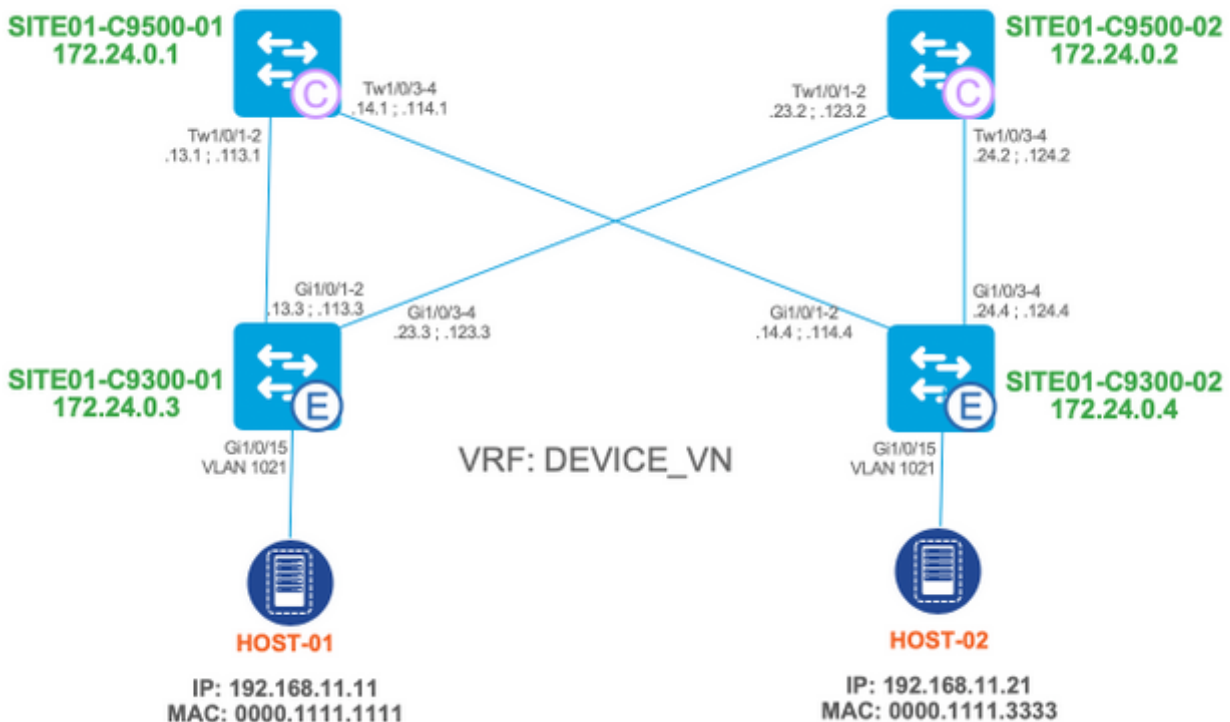


SD-Access Fabric에서 ARP 확인 문제 해결

소개

이 문서에서는 SD-Access 패브릭에서 ARP(Address Resolution Protocol) 문제를 해결하는 방법에 대해 설명합니다.

토폴로지



위치:

- SITE01-C9500-01 및 SITE01-C9500-02는 제어 노드입니다.
- SITE01-C9300-01 및 SITE01-C9300-02는 에지 노드입니다.

기본 게이트웨이의 MAC 확인 문제 해결 및 ARP-Reply에 대해 트러블슈팅하는 동일한 기술을 사용할 수 있지만, 호스트 간 통신(주로 ARP-Request)에 초점을 둡니다.

이 문서에서는 두 가지 주요 활용 사례를 소개합니다.

1. 엔드포인트(HOST-01 및 HOST-02)별로 기본 게이트웨이의 MAC 주소를 확인합니다.
2. 소스 호스트와 동일한 VLAN에 연결된 원격 호스트의 MAC 주소를 확인합니다. HOST-01에서 HOST-02로 전송된 ARP 요청입니다. HOST-02에서 HOST-01로 전송된 ARP 응답

초기 상태

다음과 같은 것으로 가정합니다.

- VLAN1021에 연결되어 해당 로컬 애니캐스트 기본 게이트웨이(192.168.11.254)에 도달할 수 있는 두 호스트(SITE01-HOST-01 및 SITE02-HOST-02)입니다.

site01-host-01#ping 192.168.11.254

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.11.254, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 60/118/204 ms

site01-host-02#ping 192.168.11.254

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.11.254, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms

팁: 최종 호스트 디바이스의 방화벽에 의해 삭제되는 ICMP 패킷과 관련된 잘못된 결론을 방지하려면 다른 방법이 아닌 엔드-호스트에서 에지 스위치로 기본 게이트웨이를 ping하는 것이 좋습니다.

- 에지 노드가 로컬 디바이스 추적 및 LISP 데이터베이스에 두 호스트를 추가했습니다.

호스트-01:

site01-c9300-01#show device-tracking database interface gi1/0/15

portDB has 1 entries for interface Gi1/0/15, 1 dynamic

<SNIP>

Network Layer Address	Link Layer Address	Interface	vlan	prlvl	age
state Time left					
DH4 192.168.11.11	0000.1111.1111	Gi1/0/15	1021	0025	34s
REACHABLE 210 s try 0(42651 s)					

site01-c9300-01#show lisp eid-table vlan 1021 ethernet database 0000.1111.1111

LISP ETR MAC Mapping Database for EID-table Vlan 1021 (IID 8189), LSBs: 0x1

Entries total 2, no-route 0, inactive 0

0000.1111.1111/48, dynamic-eid Auto-L2-group-8189, inherited from default locator-set
rloc_aba7a76a-fadd-4f6e-a44e-ef4258a1c129

Locator	Pri/Wgt	Source	State
172.24.0.3	10/10	cfg-intf	site-self, reachable

site01-c9300-01#show lisp eid-table vlan 1021 ethernet database address-resolution

LISP ETR Address Resolution for EID-table Vlan 1021 (IID 8189)

(*) -> entry being deleted

Hardware Address	Host Address	L3	InstID
0000.1111.1111	192.168.11.11/32		4100

site01-c9300-01#show lisp eid-table vrf DEVICE_VN ipv4 database 192.168.11.11/32

LISP ETR IPv4 Mapping Database for EID-table vrf DEVICE_VN (IID 4100), LSBs: 0x1

Entries total 2, no-route 0, inactive 0

192.168.11.11/32, dynamic-eid 192_168_11_0-DEVICE_VN-IPV4, inherited from default locator-set
rloc_aba7a76a-fadd-4f6e-a44e-ef4258a1c129

Locator	Pri/Wgt	Source	State
172.24.0.3	10/10	cfg-intf	site-self, reachable

호스트-02:

site01-c9300-02#show device-tracking database interface gi1/0/15

<SNIP>

Network Layer Address	Link Layer Address	Interface	vlan	prlvl	age
state	Time left				
DH4 192.168.11.21	0000.1111.3333	Gi1/0/15	1021	0025	109s
REACHABLE 142 s try 0(22885 s)					

site01-c9300-02#show lisp eid-table vlan 1021 ethernet database 0000.1111.3333

LISP ETR MAC Mapping Database for EID-table Vlan 1021 (IID 8189), LSBs: 0x1
Entries total 2, no-route 0, inactive 0

0000.1111.3333/48, dynamic-eid Auto-L2-group-8189, inherited from default locator-set
rloc_1ee7629b-33d1-425f-82f6-60104ffbd8da

Locator	Pri/Wgt	Source	State
172.24.0.4	10/10	cfg-intf	site-self, reachable

site01-c9300-02#show lisp eid-table vlan 1021 ethernet database address-resolution

LISP ETR Address Resolution for EID-table Vlan 1021 (IID 8189)
(*) -> entry being deleted

Hardware Address	Host Address	L3	InstID
0000.1111.3333	192.168.11.21/32		4100

site01-c9300-02#show lisp eid-table vrf DEVICE_VN ipv4 database 192.168.11.21/32

LISP ETR IPv4 Mapping Database for EID-table vrf DEVICE_VN (IID 4100), LSBs: 0x1
Entries total 2, no-route 0, inactive 0

192.168.11.21/32, dynamic-eid 192_168_11_0-DEVICE_VN-IPV4, inherited from default locator-set
rloc_1ee7629b-33d1-425f-82f6-60104ffbd8da

Locator	Pri/Wgt	Source	State
172.24.0.4	10/10	cfg-intf	site-self, reachable

- 두 호스트 모두 패브릭 컨트롤 플레인(제어 노드 - SITE01-C9500-01 및 SITE01-C9500-02)에 성공적으로 등록되었습니다.

site01-c9500-01#show lisp instance-id 8189 ethernet server

LISP Site Registration Information

* = Some locators are down or unreachable

= Some registrations are sourced by reliable transport

Site Name	Last Register	Up	Who Last Registered	Inst ID	EID Prefix
site_uci	never	no	--	8189	any-mac
	00:28:04	yes#	172.24.0.3:16882	8189	0000.1111.1111/48
	3d23h	yes#	172.24.0.4:19075	8189	0000.1111.3333/48

site01-c9500-01#show lisp instance-id 8189 ethernet server address-resolution

Address-resolution data for router lisp 0 instance-id 8189

L3	InstID	Host Address	Hardware Address
	4100	192.168.11.11/32	0000.1111.1111
	4100	192.168.11.21/32	0000.1111.3333

site01-c9500-01#show lisp instance-id 4100 ipv4 server

LISP Site Registration Information

* = Some locators are down or unreachable

= Some registrations are sourced by reliable transport

Site Name	Last Register	Up	Who Last Registered	Inst ID	EID Prefix
site_uci	never	no	--	4100	192.168.11.0/24
	00:27:47	yes#	172.24.0.3:16882	4100	192.168.11.11/32
	3d23h	yes#	172.24.0.4:19075	4100	192.168.11.21/32
	never	no	--	4100	192.168.12.0/24
	never	no	--	4100	192.168.16.0/24

ARP 요청 - 문제 해결 흐름

인그레스 에지 노드(SITE01-C9300-01)

첫째, 인그레스 에지 노드에서 ARP 패킷이 실제로 수신되었음을 확인하는 것이 좋습니다.

```

site01-c9300-01#monitor capture cap interface gi1/0/15 in match any buffer size 1
site01-c9300-01#monitor capture cap start
Started capture point : cap
!
! trigger ping / communication between both end-points
!
site01-c9300-01#monitor capture cap stop
Capture statistics collected at software:
Capture duration - 26 seconds
Packets received - 5
Packets dropped - 0
Packets oversized - 0

Bytes dropped in asic - 0

Capture buffer will exists till exported or cleared

Stopped capture point : cap
site01-c9300-01#show monitor capture cap buffer display-filter arp
Starting the packet display ..... Press Ctrl + Shift + 6 to exit

  3 10.098559 00:00:11:11:11:11 -> ff:ff:ff:ff:ff:ff ARP 60 Who has 192.168.11.21? Tell
192.168.11.11

site01-c9300-01#show monitor capture cap buffer display-filter arp dump
Starting the packet display ..... Press Ctrl + Shift + 6 to exit

0000  ff ff ff ff ff ff 00 00 11 11 11 11 08 06 00 01  .....
0010  08 00 06 04 00 01 00 00 11 11 11 11 c0 a8 0b 0b  .....
0020  00 00 00 00 00 00 c0 a8 0b 15 00 00 00 00 00 00  .....
0030  00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
▶ Frame 1: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
▶ Ethernet II, Src: Tektrnix_11:11:11 (00:00:11:11:11:11), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
▼ Address Resolution Protocol (request)
  Hardware type: Ethernet (1)
  Protocol type: IPv4 (0x0800)
  Hardware size: 6
  Protocol size: 4
  Opcode: request (1)
  Sender MAC address: Tektrnix_11:11:11 (00:00:11:11:11:11)
  Sender IP address: 192.168.11.11
  Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
  Target IP address: 192.168.11.21

```

이미지 1:ARP 요청 수신(인그레스 에지 노드)

수신된 ARP-Request 패킷은 CPU에 편딩되므로 대상 MAC 주소의 위치를 식별하여 ARP 패킷을 원격 호스트로 유니캐스트로(VXLAN 헤더에서)으로 전송할 수 있도록 LISP 프로토콜을 트리거할 수 있습니다.

ARP 요청이 CPU에 성공적으로 편딩되었음을 확인하기 위해 제어 평면에서 패킷 캡처를 수행할 수 있습니다(캡처된 패킷은 인그레스 인터페이스의 캡처에서와 동일하게 표시됨).

```
site01-c9300-01#monitor capture cpu control-plane in match any buffer size 1
site01-c9300-01#monitor capture cpu start
!
! trigger ping / communication between end-points
!
site01-c9300-01#monitor capture cpu stop
site01-c9300-01#show monitor capture cpu buffer display-filter arp
Starting the packet display ..... Press Ctrl + Shift + 6 to exit
521 43.928372 00:00:11:11:11:11 -> ff:ff:ff:ff:ff:ff ARP 60 Who has 192.168.11.21? Tell
192.168.11.11
```

ARP 패킷은 CPU에 편딩되며, 다음과 같은 여러 내부 프로세스에 의해 추가로 처리됩니다.

- DAI(동적 ARP 검사).
- 디바이스 추적/SISF(Switched Integrated Security Features) 프레임워크
- LISP

```
site01-c9300-01#debug platform dai all
site01-c9300-01#debug device-tracking parser
site01-c9300-01#debug lisp control-plane all
```

ARP 패킷은 다음 소프트웨어에서 처리됩니다(자세한 설명은 인라인 형태로 제공됨).

```
!
! 1. ARP packet is received by control-plane (DAI process) and is passed to SISF framework:
! 000276: Mar 26 09:44:05.046: Enqueued packet in dai software queue 000277: Mar 26
09:44:05.046: DAI processing: SMAC = 0000.1111.1111{mac} and SRC_ADDR = 192.168.11.11{ipv4}
DMAC = ffff.ffff.ffff{mac} and DST_ADDR = 192.168.11.21{ipv4}vlan: 1021, if_input: Gi1/0/15
000278: Mar 26 09:44:05.046: SISF[PRS]: ARP-REQUEST target set to 192.168.11.21
000279: Mar 26 09:44:05.046: SISF[PRS]: Gi1/0/15 vlan 1021 Arp sender LLA set to 0000.1111.1111
000280: Mar 26 09:44:05.046: SISF[PRS]: ARP sender L3 address set to 192.168.11.11
000281: Mar 26 09:44:05.047: SISF[PRS]: Gi1/0/15 vlan 1021 Advertise from access: default action
is update entry
000282: Mar 26 09:44:05.047: SISF[PRS]: Gi1/0/15 vlan 1021 Arp sender LLA set to 0000.1111.1111
000283: Mar 26 09:44:05.047: SISF[PRS]: Gi1/0/15 vlan 1021 Source and LLA match
000284: Mar 26 09:44:05.047: SISF[PRS]: Gi1/0/15 vlan 1021 preference level set 5
!
! 2a. LISP process (Ethernet instance: 8189) is invoked to send LISP MAP-REQUEST message to find
a MAC address that corresponds with target IP address: 192.168.11.21/32
!
000285: Mar 26 09:44:05.047: [XTR] LISP-0: Remote EID IID 8189 prefix 192.168.11.21/32, Change
state to incomplete (sources: <watch>, state: unknown, rlocs: 0). 000286: Mar 26 09:44:05.047:
[XTR] LISP-0: Remote EID IID 8189 prefix 192.168.11.21/32, [incomplete] Scheduling map requests
delay 00:00:00 min_elapsed 00:00:01 (sources: <watch>, state: incomplete, rlocs: 0). 000287: Mar
26 09:44:05.047: [XTR] LISP-0: Remote EID IID 8189 prefix 192.168.11.21/32, Starting idle timer
(delay 00:02:30) (sources: <watch>, state: incomplete, rlocs: 0). 000288: Mar 26 09:44:05.176:
LISP-0: IID 8189 Request processing of remote EID prefix map requests to IPv4. 000289: Mar 26
09:44:05.176: [XTR] LISP: Send map request type AR 000290: Mar 26 09:44:05.176: [XTR] LISP: Send
map request for EID prefix IID 8189 192.168.11.21/32
```

000291: Mar 26 09:44:05.176: [XTR] LISP-0: Remote EID IID 8189 prefix 192.168.11.21/32, Send map request (1) (sources:

000292: Mar 26 09:44:05.176: LISP-0: EID-AF IPv4, Sending map-request from 192.168.11.21 to 192.168.11.21 for EID 192.168.11.21/32, ITR-RLOCs 1, nonce 0xDD902BBE-0x062F365F (encap src 172.24.0.3, dst 172.24.0.2).!

!
! 2b. LISP process (Ethernet instance: 8189) receives LISP MAP-REPLY with the information about target MAC address: 0000.1111.3333.

!
000293: Mar 26 09:44:05.177: [MS] LISP: Processing received Map-Reply(2) message on GigabitEthernet1/0/4 from 172.24.0.2:4342 to 172.24.0.3:4342

000294: Mar 26 09:44:05.177: [MS] LISP: Received map reply nonce 0xDD902BBE-0x062F365F, records 1

000295: Mar 26 09:44:05.177: [MS] LISP: Parsing mapping record for EID prefix IID 8189 192.168.11.21/32

000296: Mar 26 09:44:05.177: [MS] LISP-0: This is a Address Resolution message.

000297: Mar 26 09:44:05.177: [XTR] LISP: Processing Map-Reply mapping record for IID 8189 SVC_VLAN_IAF_ARP 192.168.11.21/32 LCAF 53, ttl 1440, action none, not authoritative, 1 locator 0000.1111.3333 pri/wei=1/100 lpr

000298: Mar 26 09:44:05.177: [XTR] LISP-0: Map Request IID 8189 prefix 192.168.11.21/32 AR[LL], Received reply with rtt 1ms.

000299: Mar 26 09:44:05.177: [XTR] LISP: Processing mapping information for EID prefix IID 8189 192.168.11.21/32

000300: Mar 26 09:44:05.177: [XTR] LISP-0: Remote EID IID 8189 prefix 192.168.11.21/32, Change state to reused (sources: <map-rep>, state: incomplete, rlocs: 0).

000301: Mar 26 09:44:05.177: [XTR] LISP-0: IAF IID 8189 SVC_VLAN_IAF_ARP, Persistent db: ignore writing request, ITR disabled.

000302: Mar 26 09:44:05.177: [XTR] LISP-0: Remote EID IID 8189 prefix 192.168.11.21/32, Change state to complete (sources:

000304: Mar 26 09:44:05.177: [XTR] LISP-0: Remote EID IID 8189 prefix 0000.1111.3333/48, [incomplete] Scheduling map requests delay 00:00:00 min_elapsed 00:00:01 (sources: <watch>, state: incomplete, rlocs: 0).

000305: Mar 26 09:44:05.177: [XTR] LISP-0: Remote EID IID 8189 prefix 0000.1111.3333/48, Starting idle timer (delay 00:02:30) (sources: <watch>, state: incomplete, rlocs: 0).

!
! 3a. LISP process (Ethernet instance: 8189) is invoked again to send LISP MAP-REQUEST to determine RLOC for discovered MAC: 0000.1111.3333

!
000306: Mar 26 09:44:05.305: LISP-0: IID 8189 Request processing of remote EID prefix map requests to IPv4.

000307: Mar 26 09:44:05.306: [XTR] LISP: Send map request type remote EID prefix 000308: Mar 26 09:44:05.306: [XTR] LISP: Send map request for EID prefix IID 8189 0000.1111.3333/48

000309: Mar 26 09:44:05.306: [XTR] LISP-0: Remote EID IID 8189 prefix 0000.1111.3333/48, Send map request (1) (sources:

000310: Mar 26 09:44:05.306: LISP-0: EID-AF MAC, Sending map-request from 0.0.0.0 to 0.0.0.0 for EID 0000.1111.3333/48, ITR-RLOCs 1, nonce 0xB518EE02-0x9E2DF283 (encap src 172.24.0.3, dst 172.24.0.2).

000311: Mar 26 09:44:05.307: [XTR] LISP: Processing received Map-Reply(2) message on GigabitEthernet1/0/4 from 172.24.0.2:4342 to 172.24.0.3:4342

!
! 3b. LISP process (Ethernet instance: 8189) receives LISP MAP-REPLY with the information about

RLOC 172.24.0.4 for target MAC: 0000.1111.3333.

!
000312: Mar 26 09:44:05.307: [XTR] LISP: Received map reply nonce 0xB518EE02-0x9E2DF283, records 1
000313: Mar 26 09:44:05.307: [XTR] LISP: Processing Map-Reply mapping record for IID 8189 SVC_VLAN_IAF_MAC 0000.1111.3333/48 LCAF 2, ttl 1440, action none, not authoritative, 1 locator 172.24.0.4 pri/wei=10/10 lpR
000314: Mar 26 09:44:05.307: [XTR] LISP-0: Map Request IID 8189 prefix 0000.1111.3333/48 remote EID prefix[LL], Received reply with rtt 1ms.
000315: Mar 26 09:44:05.307: [XTR] LISP: Processing mapping information for EID prefix IID 8189 0000.1111.3333/48
000316: Mar 26 09:44:05.307: [XTR] LISP-0: Remote EID IID 8189 prefix 0000.1111.3333/48, Change state to reused (sources: <map-rep>, state: incomplete, rlocs: 0).
000317: Mar 26 09:44:05.307: [XTR] LISP-0: IAF IID 8189 SVC_VLAN_IAF_MAC, Persistent db: ignore writing request, disabled.
000318: Mar 26 09:44:05.307: [XTR] LISP-0: Remote EID IID 8189 prefix 0000.1111.3333/48, Change state to complete (sources: <map-rep>, state: reused, rlocs: 0).
000319: Mar 26 09:44:05.307: [XTR] LISP: RIB Watch Group default 172.24.0.4/32 , created.
000320: Mar 26 09:44:05.307: [XTR] LISP: RIB Watch Group default 172.24.0.4/32 , scheduling RIB update.
000321: Mar 26 09:44:05.308: [XTR] LISP-0: Remote EID IID 8189 prefix 0000.1111.3333/48, RLOCs pending rwatch update, defer fwd update (sources: <map-rep>, state: complete, rlocs: 0).
000322: Mar 26 09:44:05.308: [XTR] LISP-0: Remote EID IID 8189 prefix 0000.1111.3333/48, 1 RLOCs pending rwatch update, defer fwd update (sources: <map-rep>, state: complete, rlocs: 0).
000323: Mar 26 09:44:05.308: [XTR] LISP-0: Remote EID IID 8189 prefix 0000.1111.3333/48, Recalculated RLOC status bits from 0x0 to 0x1 (sources: <map-rep>, state: complete, rlocs: 1).
000324: Mar 26 09:44:05.308: [XTR] LISP-0: Remote EID IID 8189 prefix 0000.1111.3333/48, 1 RLOCs pending rwatch update, defer fwd update (sources: <map-rep>, state: complete, rlocs: 1).
000325: Mar 26 09:44:05.308: [XTR] LISP: RIB Watch Group default 172.24.0.4/32 , installing in RIB.
000326: Mar 26 09:44:05.308: [XTR] LISP-0: Remote shrRLOC 172.24.0.4, Reachability notification, up* allow* remote.
000327: Mar 26 09:44:05.308: [XTR] LISP-0: Remote EID IID 8189 prefix 0000.1111.3333/48, No more RLOCs pending rwatch update, schedule deferred fwd update (sources: <map-rep>, state: complete, rlocs: 1).
000328: Mar 26 09:44:05.308: [XTR] LISP: MAC, SISF L2 event: ignoring event CREATED for remote host.
000329: Mar 26 09:44:05.309: [XTR] LISP: IPv4, SISF L3 event: ignoring event UPDATED for remote host.
000330: Mar 26 09:44:05.309: [XTR] LISP: IPv4, SISF L3 event: ignoring event STATE_CHANGE for remote host.
000331: Mar 26 09:44:05.309: [XTR] LISP: MAC, SISF L2 event: ignoring event VERIFIED for remote host.
000332: Mar 26 09:44:05.309: [XTR] LISP: MAC, SISF L2 event: ignoring event ACTIVE for remote host.
000333: Mar 26 09:44:05.309: [XTR] LISP: IPv4, SISF L3 event: ignoring event CREATED for remote host.

컨트를 플레인 변환 후 MAC/LISP 테이블에는 원격 HOST의 위치에 대한 정보가 포함되어야 합니다.

site01-c9300-01#show lisp instance-id 8189 ethernet map-cache 0000.1111.3333

LISP MAC Mapping Cache for EID-table Vlan 1021 (IID 8189), 1 entries

0000.1111.3333/48, uptime: 00:31:06, expires: 23:28:53, via map-reply, complete

Sources: map-reply

State: complete, last modified: 00:31:06, map-source: 172.24.0.4

Idle, Packets out: 0(0 bytes)

Encapsulating dynamic-EID traffic

Locator	Uptime	State	Pri/Wgt	Encap-IID
---------	--------	-------	---------	-----------

172.24.0.4	00:31:06	up	10/10	-
------------	----------	----	-------	---

Last up-down state change: 00:31:06, state change count: 1

Last route reachability change: 00:31:06, state change count: 1

```
Last priority / weight change:      never/never
RLOC-probing loc-status algorithm:
Last RLOC-probe sent:              00:31:06 (rtt 1ms)
```

```
site01-c9300-01#show mac address-table dynamic | in 0000.1111.3333
```

```
1021    0000.1111.3333    CP_LEARN    Tu0
```

이 단계에서 데이터 프레임은 ARP 패킷을 최종 대상으로 전달합니다(원래 첫 번째 ARP 패킷은 삭제되지 않지만, 제어 시간이 변환될 때 버퍼링되어 IP Phone과 같은 일부 엔드포인트에 부정적인 영향을 주지 않습니다).

```
site01-c9300-01#monitor capture cpu control-plane in match any buffer size 1
```

```
site01-c9300-01#monitor capture cpu start
```

```
!
! trigger ping / communication between end-points
!
```

```
site01-c9300-01#monitor capture cpu stop
```

```
site01-c9300-01#show monitor capture cpu buffer display-filter arp
```

```
Starting the packet display ..... Press Ctrl + Shift + 6 to exit
```

```
793  53.106637 00:00:11:11:11:11 -> 00:00:11:11:33:33 ARP 42 Who has 192.168.11.21? Tell
192.168.11.11
```

```
site01-c9300-01#show monitor capture cpu buffer display-filter frame.number==793 dump
```

```
Starting the packet display ..... Press Ctrl + Shift + 6 to exit
```

```
0000  00 00 11 11 33 33 00 00 11 11 11 11 08 06 00 01  ....33.....
0010  08 00 06 04 00 01 00 00 11 11 11 11 c0 a8 0b 0b  .....
0020  00 00 00 00 00 00 c0 a8 0b 15  ....
```

```
▼ Ethernet II, Src: 00:00:11:11:11:11, Dst: 00:00:11:11:33:33
  ► Destination: 00:00:11:11:33:33
  ► Source: 00:00:11:11:11:11
  Type: ARP (0x0806)
▼ Address Resolution Protocol (request)
  Hardware type: Ethernet (1)
  Protocol type: IPv4 (0x0800)
  Hardware size: 6
  Protocol size: 4
  Opcode: request (1)
  Sender MAC address: 00:00:11:11:11:11
  Sender IP address: 192.168.11.11
  Target MAC address: 00:00:00:00:00:00
  Target IP address: 192.168.11.21
```

이미지에 표시된 대로 이더넷 대상 MAC 주소는 대상 MAC 주소를 사용하여 브로드캐스트에서 유니캐스트로 변경됩니다.

동시에 ARP 헤더 자체의 대상 MAC 주소는 변경되지 않습니다.

ARP 패킷은 유니캐스트로 다시 하드웨어로 전송됩니다. 이 하드웨어는 관련된 인접성을 통해 RLOC 172.24.0.4에 대한 L2 조회를 기반으로 합니다.

```
site01-c9300-01#show platform software fed switch 1 matm macTable vlan 1021
```

```
VLAN  MAC                               Type  Seq#  EC_Bi  Flags  machandle  siHandle
riHandle          diHandle          *a_time *e_time  ports
```



```

-----
1021 0000.0c9f.f45c 0x8002 0 98140 64 0x7fab2cc44f78 0x7fab2cc43c48
0x0 0x0 0 0 Vlan1021
1021 7c21.0d1c.f8f5 0x8002 0 98140 64 0x7fab2cc46518 0x7fab2cc43c48
0x0 0x0 0 0 Vlan1021
1021 0000.1111.1111 0x1 26 0 0 0x7fab2cf1cb88 0x7fab2cbaec48
0x0 0x7fab2ca137b8 300 15 GigabitEthernet1/0/15
1021 0000.1111.3333 0x1000001 0 0 64 0x7fab2cd7d0f8 0x7fab2cd66908
0x7fab2cb76b68 0x0 0 15 RLOC 172.24.0.4 adj_id 116

```

site01-c9300-01#show platform software fed switch 1 matm adjacencies

```

VLAN ADJ_ID ADJ_KEY Encap Link siHandle riHandle diHandle
Obj_type
-----

```

```

1021 116 0x100000074 VXLAN V4 0x7fab2cd66908 0x7fab2cb76b68 0x0
CP

```

site01-c9300-01#show platform software fed switch active matm adjacencies adjkey 0x100000074

```

ADJ_ID IF_NUMBER VNI Len Vlan Encap Link Source IP Dest IP
siHandle riHandle diHandle Obj_type
-----

```

```

116 0x420011 8189 40 1021 VXLAN V4 172.24.0.3 172.24.0.4
0x7fab2cd66908 0x7fab2cb76b68 0x0 CP

```

인터페이스 상태:

site01-c9300-01#show platform software fed switch 1 ifm if-id 0x420011

```

Interface IF_ID : 0x0000000000420011
Interface Name : L2LISP0.8189
Interface Block Pointer : 0x7fab2cbdfa28
Interface Block State : READY
Interface State : Enabled
Interface Status : ADD
Interface Ref-Cnt : 2
Interface Type : L2_LISP
Is top interface : FALSE
Asic_num : 0
Switch_num : 0
AAL port Handle : ae000063
Parent interface id : 43
Multicast Tunnel IP : 0.0.0.0
Mcast Tunnel Handle : NULL
Vlan Id : 1021
Instance Id : 8189
Dest Port : 4789
SGT : Enable
Underlay VRF (V4) : 0
Underlay VRF (V6) : 0
Flood Access-tunnel : Disable
Flood unknown ucast : Disable
Broadcast : Enable
Multicast Flood : Disable

```

Port Information

```

Handle ..... [0xae000063]
Type ..... [L2-LISP-sub]
Identifier ..... [0x420011]
Unit ..... [4325393]
L2 LISP Sub-interface Subblock
Parent iif id : 0x43

```


rcp_pmap = 0x1
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0

index = 0x5013
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0

ASIC#1:

index = 0x5012
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x0
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0

index = 0x5013
pmap = 0x00000000 0x00000000
cmi = 0x0
rcp_pmap = 0x1
al_rsc_cmi
CPU Map Index (CMI) [0]
ctiLo0 = 0
ctiLo1 = 0
ctiLo2 = 0
cpuQNum0 = 0
cpuQNum1 = 0
cpuQNum2 = 0
npuIndex = 0
stripSeg = 0
copySeg = 0

이그레스 에지 노드(SITE01-C9300-02)

인그레스 에지 노드의 모든 작업이 성공하면 ARP 패킷이 올바른 이그레스 에지 노드에서 유니캐스트(및 VXLAN 캡슐화)로 수신됩니다.

이그레스 에지 노드의 ARP 패킷은 다음과 같이 캡처할 수 있습니다(여기서 캡처에 사용되는 IP 주소는 두 에지 노드의 Loopback0입니다).

```
site01-c9300-02#monitor capture uplink interface range gi1/0/1 - 4 in match ipv4 host 172.24.0.3
host 172.24.0.4 buffer size 1
site01-c9300-02#monitor capture uplink start
!
! trigger ping / communication between both end-points
!
site01-c9300-02#monitor capture uplink stop
site01-c9300-02#show monitor capture uplink buffer display-filter arp Starting the packet
display ..... Press Ctrl + Shift + 6 to exit

  1   0.000000 00:00:11:11:11:11 -> 00:00:11:11:33:33 ARP 110 Who has 192.168.11.21? Tell
192.168.11.11

site01-c9300-02#show monitor capture uplink buffer display-filter arp dump
Starting the packet display ..... Press Ctrl + Shift + 6 to exit

0000  7c 21 0d 1d 6e f6 4c e1 75 17 6d 9f 08 00 45 00  |!.n.L.u.m...E.
0010  00 60 00 0b 40 00 fd 11 25 4a ac 18 00 03 ac 18  .`.@...%J.....
0020  00 04 ff 49 12 b5 00 4c 00 00 88 00 00 0d 00 1f  ...I...L.....
0030  fd 00 00 00 11 11 33 33 00 00 11 11 11 11 08 06  .....33.....
0040  00 01 08 00 06 04 00 01 00 00 11 11 11 11 c0 a8  .....
0050  0b 0b 00 00 00 00 00 00 c0 a8 0b 15 00 00 00 00  .....
0060  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....
▶ Frame 1: 110 bytes on wire (880 bits), 110 bytes captured (880 bits)
▶ Ethernet II, Src: 4c:e1:75:17:6d:9f, Dst: 7c:21:0d:1d:6e:f6
▶ Internet Protocol Version 4, Src: 172.24.0.3, Dst: 172.24.0.4
▶ User Datagram Protocol, Src Port: 65353, Dst Port: 4789
▼ Virtual eXtensible Local Area Network
  ▶ Flags: 0x8800, GBP Extension, VXLAN Network ID (VNI)
    Group Policy ID: 13
    VXLAN Network Identifier (VNI): 8189
    Reserved: 0
  ▶ Ethernet II, Src: 00:00:11:11:11:11, Dst: 00:00:11:11:33:33
▼ Address Resolution Protocol (request)
  Hardware type: Ethernet (1)
  Protocol type: IPv4 (0x0800)
  Hardware size: 6
  Protocol size: 4
  Opcode: request (1)
  Sender MAC address: 00:00:11:11:11:11
  Sender IP address: 192.168.11.11
  Target MAC address: 00:00:00:00:00:00
  Target IP address: 192.168.11.21
```

이 그림에서는 디코딩된 패킷 캡처를 보여 줍니다. 유니캐스트 ARP 요청이 VNI로 VXLAN 캡슐화된 프레임으로 수신되었습니다.8189(LISP 이더넷 인스턴스 ID에 해당) 및 그룹 정책 ID:13(소스

HOST-01과 연결된 SGT 값)

패킷은 다음 번 하드웨어에서 재회되고(VXLAN 헤더를 제거하기 위해) CPU에 펀딩됩니다. 아래 출력은 SPF에서 생성할 수 있습니다(Cisco TAC 감독 아래의 Show Platform Forward).

Input Packet Details:

```
###[ Ethernet ]###
  dst      = 7c:21:0d:1d:6e:f6
  src=4c:e1:75:17:6d:9f
  type     = 0x800
###[ IP ]###
  version  = 4L
  ihl     = 5L
  tos     = 0x0
  len     = 96
  id      = 28
  flags   = DF
  frag    = 0L
  ttl     = 253
  proto   = udp
  chksum  = 0x2539
  src=172.24.0.3
  dst     = 172.24.0.4
  options = ''
###[ UDP ]###
  sport    = 65353
  dport    = 4789
  len      = 76
  chksum   = 0x0
###[ VXLAN ]###
  flags    = I+N
  vxlanSGT = 0xdL
  vxlanNetworkIdentifier= 0x1ffdL
  reserved = 0x0L
###[ Ethernet ]###
  dst      = 00:00:11:11:33:33
  src=00:00:11:11:11:11
  type     = 0x806
###[ ARP ]###
  hwtype   = 0x1
  ptype    = 0x800
  hwlen    = 6
  plen     = 4
  op       = who-has
  hwsrc=00:00:11:11:11:11
  psrc=192.168.11.11
  hwdst    = 00:00:00:00:00:00
  pdst     = 192.168.11.21
###[ Padding ]###
  load     = '00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00'
```

Ingress:

```
Port : GigabitEthernet1/0/4
Global Port Number : 4
Local Port Number : 4
Asic Port Number : 3
Asic Instance : 1
Vlan : 4095
Mapped Vlan ID : 1
STP Instance : 1
BlockForward : 0
BlockLearn : 0
```

```

L3 Interface          : 40
  IPv4 Routing        : enabled
  IPv6 Routing        : enabled
  Vrf Id              : 0
Adjacency:
  Station Index       : 203
  Destination Index   : 20498
  Rewrite Index       : 59399
  Replication Bit Map : 0x11  ['remoteData', 'coreData']
Decision:
  Destination Index   : 20498  [DI_RCP_PORT1]
  Rewrite Index       : 59399
  Dest Mod Index      : 0        [IGR_FIXED_DMI_NULL_VALUE]
  CPU Map Index       : 0        [CMI_NULL]
  Forwarding Mode     : 3        [Other or Tunnel]
  Replication Bit Map :          ['remoteData', 'coreData']
  Winner              :          LISPVXLANINSTTRANSLATION LOOKUP
  Qos Label           : 1
  SGT                 : 0
  DGTID               : 0

```

EXCEPTION:

Datapath: Expected packet not replicated on interface

제어 평면에 의해 역캡슐화된 수신/전송 중임을 확인하기 위해 추가 패킷 캡처를 인그레스 방향으로 제어 평면에서 수행할 수 있습니다.

```

site01-c9300-02#monitor capture cpu control-plane both match any buffer size 1
site01-c9300-02#monitor capture cpu start

```

```

!
! trigger ping / communication between both end-points
!

```

```

site01-c9300-02#monitor capture cpu stop
site01-c9300-02#show monitor cap cpu buffer display-filter arp

```

Starting the packet display Press Ctrl + Shift + 6 to exit

```

523  22.146501 00:00:11:11:11:11 -> 00:00:11:11:33:33 ARP 60 Who has 192.168.11.21? Tell
192.168.11.11 <-- punt from Hardware to CPU
524  22.146667 00:00:11:11:11:11 -> 00:00:11:11:33:33 ARP 60 Who has 192.168.11.21? Tell
192.168.11.11 <-- inject from CPU to Hardware

```

```

site01-c9300-02#show monitor capture cpu buffer display-filter frame.number==523 dump

```

Starting the packet display Press Ctrl + Shift + 6 to exit

```

0000  00 00 11 11 33 33 00 00 11 11 11 11 08 06 00 01  ....33.....
0010  08 00 06 04 00 01 00 00 11 11 11 11 c0 a8 0b 0b  .....
0020  00 00 00 00 00 00 c0 a8 0b 15 00 00 00 00 00 00  .....
0030  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....

```

```

▶ Frame 1: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
▶ Ethernet II, Src: 00:00:11:11:11:11, Dst: 00:00:11:11:33:33
▼ Address Resolution Protocol (request)
  Hardware type: Ethernet (1)
  Protocol type: IPv4 (0x0800)
  Hardware size: 6
  Protocol size: 4
  Opcode: request (1)
  Sender MAC address: 00:00:11:11:11:11
  Sender IP address: 192.168.11.11
  Target MAC address: 00:00:00:00:00:00
  Target IP address: 192.168.11.21

```

ARP 패킷은 소프트웨어 프로세스에 의해 처리되고 하드웨어로 다시 전송됩니다. 이 동작은 디버그를 통해 확인할 수 있습니다.

```

site01-c9300-02#debug platform dai all
site01-c9300-02#show logging
584813848: Mar 26 13:29:08.721: Enqueued packet in dai software fromCAPWAP or Access Tunnel or
LISP interface queue
584813849: Mar 26 13:29:08.721: DAI processing: SMAC = 0000.1111.1111{mac} and SRC_ADDR =
192.168.11.11{ipv4} DMAC = 0000.1111.3333{mac} and DST_ADDR = 192.168.11.21{ipv4}vlan: 1021,
if_input: Tu0
584813850: Mar 26 13:29:08.721: Hijacking ARP packet on LISP interface vlan: 1021, if_input:
Tu0, link_type: 1
584813851: Mar 26 13:29:08.721: Packet consumed
584813852: Mar 26 13:29:08.722: Enqueued packet in dai software queue

```

최종 조회를 위해 패킷이 VLAN1021의 하드웨어로 전송됩니다.

```

site01-c9300-02#monitor capture vlan interface vlan 1021 in match any buffer size 1
site01-c9300-02#monitor capture vlan start
!
! trigger ping / communication between both end-points
!
site01-c9300-02#monitor capture vlan stop
site01-c9300-02#show monitor capture vlan buffer display-filter arp
Starting the packet display ..... Press Ctrl + Shift + 6 to exit

  5  21.471664 00:00:11:11:11:11 -> 00:00:11:11:33:33 ARP 60 Who has 192.168.11.21? Tell
192.168.11.11

```

```

site01-c9300-02#show monitor capture vlan buffer display-filter arp dump
Starting the packet display ..... Press Ctrl + Shift + 6 to exit

0000  00 00 11 11 33 33 00 00 11 11 11 11 08 06 00 01  ....33.....
0010  08 00 06 04 00 01 00 00 11 11 11 11 c0 a8 0b 0b  .....
0020  00 00 00 00 00 00 c0 a8 0b 15 00 00 00 00 00 00  .....
0030  00 00 00 00 00 00 00 00 00 00 00 00 00 00  .....

```



```

▶ Frame 1: 60 bytes on wire (480 bits), 60 bytes captured (480 bits)
▶ Ethernet II, Src: 00:00:11:11:11:11, Dst: 00:00:11:11:33:33
▼ Address Resolution Protocol (request)
  Hardware type: Ethernet (1)
  Protocol type: IPv4 (0x0800)
  Hardware size: 6
  Protocol size: 4
  Opcode: request (1)
  Sender MAC address: 00:00:11:11:11:11
  Sender IP address: 192.168.11.11
  Target MAC address: 00:00:00:00:00:00
  Target IP address: 192.168.11.21

```

최종 조회는 대상 MAC 주소를 기반으로 합니다.

```
site01-c9300-02#show mac address-table dynamic address 0000.1111.3333
```

```
Mac Address Table
```

```

-----
Vlan    Mac Address      Type      Ports
----    -
1021    0000.1111.3333  DYNAMIC  Gi1/0/15
Total Mac Addresses for this criterion: 1

```

```
site01-c9300-02#show platform software fed switch 1 matm macTable vlan 1021
```

```

VLAN  MAC                Type  Seq#  EC_Bi  Flags  machandle      siHandle
riHandle          diHandle          *a_time *e_time  ports
-----
1021  0000.1111.3333      0x1   1554   0       0  0x7fe044d9ece8  0x7fe044a34518
0x0    0x7fe044948588      300    11  GigabitEthernet1/0/15

```

ARP 패킷은 이그레스 에지 노드의 이그레스 포트에 전달됩니다.

ARP 회신 - 문제 해결 흐름

ARP 회신은 이 문서에 제시된 ARP 요청과 동일한 방식으로 트러블슈팅을 수행할 수 있습니다.