IOS IPSec 및 IKE 디버깅 - IKEv1 기본 모드 문제 해결

목차

소개

이 문서에서는 주 모드 및 PSK(pre-shared key)가 사용될 때 Cisco IOS® 소프트웨어의 디버깅을 이해하는 정보를 제공합니다.

이 문서에서는 구성의 특정 디버그 행을 변환하는 방법에 대한 정보도 제공합니다.

다음 항목은 논의되지 않습니다.

- 터널이 설정된 후 트래픽 전달
- IPSec 또는 IKE(Internet Key Exchange)의 기본 개념

핵심 문제

IKE 및 IPSec 디버그는 암호화 경향이 있습니다.Cisco TAC(Technical Assistance Center)에서는 이러한 버그를 사용하여 IPSec VPN 터널 **설정**에 문제가 있는 위치를 파악하는 경우가 많습니다.

시나리오

주 모드는 일반적으로 LAN-to-LAN 터널 간에 또는 인증서를 인증에 사용할 때 ezvpn(원격 액세스)에서 사용됩니다.

이러한 디버그는 15.2(1)T 소프트웨어 릴리스를 실행하는 Cisco IOS 디바이스에서 가져온 것입니다.

이 문서에서는 두 가지 주요 시나리오에 대해 설명합니다.

- IOS 개시자 측
- IOS responder 측

이 문서에서는 IPv6를 기반으로 두 사이트 간의 VTI 기반 터널이 설정됩니다.

> **참고:**
>
> 이 문서에 사용된 명령에 대한 자세한 내용을 보려면 명령 조회 도구(등록된 고객만 해당)를 사용합니다.
>
> **debug** 명령을 사용하기 전에 디버그 명령에 대한 중요 정보를 참조하십시오.

사용된 디버그

- **디버그 암호화 isakmp**
- **디버그 암호화 ipsec**
- **디버그 암호화 kmi**

IOS 라우터 컨피그레이션

암호화 구성

```
crypto isakmp policy 10
```

```
authentication pre-share

crypto isakmp key cisco address ipv6 ::/0

crypto ipsec transform-set TRA esp-aes esp-sha-hmac
mode transport

crypto ipsec profile PRO
set transform-set TRA

interface Tunnel23
ip address 192.168.23.2 255.255.255.0
ipv6 address FE80::23:2 link-local
tunnel source Ethernet0/0
tunnel mode ipsec ipv6
tunnel destination 2001: DB8::3
tunnel protection ipsec profile PRO
```

기타

```
crypto isakmp policy 10
authentication pre-share

crypto isakmp key cisco address ipv6 ::/0

crypto ipsec transform-set TRA esp-aes esp-sha-hmac
mode transport

crypto ipsec profile PRO
set transform-set TRA

interface Tunnel23
ip address 192.168.23.3 255.255.255.0
ipv6 address FE80::23:3 link-local
tunnel source Ethernet0/0
tunnel mode ipsec ipv6
tunnel destination 2001: DB8::2
tunnel protection ipsec profile PRO
```

디버깅

IOS Responder Side

주 모드 메시지 1(MM1)

IKE에 대한 초기 제안에는 다음이 포함됩니다.

- 암호화
- 해싱
- DH(Diffie-Hellman) 그룹
- 수명

```
*Sep 21 08:33:43.377: ISAKMP (0) : received packet from 2001: DB8::2 dport 500
```

```
sport 500 Global (N) NEW SA
*Sep 21 08:33:43.377: ISAKMP: Created a peer struct for 2001: DB8::2, peer port
500
*Sep 21 08:33:43.377: ISAKMP: New peer created peer = 0x8E45588
peer_handle = 0x8000000A
*Sep 21 08:33:43.377: ISAKMP: Locking peer struct 0x8E45588, refcount 1 for
crypto_isakmp_process_block
*Sep 21 08:33:43.377: ISAKMP: local port 500, remote port 500
*Sep 21 08:33:43.377: ISAKMP: (0):insert sa successfully sa = 6D12A00
*Sep 21 08:33:43.377: ISAKMP: (0):Input = IKE_MESG_FROM_PEER, IKE_MM_EXCH
*Sep 21 08:33:43.377: ISAKMP: (0): Old State = IKE_READY  New State = IKE_R_MM1
*Sep 21 08:33:43.377: ISAKMP: (0): processing SA payload. message ID = 0
*Sep 21 08:33:43.377: ISAKMP: (0):found peer pre-shared key matching 2001:
DB8::2
*Sep 21 08:33:43.377: ISAKMP: (0): local preshared key found
*Sep 21 08:33:43.377: ISAKMP: Scanning profiles for xauth ...
*Sep 21 08:33:43.377: ISAKMP: (0):Checking ISAKMP transform 1 against priority
10 policy
*Sep 21 08:33:43.377: ISAKMP:      encryption DES-CBC
*Sep 21 08:33:43.377: ISAKMP:      hash SHA
*Sep 21 08:33:43.377: ISAKMP:      default group 1
*Sep 21 08:33:43.377: ISAKMP:      auth pre-share
*Sep 21 08:33:43.377: ISAKMP:      life type in seconds
*Sep 21 08:33:43.377: ISAKMP:      life duration (VPI) of  0x0 0x1 0x51 0x80
*Sep 21 08:33:43.377: ISAKMP: (0):atts are acceptable. Next payload is 0
*Sep 21 08:33:43.377: ISAKMP: (0):Acceptable atts:actual life: 0
*Sep 21 08:33:43.377: ISAKMP: (0):Acceptable atts:life: 0
*Sep 21 08:33:43.377: ISAKMP: (0):Fill atts in sa vpi_length:4
*Sep 21 08:33:43.377: ISAKMP: (0):Fill atts in sa life_in_seconds:86400
*Sep 21 08:33:43.377: ISAKMP: (0):Returning Actual lifetime: 86400
*Sep 21 08:33:43.377: ISAKMP: (0):: Started lifetime timer: 86400.

*Sep 21 08:33:43.377: ISAKMP: (0):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_MAIN_MODE
*Sep 21 08:33:43.377: ISAKMP: (0): Old State = IKE_R_MM1  New State = IKE_R_MM1
```

관련 구성:

```
crypto isakmp policy 10
authentication pre-share
```

주 모드 메시지 2(MM2) - 회신 보내기

```
*Sep 21 08:33:43.377: ISAKMP: (0): sending packet to 2001: DB8::2 my_port 500
peer_port 500 (R) MM_SA_SETUP
*Sep 21 08:33:43.377: ISAKMP: (0): Sending an IKE IPv6 Packet.
*Sep 21 08:33:43.377: ISAKMP: (0):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_COMPLETE
*Sep 21 08:33:43.377: ISAKMP: (0): Old State = IKE_R_MM1  New State = IKE_R_MM2
```

주 모드 메시지 3(MM3)

포함 내용:

- NAT(Network Address Translation) 검색
- DH 교환 파트 1

```
*Sep 21 08:33:43.381: ISAKMP (0): received packet from 2001:DB8::2 dport 500
sport 500 Global (R) MM_SA_SETUP
*Sep 21 08:33:43.381: ISAKMP: (0):Input = IKE_MESG_FROM_PEER, IKE_MM_EXCH
*Sep 21 08:33:43.381: ISAKMP: (0): Old State = IKE_R_MM2  New State = IKE_R_MM3
*Sep 21 08:33:43.381: ISAKMP: (0): processing KE payload. message ID = 0
*Sep 21 08:33:43.393: ISAKMP: (0): processing NONCE payload. message ID = 0
*Sep 21 08:33:43.393: ISAKMP: (0):found peer pre-shared key matching 2001:
DB8::2
*Sep 21 08:33:43.393: ISAKMP: (1011): processing vendor id payload
*Sep 21 08:33:43.393: ISAKMP: (1011): vendor ID is DPD
*Sep 21 08:33:43.393: ISAKMP: (1011): processing vendor id payload
*Sep 21 08:33:43.393: ISAKMP: (1011): speaking to another IOS box!
*Sep 21 08:33:43.393: ISAKMP: (1011): processing vendor id payload
*Sep 21 08:33:43.393: ISAKMP: (1011): vendor ID seems Unity/DPD but major 0
mismatch
*Sep 21 08:33:43.393: ISAKMP: (1011): vendor ID is XAUTH
*Sep 21 08:33:43.393: ISAKMP: (1011):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_MAIN_MODE
*Sep 21 08:33:43.393: ISAKMP: (1011): Old State = IKE_R_MM3  New State =
IKE_R_MM3
```

주 모드 메시지 4(MM4)

포함 내용:

- NAT 탐지 페이로드
- DH 교환 계속

```
*Sep 21 08:33:43.405: ISAKMP: (1011): sending packet to 2001: DB8::2 my_port
500 peer_port 500 (R) MM_KEY_EXCH
*Sep 21 08:33:43.405: ISAKMP: (1011): Sending an IKE IPv6 Packet.
*Sep 21 08:33:43.405: ISAKMP: (1011):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_COMPLETE
*Sep 21 08:33:43.405: ISAKMP: (1011): Old State = IKE_R_MM3  New State =
IKE_R_MM4
```

MM5(Main Mode Message 5) - 개시자가 ID를 보냅니다.

포함 내용:

- 로컬 ID 정보
- 키

```
*Sep 21 08:33:43.425: ISAKMP (1011): received packet from 2001: DB8::2 dport
500 sport 500 Global (R) MM_KEY_EXCH
*Sep 21 08:33:43.425: ISAKMP: (1011):Input = IKE_MESG_FROM_PEER, IKE_MM_EXCH
*Sep 21 08:33:43.425: ISAKMP: (1011): Old State = IKE_R_MM4  New State =
IKE_R_MM5

*Sep 21 08:33:43.425: ISAKMP: (1011): processing ID payload. message ID = 0
*Sep 21 08:33:43.425: ISAKMP (1011): ID payload
       next-payload : 8
       type         : 5
       address      : 2001: DB8::2
       protocol     : 17
       port         : 500
       length       : 24
```

```
*Sep 21 08:33:43.425: ISAKMP: (0):: peer matches *none* of the profiles
*Sep 21 08:33:43.425: ISAKMP: (1011): processing HASH payload. message ID = 0
*Sep 21 08:33:43.425: ISAKMP: (1011): processing NOTIFY INITIAL_CONTACT
protocol 1 spi 0, message ID = 0, sa = 0x6D12A00
*Sep 21 08:33:43.425: ISAKMP: (1011): SA authentication status: authenticated
*Sep 21 08:33:43.425: ISAKMP: (1011): SA has been authenticated with 2001:
DB8::2
*Sep 21 08:33:43.425: ISAKMP: (1011): SA authentication status: authenticated
*Sep 21 08:33:43.425: ISAKMP: (1011): Process initial contact, bring down
existing phase 1 and 2 SA's with local 2001: DB8::3 remote 2001: DB8::2
remote port 500
*Sep 21 08:33:43.425: ISAKMP: Trying to insert a peer 2001: DB8::3/2001:
DB8::2/500/,  and inserted successfully 8E45588.
*Sep 21 08:33:43.425: ISAKMP: (1011):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_MAIN_MODE
*Sep 21 08:33:43.425: ISAKMP: (1011): Old State = IKE_R_MM5  New State =
IKE_R_MM5
```

주 모드 메시지 6(MM6) - 응답자가 ID를 보냅니다.1단계 완료.

포함 내용:

- 피어에서 보낸 원격 ID
- 선택할 터널 그룹에 대한 최종 결정

```
*Sep 21 08:33:43.425: IPSEC(key_engine): got a queue event with 1 KMI message(s)
*Sep 21 08:33:43.425: ISAKMP: (1011): SA is doing pre-shared key authentication
using id type ID_IPV6_ADDR
*Sep 21 08:33:43.425: ISAKMP (1011): ID payload
       next-payload : 8
       type         : 5
       address      : 2001: DB8::3
       protocol     : 17
       port         : 500
       length       : 24
*Sep 21 08:33:43.425: ISAKMP: (1011):Total payload length: 24
*Sep 21 08:33:43.425: ISAKMP: (1011): sending packet to 2001: DB8::2 my_port
500 peer_port 500 (R) MM_KEY_EXCH
*Sep 21 08:33:43.425: ISAKMP: (1011): Sending an IKE IPv6 Packet.
*Sep 21 08:33:43.425: ISAKMP: (1011):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_COMPLETE
*Sep 21 08:33:43.425: ISAKMP: (1011): Old State = IKE_R_MM5  New State =
IKE_P1_COMPLETE
```

관련 구성:

```
crypto isakmp identity ...
```

빠른 모드 메시지 1(QM1)

```
*Sep 21 08:33:43.433: ISAKMP (1011): received packet from 2001: DB8::2 dport
500 sport 500 Global (R) QM_IDLE
*Sep 21 08:33:43.433: ISAKMP: set new node 1371333358 to QM_IDLE
*Sep 21 08:33:43.433: ISAKMP: (1011): processing HASH payload. message ID =
1371333358
*Sep 21 08:33:43.433: ISAKMP: (1011): processing SA payload. message ID =
1371333358
```

```
*Sep 21 08:33:43.433: ISAKMP: (1011):Checking IPSec proposal 1
*Sep 21 08:33:43.433: ISAKMP: transform 1, ESP_AES
*Sep 21 08:33:43.433: ISAKMP:   attributes in transform:
*Sep 21 08:33:43.433: ISAKMP:      encaps is 1 (Tunnel)
*Sep 21 08:33:43.433: ISAKMP:      SA life type in seconds
*Sep 21 08:33:43.433: ISAKMP:      SA life duration (basic) of 3600
*Sep 21 08:33:43.433: ISAKMP:      SA life type in kilobytes
*Sep 21 08:33:43.433: ISAKMP:      SA life duration (VPI) of  0x0 0x46 0x50 0x0
*Sep 21 08:33:43.433: ISAKMP:      authenticator is HMAC-SHA
*Sep 21 08:33:43.433: ISAKMP:      key length is 128
*Sep 21 08:33:43.433: ISAKMP: (1011):atts are acceptable.
*Sep 21 08:33:43.433: IPSEC(validate_proposal_request): proposal part #1
*Sep 21 08:33:43.433: IPSEC(validate_proposal_request): proposal part #1,
 (key eng. msg.) INBOUND local= 2001: DB8::3:0, remote= 2001: DB8::2:0,
    local_proxy= ::/0/256/0,
    remote_proxy= ::/0/256/0,
   protocol= ESP, transform= NONE  (Tunnel),
   lifedur= 0s and 0kb,
   spi= 0x0(0), conn_id= 0, keysize= 128, flags= 0x0
*Sep 21 08:33:43.433: ISAKMP: (1011): processing NONCE payload. message ID =
1371333358
*Sep 21 08:33:43.433: ISAKMP: (1011): processing ID payload. message ID =
1371333358
*Sep 21 08:33:43.433: ISAKMP: (1011): processing ID payload. message ID =
1371333358
*Sep 21 08:33:43.433: ISAKMP: (1011):QM Responder gets spi
*Sep 21 08:33:43.433: ISAKMP: (1011):Node 1371333358, Input =
IKE_MESG_FROM_PEER, IKE_QM_EXCH
*Sep 21 08:33:43.433: ISAKMP: (1011): Old State = IKE_QM_READY  New State =
IKE_QM_SPI_STARVE
```

관련 구성:

```
tunnel mode ipsec ipv6
```

빠른 모드 메시지 2(QM2)

포함 내용:

- Remote end는 매개 변수를 전송합니다.
- 2단계 중 2단계 중 짧은 단계가 선택됩니다.

```
*Sep 21 08:33:43.433: ISAKMP: (1011): sending packet to 2001: DB8::2 my_port
500 peer_port 500 (R) QM_IDLE
*Sep 21 08:33:43.433: ISAKMP: (1011): Sending an IKE IPv6 Packet.
*Sep 21 08:33:43.433: ISAKMP: (1011):Node 1371333358, Input =
IKE_MESG_INTERNAL, IKE_GOT_SPI
*Sep 21 08:33:43.433: ISAKMP: (1011): Old State = IKE_QM_SPI_STARVE  New
State = IKE_QM_R_QM2
*Sep 21 08:33:43.437: IPSEC(key_engine): got a queue event with 1 KMI message(s)
R3(config-if)#
*Sep 21 08:33:43.437: IPSEC(crypto_ipsec_create_ipsec_sas): Map found
Tunnel23-head-0
*Sep 21 08:33:43.437: IPSEC(crypto_ipsec_sa_find_ident_head): reconnecting
with the same proxies and peer 2001: DB8::2
*Sep 21 08:33:43.437: IPSEC(create_sa): sa created,
 (sa) sa_dest= 2001: DB8::3, sa_proto= 50,
   sa_spi= 0x221A7153(572158291),
   sa_trans= esp-aes esp-sha-hmac , sa_conn_id= 305
```

```
   sa_lifetime(k/sec)= (4608000/3532)
*Sep 21 08:33:43.437: IPSEC(create_sa): sa created,
 (sa) sa_dest= 2001: DB8::2, sa_proto= 50,
   sa_spi= 0x45F16A9A(1173449370),
   sa_trans= esp-aes esp-sha-hmac , sa_conn_id= 306
   sa_lifetime(k/sec)= (4608000/3532)
```

관련 구성:

```
crypto ipsec transform-set TRA esp-aes esp-sha-hmac
mode transport
crypto ipsec profile PRO
set transform-set TRA
interface tunnel23
tunnel mode ipsec ipv6
tunnel protection ipsec profile PRO
```

QM3(Quick Mode Message 3) - 2단계를 완료하고 인터페이스를 가동해야 합니다.

```
*Sep 21 08:33:43.437: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel23,
changed state to up
*Sep 21 08:33:43.437: ISAKMP (1011): received packet from 2001: DB8::2 dport
500 sport 500 Global (R) QM_IDLE
*Sep 21 08:33:43.437: ISAKMP: (1011): deleting node 1371333358 error FALSE
reason "QM done (await)"
*Sep 21 08:33:43.437: ISAKMP: (1011):Node 1371333358, Input =
IKE_MESG_FROM_PEER, IKE_QM_EXCH
*Sep 21 08:33:43.437: ISAKMP: (1011): Old State = IKE_QM_R_QM2  New State =
IKE_QM_PHASE2_COMPLETE
*Sep 21 08:33:43.437: IPSEC(key_engine): got a queue event with 1 KMI message(s
*Sep 21 08:33:43.437: IPSEC(key_engine_enable_outbound): rec'd enable notify
from ISAKMP
```

IOS 라우터 - 개시자

주 모드 메시지 1(MM1) - 초기 연락처

포함 내용:

- 공급업체 ID(VID)
- 용량
- 1단계 제안서
- IKE SA(Security Association)
- IPSec에서 SA용 템플릿을 이미 생성

```
*Sep 21 08:33:43.245: %CRYPTO-6-ISAKMP_ON_OFF: ISAKMP is ON
*Sep 21 08:33:43.245: IPSEC(sa ident sadb root initialize created IPv6 ACL %s)
: Tunnel23-head-0-65537-Tunnel23-head-0-ACL-6-IPSECV6-ACL
*Sep 21 08:33:43.245: IPSEC(recalculate_mtu) : reset sadb_root 79E82A8 mtu to
1500
*Sep 21 08:33:43.245: IPSEC(adjust_mtu) : adjusting ident ip mtu from 1460 to
1500,
 (identity) local= 2001: DB8::2:0, remote= 2001: DB8::3:0,
   local_proxy= ::/0/256/0,
```

```
   remote_proxy= ::/0/256/0
*Sep 21 08:33:43.245: IPSEC(adjust_mtu): adjusting path mtu from 1460 to 1500,
 (identity) local= 2001: DB8::2:0, remote= 2001: DB8::3:0,
   local_proxy= ::/0/256/0,
   remote_proxy= ::/0/256/0
*Sep 21 08:33:43.245: IPSEC(sa_request): ,
 (key eng. msg.) OUTBOUND local= 2001: DB8::2:500, remote= 2001: DB8::3:500,
   local_proxy= ::/0/256/0,
   remote_proxy= ::/0/256/0,
   protocol= ESP, transform= esp-aes esp-sha-hmac  (Tunnel),
   lifedur= 3600s and 4608000kb,
   spi= 0x0(0), conn_id= 0, keysize= 128, flags= 0x0
*Sep 21 08:33:43.245: ISAKMP: (0): SA request profile is (NULL)
*Sep 21 08:33:43.245: ISAKMP: Created a peer struct for 2001: DB8::3, peer port
500
*Sep 21 08:33:43.245: ISAKMP: New peer created peer = 0x9344BE8 peer_handle =
0x80000008
*Sep 21 08:33:43.245: ISAKMP: Locking peer struct 0x9344BE8, refcount 1 for
isakmp_initiator
*Sep 21 08:33:43.245: ISAKMP: local port 500, remote port 500
*Sep 21 08:33:43.245: ISAKMP: set new node 0 to QM_IDLE
*Sep 21 08:33:43.245: ISAKMP: (0):insert sa successfully sa = 944C840
*Sep 21 08:33:43.245: ISAKMP: (0):Can not start Aggressive mode, trying Main
mode.
*Sep 21 08:33:43.245: ISAKMP: (0):found peer pre-shared key matching 2001:
DB8::3
*Sep 21 08:33:43.245: ISAKMP: (0):Input = IKE_MESG_FROM_IPSEC, IKE_SA_REQ_MM
*Sep 21 08:33:43.245: ISAKMP: (0): Old State = IKE_READY  New State = IKE_I_MM1
*Sep 21 08:33:43.245: ISAKMP: (0): beginning Main Mode exchange
*Sep 21 08:33:43.245: ISAKMP: (0): sending packet to 2001: DB8::3 my_port 500
peer_port 500 (I) MM_NO_STATE
*Sep 21 08:33:43.245: ISAKMP: (0): Sending an IKE IPv6 Packet.
```

관련 구성:

```
crypto isakmp policy 10
authentication pre-share
```

주 모드 메시지 2(MM2) - 초기 연락처에 회신

포함 내용:

- 피어가 사용할 ISAKMP(Internet Security Association and Key Management Protocol) 정책을 선택합니다.
- IKE SA

```
*Sep 21 08:33:43.249: ISAKMP (0): received packet from 2001: DB8::3 dport 500
sport 500 Global (I) MM_NO_STATE
*Sep 21 08:33:43.249: ISAKMP: (0):Input = IKE_MESG_FROM_PEER, IKE_MM_EXCH
*Sep 21 08:33:43.249: ISAKMP: (0): Old State = IKE_I_MM1  New State = IKE_I_MM2

*Sep 21 08:33:43.249: ISAKMP: (0): processing SA payload. message ID = 0
*Sep 21 08:33:43.249: ISAKMP: (0):found peer pre-shared key matching 2001:
DB8::3
*Sep 21 08:33:43.249: ISAKMP: (0): local preshared key found
*Sep 21 08:33:43.249: ISAKMP : Scanning profiles for xauth ...
*Sep 21 08:33:43.249: ISAKMP: (0):Checking ISAKMP transform 1 against priority
10 policy
*Sep 21 08:33:43.249: ISAKMP:      encryption DES-CBC
```

```
*Sep 21 08:33:43.249: ISAKMP:      hash SHA
*Sep 21 08:33:43.249: ISAKMP:      default group 1
*Sep 21 08:33:43.249: ISAKMP:      auth pre-share
*Sep 21 08:33:43.249: ISAKMP:      life type in seconds
*Sep 21 08:33:43.249: ISAKMP:      life duration (VPI) of  0x0 0x1 0x51 0x80
*Sep 21 08:33:43.249: ISAKMP: (0):atts are acceptable. Next payload is 0
*Sep 21 08:33:43.249: ISAKMP: (0):Acceptable atts:actual life: 0
*Sep 21 08:33:43.249: ISAKMP: (0):Acceptable atts:life: 0
*Sep 21 08:33:43.249: ISAKMP: (0):Fill atts in sa vpi_length:4
*Sep 21 08:33:43.249: ISAKMP: (0):Fill atts in sa life_in_seconds:86400
*Sep 21 08:33:43.249: ISAKMP: (0):Returning Actual lifetime: 86400
*Sep 21 08:33:43.249: ISAKMP: (0):: Started lifetime timer: 86400.

*Sep 21 08:33:43.249: ISAKMP: (0):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_MAIN_MODE
*Sep 21 08:33:43.249: ISAKMP: (0): Old State = IKE_I_MM2  New State =
IKE_I_MM2
```

주 모드 메시지 3(MM3) - NAT 검색 및 Diffie-Hellman Exchange

포함 내용:

- NAT 검색 페이로드 및 해시
- DH 교환 시작
- DPD(Dead Peer Detection) 지원

```
*Sep 21 08:33:43.249: ISAKMP: (0): sending packet to 2001: DB8::3 my_port 500
peer_port 500 (I) MM_SA_SETUP
*Sep 21 08:33:43.249: ISAKMP: (0): Sending an IKE IPv6 Packet.
*Sep 21 08:33:43.249: ISAKMP: (0):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_COMPLETE
*Sep 21 08:33:43.249: ISAKMP: (0): Old State = IKE_I_MM2  New State = IKE_I_MM3
```

주 모드 메시지 4(MM4) - NAT 검색 및 Diffie-Hellman Exchange

포함 내용:

- NAT 검색 페이로드
- DH 교환 시작
- 추가 VID(DPD, Unity 지원)
- 다른 IOS 디바이스와의 통화 지식

```
*Sep 21 08:33:43.273: ISAKMP (0): received packet from 2001: DB8::3 dport 500
sport 500 Global (I) MM_SA_SETUP
*Sep 21 08:33:43.273: ISAKMP: (0):Input = IKE_MESG_FROM_PEER, IKE_MM_EXCH
*Sep 21 08:33:43.273: ISAKMP: (0): Old State = IKE_I_MM3  New State = IKE_I_MM4

*Sep 21 08:33:43.273: ISAKMP: (0): processing KE payload. message ID = 0
*Sep 21 08:33:43.281: ISAKMP: (0): processing NONCE payload. message ID = 0
*Sep 21 08:33:43.281: ISAKMP: (0):found peer pre-shared key matching 2001:
DB8::3
*Sep 21 08:33:43.281: ISAKMP: (1011): processing vendor id payload
*Sep 21 08:33:43.281: ISAKMP: (1011): vendor ID is Unity
*Sep 21 08:33:43.281: ISAKMP: (1011): processing vendor id payload
*Sep 21 08:33:43.281: ISAKMP: (1011): vendor ID is DPD
*Sep 21 08:33:43.281: ISAKMP: (1011): processing vendor id payload
```

```
*Sep 21 08:33:43.281: ISAKMP: (1011): speaking to another IOS box!
*Sep 21 08:33:43.281: ISAKMP: (1011):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_MAIN_MODE
*Sep 21 08:33:43.281: ISAKMP: (1011): Old State = IKE_I_MM4  New State =
IKE_I_MM4
```

주 모드 메시지 5(MM5) - ID 보내기

포함 내용:

- 원격 피어 ID(ID)

```
*Sep 21 08:33:43.293: ISAKMP: (1011): Send initial contact
*Sep 21 08:33:43.293: ISAKMP: (1011): SA is doing pre-shared key authentication
using id type ID_IPV6_ADDR
*Sep 21 08:33:43.293: ISAKMP (1011): ID payload
       next-payload : 8
       type         : 5
        address      : 2001: DB8::2
       protocol     : 17
       port         : 500
       length       : 24
*Sep 21 08:33:43.293: ISAKMP: (1011):Total payload length: 24
*Sep 21 08:33:43.293: ISAKMP: (1011): sending packet to 2001: DB8::3 my_port
500 peer_port 500 (I) MM_KEY_EXCH
*Sep 21 08:33:43.293: ISAKMP: (1011): Sending an IKE IPv6 Packet.
*Sep 21 08:33:43.293: ISAKMP: (1011):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_COMPLETE
*Sep 21 08:33:43.293: ISAKMP: (1011): Old State = IKE_I_MM4  New State =
IKE_I_MM5
```

관련 구성:

```
crypto isakmp identity ...
```

주 모드 메시지 6(MM6) - 원격 피어 ID, 1단계가 설정됨

포함 내용:

- 키 재설정 시간 시작됨
- 원격 ID(이 경우 주소)
- 프로필에 대한 결정

```
*Sep 21 08:33:43.297: ISAKMP (1011): received packet from 2001: DB8::3 dport
500 sport 500 Global (I) MM_KEY_EXCH
*Sep 21 08:33:43.297: ISAKMP: (1011): processing ID payload. message ID = 0
*Sep 21 08:33:43.297: ISAKMP (1011): ID payload
       next-payload : 8
       type         : 5
       address      : 2001: DB8::3
       protocol     : 17
       port         : 500
       length       : 24
*Sep 21 08:33:43.297: ISAKMP: (0):: peer matches *none* of the profiles
*Sep 21 08:33:43.297: ISAKMP: (1011): processing HASH payload. message ID = 0
*Sep 21 08:33:43.297: ISAKMP: (1011): SA authentication status: authenticated
```

```
*Sep 21 08:33:43.297: ISAKMP: (1011): SA has been authenticated with 2001:
DB8::3
*Sep 21 08:33:43.297: ISAKMP: Trying to insert a peer 2001: DB8::2/2001:
DB8::3/500/,  and inserted successfully 9344BE8.
*Sep 21 08:33:43.297: ISAKMP: (1011):Input = IKE_MESG_FROM_PEER, IKE_MM_EXCH
*Sep 21 08:33:43.297: ISAKMP: (1011): Old State = IKE_I_MM5  New State =
IKE_I_MM6

*Sep 21 08:33:43.297: ISAKMP: (1011):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_MAIN_MODE
*Sep 21 08:33:43.297: ISAKMP: (1011): Old State = IKE_I_MM6  New State =
IKE_I_MM6

*Sep 21 08:33:43.301: ISAKMP: (1011):Input = IKE_MESG_INTERNAL,
IKE_PROCESS_COMPLETE
*Sep 21 08:33:43.301: ISAKMP: (1011): Old State = IKE_I_MM6  New State =
IKE_P1_COMPLETE
```

관련 구성:

```
crypto isakmp identity ...
```

빠른 모드 메시지 1(QM1) - 피어 시작 단계 2

포함 내용:

- 원격 및 로컬 프록시 ID
- 변형 집합

```
*Sep 21 08:33:43.301: ISAKMP: (1011):beginning Quick Mode exchange, M-ID of
1371333358*Sep 21 08:33:43.301: ISAKMP: (1011):QM Initiator gets spi
*Sep 21 08:33:43.301: ISAKMP: (1011): sending packet to 2001: DB8::3 my_port
500 peer_port 500 (I) QM_IDLE
*Sep 21 08:33:43.301: ISAKMP: (1011): Sending an IKE IPv6 Packet.
*Sep 21 08:33:43.301: ISAKMP: (1011):Node 1371333358, Input =
IKE_MESG_INTERNAL, IKE_INIT_QM
*Sep 21 08:33:43.301: ISAKMP: (1011): Old State = IKE_QM_READY  New State =
IKE_QM_I_QM1
*Sep 21 08:33:43.301: ISAKMP: (1011):Input = IKE_MESG_INTERNAL,
IKE_PHASE1_COMPLETE
*Sep 21 08:33:43.301: ISAKMP: (1011): Old State = IKE_P1_COMPLETE  New State =
IKE_P1_COMPLETE
```

관련 구성:

```
crypto ipsec transform-set TRA esp-aes esp-sha-hmac
mode transport

crypto ipsec profile PRO
set transform-set TRA
```

빠른 모드 메시지 2(QM2)

포함 내용:

- 프록시 ID 확인

- 터널 유형
- PFS(Perfect Forwarding Secrecy) 설정

```
*Sep 21 08:33:43.305: ISAKMP (1011): received packet from 2001: DB8::3 dport
500 sport 500 Global (I) QM_IDLE
*Sep 21 08:33:43.305: ISAKMP: (1011): processing HASH payload. message ID =
1371333358
*Sep 21 08:33:43.305: ISAKMP: (1011): processing SA payload. message ID =
1371333358
*Sep 21 08:33:43.305: ISAKMP: (1011):Checking IPSec proposal 1
*Sep 21 08:33:43.305: ISAKMP: transform 1, ESP_AES
*Sep 21 08:33:43.305: ISAKMP:   attributes in transform:
*Sep 21 08:33:43.305: ISAKMP:      encaps is 1 (Tunnel)
*Sep 21 08:33:43.305: ISAKMP:      SA life type in seconds
*Sep 21 08:33:43.305: ISAKMP:      SA life duration (basic) of 3600
*Sep 21 08:33:43.305: ISAKMP:      SA life type in kilobytes
*Sep 21 08:33:43.305: ISAKMP:      SA life duration (VPI) of  0x0 0x46 0x50 0x0
*Sep 21 08:33:43.305: ISAKMP:      authenticator is HMAC-SHA
*Sep 21 08:33:43.305: ISAKMP:      key length is 128
*Sep 21 08:33:43.305: ISAKMP: (1011):atts are acceptable.
*Sep 21 08:33:43.305: IPSEC(validate_proposal_request): proposal part #1
*Sep 21 08:33:43.305: IPSEC(validate_proposal_request): proposal part #1,
 (key eng. msg.) INBOUND local= 2001: DB8::2:0, remote= 2001: DB8::3:0,
   local_proxy= ::/0/256/0,
   remote_proxy= ::/0/256/0,
   protocol= ESP, transform= NONE  (Tunnel),
   lifedur= 0s and 0kb,
   spi= 0x0(0), conn_id= 0, keysize= 128, flags= 0x0
*Sep 21 08:33:43.305: ISAKMP: (1011): processing NONCE payload. message ID =
1371333358
*Sep 21 08:33:43.305: ISAKMP: (1011): processing ID payload. message ID =
1371333358
*Sep 21 08:33:43.305: ISAKMP: (1011): processing ID payload. message ID =
1371333358
```

관련 구성:

```
crypto ipsec transform-set TRA esp-aes esp-sha-hmac
mode transport

crypto ipsec profile PRO
set transform-set TRA

interface tunnel23
tunnel mode ipsec ipv6
tunnel protection ipsec profile PRO
```

빠른 모드 메시지 3(QM3) - 2단계 설정

포함 내용:

- 트래픽을 전달할 보안 정책 인덱스(SPI) 설정

```
*Sep 21 08:33:43.305: ISAKMP: (1011): Sending an IKE IPv6 Packet.
*Sep 21 08:33:43.305: ISAKMP: (1011): deleting node 1371333358 error FALSE
reason "No Error"
*Sep 21 08:33:43.305: ISAKMP: (1011):Node 1371333358, Input =
IKE_MESG_FROM_PEER, IKE_QM_EXCH
```

```
*Sep 21 08:33:43.305: ISAKMP: (1011): Old State = IKE_QM_I_QM1  New State =
IKE_QM_PHASE2_COMPLETE
*Sep 21 08:33:43.305: IPSEC(key_engine): got a queue event with 1 KMI message(s)
*Sep 21 08:33:43.305: IPSEC(crypto_ipsec_create_ipsec_sas): Map found
Tunnel23-head-0
*Sep 21 08:33:43.305: IPSEC(crypto_ipsec_sa_find_ident_head): reconnecting
with the same proxies and peer 2001: DB8::3
*Sep 21 08:33:43.305: IPSEC(create_sa): sa created,
 (sa) sa_dest= 2001: DB8::2, sa_proto= 50,
   sa_spi= 0x45F16A9A(1173449370),
   sa_trans= esp-aes esp-sha-hmac , sa_conn_id= 305
   sa_lifetime(k/sec)= (4608000/3439)
*Sep 21 08:33:43.305: IPSEC(create_sa): sa created,
 (sa) sa_dest= 2001: DB8::3, sa_proto= 50,
   sa_spi= 0x221A7153(572158291),
   sa_trans= esp-aes esp-sha-hmac , sa_conn_id= 306
   sa_lifetime(k/sec)= (4608000/3439)
R2(config-if)#
*Sep 21 08:33:43.309: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Tunnel23, changed state to up
```

터널 확인

```
sh crypto ipsec sa

interface: Tunnel23
   Crypto map tag: Tunnel23-head-0, local addr 2001: DB8::2

  protected vrf: (none)
  local  ident (addr/mask/prot/port): (::/0/0/0)
  remote ident (addr/mask/prot/port): (::/0/0/0)
  current_peer 2001: DB8::3 port 500
    PERMIT, flags={origin_is_acl,}
    #pkts encaps: 4, #pkts encrypt: 4, #pkts digest: 4
    #pkts decaps: 4, #pkts decrypt: 4, #pkts verify: 4
   #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.: 2001: DB8::2,
    remote crypto endpt.: 2001: DB8::3
    path mtu 1500, ipv6 mtu 1500, ipv6 mtu idb Ethernet0/0
    current outbound spi: 0x221A7153(572158291)
    PFS (Y/N): N, DH group: none

    inbound esp sas:
      spi: 0x45F16A9A(1173449370)
       transform: esp-aes esp-sha-hmac ,
       in use settings ={Tunnel, }
       conn id: 305, flow_id: SW:305, sibling_flags 80000041, crypto map:
Tunnel23-head-0
       sa timing: remaining key lifetime (k/sec): (4183789/3408)
       IV size: 16 bytes
       replay detection support: Y
       Status: ACTIVE

    inbound ah sas:

    inbound pcp sas:
```

```
    outbound esp sas:
      spi: 0x221A7153(572158291)
       transform: esp-aes esp-sha-hmac ,
       in use settings ={Tunnel, }
       conn id: 306, flow_id: SW:306, sibling_flags 80000041, crypto map:
Tunnel23-head-0
       sa timing: remaining key lifetime (k/sec): (4183790/3408)
       IV size: 16 bytes
       replay detection support: Y
       Status: ACTIVE

R2(config-if)#do ping fe80::23:3
Output Interface: tunnel23
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to FE80::23:3, timeout is 2 seconds:
Packet sent with a source address of FE80::23:2%Tunnel23
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/11/20 ms
R2(config-if)#do sh crypto ipsec sa | i caps|ident
  local  ident (addr/mask/prot/port): (::/0/0/0)
  remote ident (addr/mask/prot/port): (::/0/0/0)
    #pkts encaps: 9, #pkts encrypt: 9, #pkts digest: 9
    #pkts decaps: 9, #pkts decrypt: 9, #pkts verify: 9
```

터널이 작동 중이고 트래픽을 전달합니다.

관련 정보

- IPSec에 대한 위키백과 문서 ;표준 및 참조 자료에는 유용한 정보가 많이 포함되어 있습니다.
- ASA IPsec 및 IKE Debugs(IKEv1 Aggressive Mode) 문제 해결 기술 참고
- ASA IPsec 및 IKE 디버깅(IKEv1 기본 모드) 문제 해결 TechNote
- 기술 지원 및 문서 – Cisco Systems