): speaking to another IOS box! *Mar 1 00:05:28.331: ISAKMP (2): ID payload next-payload : 8 type : 1 protocol : 17 port : 500 length : 8 *Mar 1 00:05:28.335: ISAKMP (2): Total payload length: 12 *Mar 1 00:05:28.343: ISAKMP (0:2): sending packet to 10.1.3.1 (I) MM_KEY_EXCH *Mar 1 00:05:28.399: ISAKMP (0:2): received packet from 10.1.3.1 (I) MM_KEY_EXCH *Mar 1 00:05:28.407: ISAKMP (0:2): processing ID payload. message ID = 0 *Mar 1 00:05:28.411: ISAKMP (0:2): processing HASH payload. message ID = 0 *Mar 1 00:05:28.419: ISAKMP (0:2): SA has been authenticated with 10.1.3.1 *Mar 1 00:05:28.419: ISAKMP (0:2): beginning Quick Mode exchange, M-ID of -1872859789 *Mar 1 00:05:28.439: ISAKMP (0:2): sending packet to 10.1.3.1 (I) QM_IDLE *Mar 1 00:05:28.799: ISAKMP (0:2): received packet from 10.1.3.1 (I) **QM_IDLE**
!--- The IKE phase 1 SA has been successfully !--- negotiated between Hub and Spoke 2. *Mar 1 00:05:28.815: ISAKMP (0:2): processing HASH payload. message ID = -1872859789 *Mar 1 00:05:28.815: ISAKMP (0:2): processing SA payload. message ID = -1872859789 *Mar 1 00:05:28.819: ISAKMP (0:2): **Checking IPSec proposal 1**

!--- IKE exchanges IPsec phase 2 parameters !--- between Hub and Spoke 2. *Mar 1 00:05:28.819: ISAKMP: transform 1, ESP_DES *Mar 1 00:05:28.823: ISAKMP: attributes in transform: *Mar 1 00:05:28.823: ISAKMP: encaps is 1 *Mar 1 00:05:28.827: ISAKMP: SA life type in seconds *Mar 1 00:05:28.827: ISAKMP: SA life duration (basic) of 3600 *Mar 1 00:05:28.827: ISAKMP: SA life type in kilobytes *Mar 1 00:05:28.831: ISAKMP: SA life duration (VPI) of 0x0 0x46 0x50 0x0 *Mar 1 00:05:28.835: ISAKMP: authenticator is HMAC-MD5 *Mar 1 00:05:28.839: ISAKMP (0:2): **atts are acceptable.**
!--- IPsec phase 2 parameters have been successfully !--- exchanged between Hub and Spoke 2.
*Mar 1 00:05:28.843: IPSEC(validate_proposal_request): proposal part #1, (key eng. msg.) INBOUND local= 10.1.4.1, remote= 10.1.3.1, local_proxy= 172.16.1.0/255.255.255.0/0/0 (type=4), remote_proxy= 192.168.1.0/255.255.255.0/0/0 (type=4), protocol= ESP, transform= esp-des esp-md5-hmac , lifedur= 0s and 0kb, spi= 0x0(0), conn_id= 0, keysize= 0, flags= 0x4 *Mar 1 00:05:28.855: ISAKMP (0:2): processing NONCE payload. message ID = -1872859789 *Mar 1 00:05:28.859: ISAKMP (0:2): processing ID payload. message ID = -1872859789 *Mar 1 00:05:28.863: ISAKMP (0:2): processing ID payload. message ID = -1872859789 *Mar 1 00:05:28.891: ISAKMP (0:2): Creating IPSec SAs *Mar 1 00:05:28.891: inbound SA from 10.1.3.1 to 10.1.4.1 (proxy 192.168.1.0 to 172.16.1.0) *Mar 1 00:05:28.895: has spi 0x1B7A414E and conn_id 2002 and flags 4 *Mar 1 00:05:28.899: lifetime of 3600 seconds *Mar 1 00:05:28.899: lifetime of 4608000 kilobytes *Mar 1 00:05:28.903: outbound SA from 10.1.4.1 to 10.1.3.1 (proxy 172.16.1.0 to 192.168.1.0) *Mar 1 00:05:28.907: has spi -385025107 and conn_id 2003 and flags C *Mar 1 00:05:28.911: lifetime of 3600 seconds *Mar 1 00:05:28.911: lifetime of 4608000 kilobytes *Mar 1 00:05:28.915: ISAKMP (0:2): sending packet to 10.1.3.1 (I) QM_IDLE *Mar 1 00:05:28.919: ISAKMP (0:2): deleting node -1872859789 error FALSE reason "" *Mar 1 00:05:28.923: IPSEC(key_engine): got a queue event... *Mar 1 00:05:28.927: IPSEC(initialize_sas): , (key eng. msg.) INBOUND local= 10.1.4.1, remote= 10.1.3.1, local_proxy= 172.16.1.0/255.255.255.0/0/0 (type=4), remote_proxy= 192.168.1.0/255.255.255.0/0/0 (type=4), protocol= ESP, transform= esp-des esp-md5-hmac , lifedur= 3600s and 4608000kb, spi= 0x1B7A414E(460996942), conn_id= 2002, keysize= 0, flags= 0x4
*Mar 1 00:05:28.939: IPSEC(initialize_sas): , (key eng. msg.) OUTBOUND local= 10.1.4.1, remote= 10.1.3.1, local_proxy= 172.16.1.0/255.255.255.0/0/0 (type=4), remote_proxy= 192.168.1.0/255.255.255.0/0/0 (type=4), protocol= ESP, transform= esp-des esp-md5-hmac , lifedur= 3600s and 4608000kb, spi= 0xE90CFBAD(3909942189), conn_id= 2003, keysize= 0, flags= 0xC
*Mar 1 00:05:28.951: **IPSEC(create_sa): sa created,**
  (sa) **sa_dest= 10.1.4.1**, sa_prot= 50,
    sa_spi= 0x1B7A414E(460996942),
    sa_trans= esp-des esp-md5-hmac , sa_conn_id= 2002
*Mar 1 00:05:28.959: **IPSEC(create_sa): sa created,**
  (sa) **sa_dest= 10.1.3.1**, sa_prot= 50,
    sa_spi= 0xE90CFBAD(3909942189),
    sa_trans= esp-des esp-md5-hmac , sa_conn_id= 2003
!--- IPsec tunnel has been created between routers !--- Hub and Spoke 2. This establishes a tunnel between Spoke 1 !--- and Spoke 2 through Hub.

debug crypto isakmp 및 **debug crypto ipsec** 명령의 Spoke 1 라우터 출력입니다.

*Mar 1 00:03:28.771: **IPSEC(sa_request)**: ,
  (key eng. msg.) OUTBOUND local= 10.1.2.1, remote= 10.1.4.1,
    local_proxy= 172.16.1.0/255.255.255.0/0/0 (type=4),
    remote_proxy= 192.168.1.0/255.255.255.0/0/0 (type=4),
    protocol= ESP, transform= esp-des esp-md5-hmac ,
    lifedur= 3600s and 4608000kb,
    spi= 0xD44FE97C(3562006908), conn_id= 0, keysize= 0, flags= 0x400C
!--- Request sent after the ping. *Mar 1 00:03:28.787: ISAKMP: received ke message (1/1) *Mar 1 00:03:28.791: ISAKMP: local port 500, remote port 500 *Mar 1 00:03:28.799: ISAKMP (0:1): **beginning Main Mode exchange**
!--- Initial IKE phase 1 parameters are exchanged !--- between Spoke 1 and Hub. *Mar 1 00:03:28.803: ISAKMP (0:1): sending packet to 10.1.4.1 (I) MM_NO_STATE. *Mar 1 00:03:38.807: ISAKMP (0:1): retransmitting phase 1 MM_NO_STATE... *Mar 1 00:03:38.807: ISAKMP (0:1): incrementing error counter on sa: retransmit phase 1 *Mar 1 00:03:38.811: ISAKMP (0:1): retransmitting phase 1 MM_NO_STATE *Mar 1 00:03:38.811: ISAKMP (0:1): sending packet to 10.1.4.1 (I) MM_NO_STATE *Mar 1 00:03:48.815: ISAKMP (0:1): retransmitting phase 1 MM_NO_STATE... *Mar 1 00:03:48.815: ISAKMP (0:1): incrementing error counter on sa: retransmit phase 1 *Mar 1 00:03:48.819: ISAKMP (0:1): retransmitting phase 1 MM_NO_STATE *Mar 1 00:03:48.819: ISAKMP (0:1): sending packet to 10.1.4.1 (I) MM_NO_STATE *Mar 1 00:03:49.355: ISAKMP (0:1): received

packet from 10.1.4.1 (I) MM_NO_STATE *Mar 1 00:03:49.363: ISAKMP (0:1): processing SA payload. message ID = 0 *Mar 1 00:03:49.363: ISAKMP (0:1): found peer pre-shared key matching 10.1.4.1 *Mar 1 00:03:49.367: ISAKMP (0:1): Checking ISAKMP transform 1 against priority 10 policy *Mar 1 00:03:49.367: ISAKMP: encryption DES-CBC *Mar 1 00:03:49.371: ISAKMP: hash MD5 *Mar 1 00:03:49.371: ISAKMP: default group 1 *Mar 1 00:03:49.375: ISAKMP: auth pre-share *Mar 1 00:03:49.375: ISAKMP: life type in seconds *Mar 1 00:03:49.375: ISAKMP: life duration (VPI) of 0x0 0x1 0x51 0x80 *Mar 1 00:03:49.379: ISAKMP (0:1): **atts are acceptable.**
Next payload is 0
!--- IKE phase 1 parameters have been sucessfully !--- negotiated between Spoke 1 and Hub. *Mar 1 00:03:50.835: ISAKMP (0:1): SA is doing pre-shared key authentication using id type ID_IPV4_ADDR *Mar 1 00:03:50.851: ISAKMP (0:1): sending packet to 10.1.4.1 (I) MM_SA_SETUP *Mar 1 00:03:52.759: ISAKMP (0:1): received packet from 10.1.4.1 (I) MM_SA_SETUP *Mar 1 00:03:52.763: ISAKMP (0:1): processing KE payload. message ID = 0 *Mar 1 00:03:54.635: ISAKMP (0:1): processing NONCE payload. message ID = 0 *Mar 1 00:03:54.639: ISAKMP (0:1): found peer pre-shared key matching 10.1.4.1 *Mar 1 00:03:54.651: ISAKMP (0:1): SKEYID state generated *Mar 1 00:03:54.655: ISAKMP (0:1): processing vendor id payload *Mar 1 00:03:54.663: ISAKMP (0:1): speaking to another IOS box! *Mar 1 00:03:54.663: ISAKMP (1): ID payload next-payload : 8 type : 1 protocol : 17 port : 500 length : 8 *Mar 1 00:03:54.667: ISAKMP (1): Total payload length: 12 *Mar 1 00:03:54.675: ISAKMP (0:1): sending packet to 10.1.4.1 (I) MM_KEY_EXCH *Mar 1 00:03:54.759: ISAKMP (0:1): received packet from 10.1.4.1 (I) MM_KEY_EXCH *Mar 1 00:03:54.767: ISAKMP (0:1): processing ID payload. message ID = 0 *Mar 1 00:03:54.767: ISAKMP (0:1): processing HASH payload. message ID = 0 *Mar 1 00:03:54.775: ISAKMP (0:1): SA has been authenticated with 10.1.4.1 *Mar 1 00:03:54.779: ISAKMP (0:1): beginning Quick Mode exchange, M-ID of 581713929 *Mar 1 00:03:54.799: ISAKMP (0:1): sending packet to 10.1.4.1 (I) QM_IDLE *Mar 1 00:03:55.155: ISAKMP (0:1): received packet from 10.1.4.1 (I) QM_IDLE *Mar 1 00:03:55.171: ISAKMP (0:1): processing HASH payload. message ID = 581713929 *Mar 1 00:03:55.175: ISAKMP (0:1): processing SA payload. message ID = 581713929 *Mar 1 00:03:55.179: ISAKMP (0:1): **Checking IPSec proposal 1**
!--- IKE exchanges the IPsec phase 2 parameters between !--- Spoke 1 and Hub. *Mar 1 00:03:55.179: ISAKMP: transform 1, ESP_DES *Mar 1 00:03:55.183: ISAKMP: attributes in transform: *Mar 1 00:03:55.183: ISAKMP: encaps is 1 *Mar 1 00:03:55.183: ISAKMP: SA life type in seconds *Mar 1 00:03:55.187: ISAKMP: SA life duration (basic) of 3600 *Mar 1 00:03:55.187: ISAKMP: SA life type in kilobytes *Mar 1 00:03:55.191: ISAKMP: SA life duration (VPI) of 0x0 0x46 0x50 0x0 *Mar 1 00:03:55.195: ISAKMP: authenticator is HMAC-MD5 *Mar 1 00:03:55.199: ISAKMP (0:1): **atts are acceptable.**
!--- IKE has successfully negotiated phase 2 IPsec !--- SA between Hub and Spoke 2. *Mar 1 00:03:55.203: IPSEC(validate_proposal_request): proposal part #1, (key eng. msg.) INBOUND local= 10.1.2.1, remote= 10.1.4.1, local_proxy= 172.16.1.0/255.255.255.0/0/0 (type=4), remote_proxy= 192.168.1.0/255.255.255.0/0/0 (type=4), protocol= ESP, transform= esp-des esp-md5-hmac , lifedur= 0s and 0kb, spi= 0x0(0), conn_id= 0, keysize= 0, flags= 0x4 *Mar 1 00:03:55.219: ISAKMP (0:1): processing NONCE payload. message ID = 581713929 *Mar 1 00:03:55.219: ISAKMP (0:1): processing ID payload. message ID = 581713929 *Mar 1 00:03:55.223: ISAKMP (0:1): processing ID payload. message ID = 581713929 *Mar 1 00:03:55.251: ISAKMP (0:1): Creating IPSec SAs *Mar 1 00:03:55.255: inbound SA from 10.1.4.1 to 10.1.2.1 (proxy 192.168.1.0 to 172.16.1.0) *Mar 1 00:03:55.259: has spi 0xD44FE97C and conn_id 2000 and flags 4 *Mar 1 00:03:55.263: lifetime of 3600 seconds *Mar 1 00:03:55.263: lifetime of 4608000 kilobytes *Mar 1 00:03:55.267: outbound SA from 10.1.2.1 to 10.1.4.1 (proxy 172.16.1.0 to 192.168.1.0) *Mar 1 00:03:55.271: has spi -86399127 and conn_id 2001 and flags C *Mar 1 00:03:55.271: lifetime of 3600 seconds *Mar 1 00:03:55.275: lifetime of 4608000 kilobytes *Mar 1 00:03:55.279: ISAKMP (0:1): sending packet to 10.1.4.1 (I) QM_IDLE *Mar 1 00:03:55.283: ISAKMP (0:1): deleting node 581713929 error FALSE reason " " *Mar 1 00:03:55.287: IPSEC(key_engine): got a queue event... *Mar 1 00:03:55.291: IPSEC(initialize_sas): , (key eng. msg.) INBOUND local= 10.1.2.1, remote= 10.1.4.1, local_proxy= 172.16.1.0/255.255.255.0/0/0 (type=4), remote_proxy= 192.168.1.0/255.255.255.0/0/0 (type=4), protocol= ESP, transform= esp-des esp-md5-hmac , lifedur= 3600s and 4608000kb, spi= 0xD44FE97C(3562006908), conn_id= 2000, keysize= 0, flags= 0x4 *Mar 1 00:03:55.303: IPSEC(initialize_sas): , (key eng. msg.) OUTBOUND local= 10.1.2.1, remote= 10.1.4.1, local_proxy= 172.16.1.0/255.255.255.0/0/0 (type=4), remote_proxy= 192.168.1.0/255.255.255.0/0/0 (type=4), protocol= ESP, transform= esp-des esp-md5-hmac , lifedur= 3600s and 4608000kb, spi= 0xFAD9A769(4208568169), conn_id= 2001, keysize= 0, flags= 0xC *Mar 1 00:03:55.319:
IPSEC(create_sa): sa created,
(sa) **sa_dest= 10.1.2.1,** sa_prot= 50,
sa_spi= 0xD44FE97C(3562006908),
sa_trans= esp-des esp-md5-hmac , sa_conn_id= 2000
*Mar 1 00:03:55.323: **IPSEC(create_sa): sa created,**

```
  (sa) sa_dest= 10.1.4.1, sa_prot= 50,
    sa_spi= 0xFAD9A769(4208568169),
    sa_trans= esp-des esp-md5-hmac , sa_conn_id= 2001
!--- The IPsec tunnel between Spoke 1 and Hub is set up.
```

관련 정보

- IP 보안 문제 해결 - 디버그 명령 이해 및 사용
- IPsec 컨피그레이션 예
- IPsec 협상/IKE 프로토콜
- 기술 지원 및 문서 – Cisco Systems