

Configuring IPsec Router-to-Router Hub and Spoke with Communication Between the Spokes

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Related Information

Introduction

This sample configuration shows a hub and spoke IPsec design between three routers. This configuration differs from other hub and spoke configurations because in this example, communication is enabled between the spoke sites by going through the hub. In other words, there is not a direct IPsec tunnel between the two spoke routers. All packets are sent across the tunnel to the hub router where it redistributes them out the IPsec tunnel shared with the other spoke router. This configuration is possible as a result of the resolution to Cisco bug ID CSCdp09904 (registered customers only) . This fix was integrated into Cisco IOS® Software Release 12.2(5) and this release is the minimum requirement for this configuration.

In order to configure the generic routing encapsulation (GRE) tunnel over IPsec with OSPF, refer to [Configuring a GRE Tunnel over IPsec with OSPF](#).

In order to configure the basic Cisco IOS® Firewall configuration on a GRE tunnel with Network Address Translation (NAT), refer to [Configuring Router-to-Router IPsec \(Pre-shared Keys\) on GRE Tunnel with IOS Firewall and NAT](#).

Prerequisites

Requirements

This document requires a basic understanding of IPsec protocol. Refer to [An Introduction to IP Security \(IPsec\) Encryption](#) to learn more about IPsec.

The objective of this document is to ensure Encryption is done between these routers:

- 172.16.1.0/24 (Spoke 1) to 10.1.1.0/24 (Hub)
- 192.168.1.0/24 (Spoke 2) to 10.1.1.0/24 (Hub)

- 172.16.1.0/24 (Spoke 1) to 192.168.1.0/24 (Spoke 2)

Components Used

The information in this document is based on these software and hardware versions.

- Cisco IOS Software Release 12.2(24a) (c2500-ik8s-1.122-24a.bin)
- Cisco 2500 routers

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, make sure that you understand the potential impact of any command.

Conventions

Refer to Cisco Technical Tips Conventions for more information on document conventions.

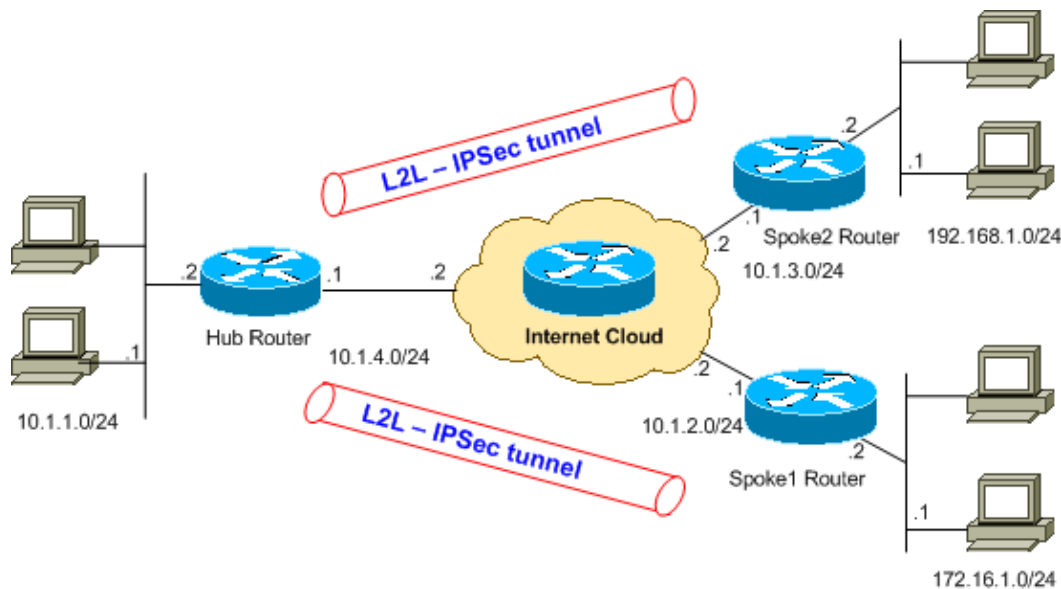
Configure

In this section, you are presented with the information to configure the features described in this document.

Note: Use the Command Lookup Tool (registered customers only) to find more information on the commands used in this document.

Network Diagram

This document uses the network setup shown in this diagram.



Note: The IP addressing schemes used in this configuration are not legally routable on the Internet. They are RFC 1918 addresses which have been used in a lab environment.

Configurations

This document uses these configurations.

The **show running-config** command displays the running configuration on the router.

- Hub Router
- Spoke 1 Router
- Spoke 2 Router

Hub Router
<pre>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</pre>

```

!--- 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.

```

Spoke 1 Router

```

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#

```

Spoke 2 Router

```

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#
```

Add Another Spoke

If you need to add another spoke router (spoke3) to the existing hub router in addition to spoke1 and spoke2, all that is required is the creation of a new LAN-to-LAN (L2L) tunnel from the hub to spoke3. However, since only one crypto map can be configured per physical interface, you must use the same crypto map name when adding this tunnel. This is possible when you use different line numbers for each remote site.

Note: The crypto map might need to be removed and re-applied to the interface when the new tunnel entry is added. When the crypto map is removed all active tunnels are cleared.

```
Hub Router
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

```

Spoke 3 Router

```

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#

```

Verify

Use this section to confirm that your configuration works properly.

The Output Interpreter Tool (registered customers only) (OIT) supports certain **show** commands. Use the OIT to view an analysis of **show** command output.

In order to verify this configuration, try an extended **ping** command sourced from the ethernet1 interface address on Spoke 1, destined for the ethernet1 interface address in Spoke 2.

- **ping** Used to diagnose basic network connectivity.

```

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** Shows the settings used by current (IPSec) security associations (SAs).
- **show crypto isakmp sa** Shows all current IKE SAs at a peer.
- **show crypto engine connections active** Shows the number of packets transmitted across each IPSec SA.

Sample show Output

This output is from the **show crypto engine connections active** command issued on the Hub router.

```

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

```

From this example, you can see that each tunnel has encrypted and decrypted 10 packets, which proves that the traffic came through the Hub router.

Note: Two IPsec SAs are created for each peer (one in each direction). For example, in the hub router there are four IPsec SAs created for two peers.

Troubleshoot

This section provides information you can use to troubleshoot your configuration.

Troubleshooting Commands

Note: Refer to Important Information on Debug Commands before you use **debug** commands.

- **debug crypto ipsec** Shows the IPsec negotiations of phase 2.
- **debug crypto isakmp** Shows the ISAKMP negotiations of phase 1.
- **debug crypto engine** Shows the traffic that is encrypted.
- **clear crypto isakmp** Clears the SAs related to phase 1.
- **clear crypto sa** Clears the SAs related to phase 2.

Sample debug Output

This is the hub router output from the **debug crypto ipsec** and **debug crypto isakmp** commands.

```

*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_SETUP
*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 successfully 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.

```

This is Spoke 1 router output from the **debug crypto isakmp** and **debug crypto ipsec** commands.

```

*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.

```

Related Information

- **IP Security Troubleshooting – Understanding and Using debug Commands**
 - **IPsec Configuration Examples**
 - **IPsec Negotiation/IKE Protocol**
 - **Technical Support & Documentation – Cisco Systems**
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