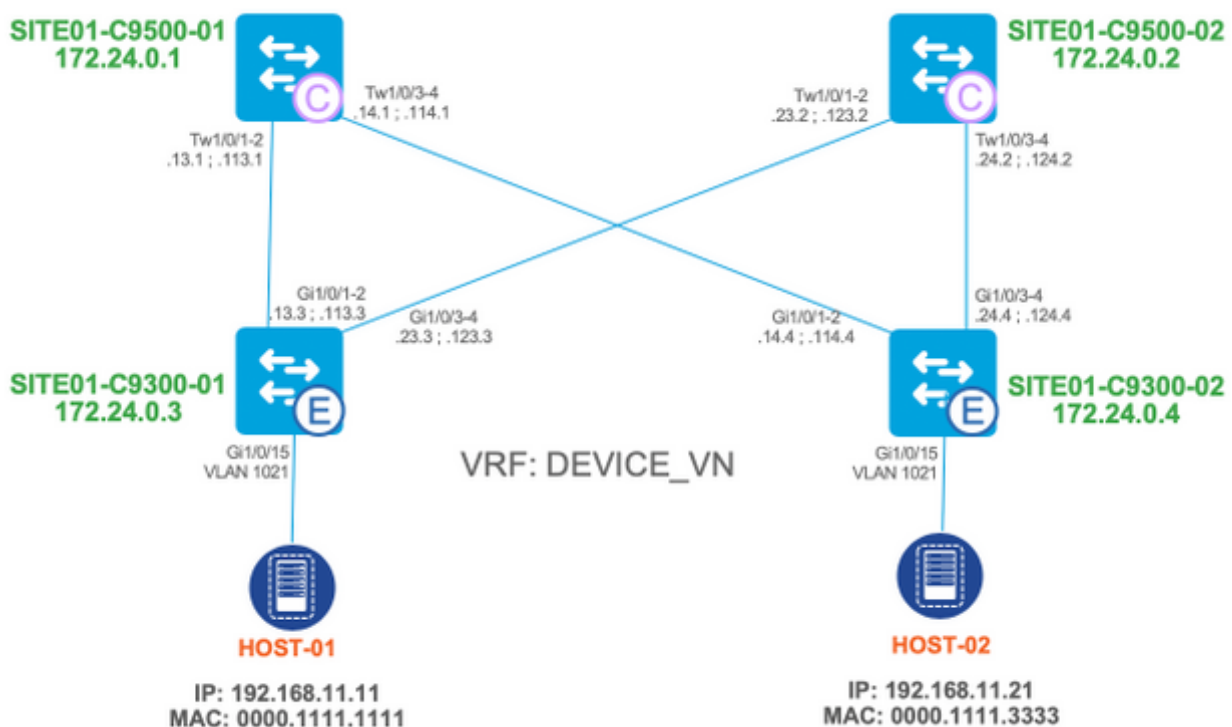


Fehlerbehebung bei ARP-Auflösung in SD-Access-Fabric

Einführung

In diesem Dokument wird die Fehlerbehebung für das Address Resolution Protocol (ARP) in der SD-Access-Fabric beschrieben.

Topologie



wobei:

- SITE01-C9500-01 und SITE01-C9500-02 sind Steuerungsknoten.
- SITE01-C9300-01 und SITE01-C9300-02 sind Edge-Knoten.

Der Fokus liegt auf der Kommunikation zwischen Host und Host (hauptsächlich ARP-Request), obwohl die gleichen Fehlerbehebungsverfahren zur Behebung der MAC-Auflösung des Standard-Gateways und für ARP-Reply eingesetzt werden können.

In diesem Dokument werden zwei wichtige Anwendungsfälle vorgestellt:

1. Auflösen der MAC-Adresse des Standard-Gateways durch Endpunkte (HOST-01 und HOST-02).
2. Auflösen der MAC-Adresse des Remote-Hosts, der im selben VLAN wie der Quell-Host verbunden ist: ARP-Anfrage von HOST-01 an HOST-02 gesendet. ARP-Antwort von HOST-02 an HOST-01 gesendet.

Ausgangsstatus

Es wird davon ausgegangen, dass

- Beide Hosts (SITE01-HOST-01 und SITE02-HOST-02), die mit VLAN1021 verbunden sind und das entsprechende lokale Anycast-Standardgateway (192.168.11.254) erreichen können.

```
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
```

Tipp: Es wird empfohlen, das Standard-Gateway vom End-Host zum Edge-Switch zu pingen, nicht umgekehrt, um falsche Schlussfolgerungen in Bezug auf ICMP-Pakete zu vermeiden, die von einer Firewall auf dem End-Host-Gerät verworfen werden.

- Edge Node hat beide Hosts der lokalen Geräteverfolgung und den LISP-Datenbanken hinzugefügt:

HOST-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

HOST-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_lee7629b-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_lee7629b-33d1-425f-82f6-60104ffbd8da

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

- Beide Hosts wurden erfolgreich auf der Fabric-Kontrollebene registriert (Steuerungsknoten - SITE01-C9500-01 & SITE01-C9500-02):

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-Anfrage - Fehlerbehebungsablauf

Eingangs-Edge-Knoten (SITE01-C9300-01)

Zunächst ist es immer gut zu bestätigen, dass das ARP-Paket tatsächlich vom Eingangs-Edge-Knoten empfangen wird:

```
site01-c9300-01#monitor capture cap interface gil/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 .....
0030 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

```

Bild 1: empfangene ARP-Anfrage (Eingangs-Edge-Knoten)

Das empfangene ARP-Request-Paket wird an die CPU geleitet, sodass das LISP-Protokoll ausgelöst werden kann, um den Speicherort der Ziel-MAC-Adresse zu identifizieren, sodass das ARP-Paket als Unicast (im VXLAN-Header) an den Remote-Host gesendet werden kann.

Um zu bestätigen, dass die ARP-Anforderung erfolgreich an die CPU gesendet wurde, kann die Paketerfassung auf Kontrollebene durchgeführt werden (das erfasste Paket sieht genau so aus wie bei der Erfassung auf der Eingangs-Schnittstelle):

```

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

```

Das ARP-Paket wird an die CPU übergeben und von mehreren internen Prozessen weiterverarbeitet, darunter:

- DAI (Dynamic ARP Inspection).
- Device-Tracking/SISF (Switched Integrated Security Features) Framework.
- LISP.

```

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

```

Als Nächstes wird das ARP-Paket in der Software verarbeitet (detaillierte, inline bereitgestellte Erklärung):

```

!
! 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 lms.

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.

Nach der Konvergenz auf Kontrollebene sollten MAC-/LISP-Tabellen Informationen über den Standort des Remote-HOST enthalten.

```
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
```

In dieser Phase leitet die Datenebene das ARP-Paket an das endgültige Ziel weiter (beachten Sie, dass das erste ursprüngliche ARP-Paket nicht verworfen, sondern für die Zeit gepuffert wird, in der die Steuerungszeit konvergiert, um mögliche negative Auswirkungen auf einige Endpunkte wie IP-Telefone zu vermeiden):

```
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

```

Wie im Bild gezeigt, wird die Ethernet-Ziel-MAC-Adresse mit der Ziel-MAC-Adresse von Broadcast zu Unicast geändert.

Gleichzeitig wird die Ziel-MAC-Adresse im ARP-Header selbst nicht geändert.

Das ARP-Paket wird als Unicast zurück an die Hardware gesendet, wo es in einen Unicast-VXLAN-Header auf Basis der L2-Suche nach RLOC 172.24.0.4 über die zugehörige Adjacency eingekapselt ist:

```
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	

Schnittstellenstatus:

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
Switch Num : 1
Asic Num : 0
Encap PORT LE handle : 0x7fab2ca9d1c8
Decap PORT LE handle : 0x7fab2ca9d018
L3IF LE handle : 0x7fab2ca9d698
SI handle decap : 0x7fab2cc00948
DI handle : 0x7fab2c311688
RI handle : 0x7fab2cbfdff8
RCP Service ID : 0x0
TRANS HTM handle : 0x7fab2cbfe5a8
TRANS CATCH ALL handle : 0x7fab2c3125a8
Port L2 Subblock
Enabled [No]
Allow dot1q [No]
Allow native [No]
Default VLAN [0]
Allow priority tag ... [No]
Allow unknown unicast [No]
Allow unknown multicast[No]
Allow unknown broadcast[No]
Allow unknown multicast[Enabled]
Allow unknown unicast [Enabled]
Protected [No]
IPv4 ARP snoop [No]
IPv6 ARP snoop [No]
Jumbo MTU [0]
Learning Mode [0]
Vepa [Disabled]
Port QoS Subblock
Trust Type [0x7]

Default Value [0]
Ingress Table Map [0x0]
Egress Table Map [0x0]
Queue Map [0x0]
Port Netflow Subblock
Port Policy Subblock
List of Ingress Policies attached to an interface
List of Egress Policies attached to an interface
Port CTS Subblock
Disable SGACL [0x0]
Trust [0x0]
Propagate [0x0]
Port SGT [0xffff]
Ref Count : 2 (feature Ref Counts + 1)
IFM Feature Ref Counts
FID : 96 (AAL_FEATURE_L2_MULTICAST_IGMP), Ref Count : 1
No Sub Blocks Present

Alle internen Handler können (nach Aktivierung des internen Dienstes im Konfigurationsmodus) detailliert überprüft werden:

Stationsindex:

site01-c9300-01#show platform hardware fed switch 1 fwd-asic abstraction print-resource-handle 0x7fab2cd66908 1

Handle:0x7fab2cd66908 Res-Type:ASIC_RSC_SI Res-Switch-Num:255 Asic-Num:255 Feature-ID:AL_FID_L2_WIRELESS Lkp-ftr-id:LKP_FEAT_INVALID ref_count:1
priv_ri/priv_si Handle: 0x7fab2cb76b68Hardware Indices/Handles: index0:0xd4
mtu_index/l3u_ri_index0:0x0 index1:0xd4 mtu_index/l3u_ri_index1:0x0
Features sharing this resource:58 (1)]
Cookie length: 56
00 00 00 00 00 00 00 00 fd 03 00 00 00 00 00 00 00 00 00 00 00 07 00 74 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

Detailed Resource Information (ASIC# 0)

Station Index (SI) [0xd4]

RI = 0x3c

DI = 0x5012

stationTableGenericLabel = 0
stationFdConstructionLabel = 0x7
lookupSkipIdIndex = 0
rcpServiceId = 0
dejaVuPreCheckEn = 0
Replication Bitmap: LD

Detailed Resource Information (ASIC# 1)

Station Index (SI) [0xd4]

RI = 0x3c

DI = 0x5013

stationTableGenericLabel = 0
stationFdConstructionLabel = 0x7
lookupSkipIdIndex = 0
rcpServiceId = 0
dejaVuPreCheckEn = 0
Replication Bitmap: LD

=====
Umschreiben:

site01-c9300-01#show platform hardware fed switch 1 fwd-asic abstraction print-resource-handle 0x7fab2cb76b68 1

Handle:0x7fab2cb76b68 Res-Type:ASIC_RSC_RI Res-Switch-Num:255 Asic-Num:255 Feature-ID:AL_FID_L2_WIRELESS Lkp-ftr-id:LKP_FEAT_INVALID ref_count:1
priv_ri/priv_si Handle: 0x7fab2cd66b38Hardware Indices/Handles: index0:**0x3c**
mtu_index/l3u_ri_index0:0x0 index1:**0x3c** mtu_index/l3u_ri_index1:0x0
Features sharing this resource:58 (1)
Cookie length: 56
00 00 00 00 00 00 00 00 fd 03 00 00 00 00 00 00 00 00 00 00 00 07 00 74 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

Detailed Resource Information (ASIC# 0)

Detailed Resource Information (ASIC# 1)

=====
Zielindex:

site01-c9300-01#show platform hardware fed switch 1 fwd-asic resource asic all destination-index range 0x5012 0x5013

ASIC#0:

index = 0x5012
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

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
```

Egress Edge Node (SITE01-C9300-02)

Wenn alle Vorgänge am Eingangs-Edge-Knoten erfolgreich ausgeführt wurden, wird das ARP-Paket als Unicast (und VXLAN-gekapselt) im richtigen Ausgangs-Edge-Knoten empfangen.

Das ARP-Paket am Egress Edge Node kann wie folgt erfasst werden (wobei für die Erfassung verwendete IP-Adressen Loopback0 beider Edge-Knoten sind):

```
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 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

Dieses Bild zeigt die dekodierte Paketerfassung, bei der Unicast-ARP-Anforderung als VXLAN-gekapselter Frame mit VNI empfangen wurde: 8189 (entspricht LISP Ethernet Instance-ID) und Group Policy ID: 13 (dies ist der SGT-Wert, der dem Quell-HOST-01 zugeordnet ist).

Das Paket wird als Nächstes in der Hardware (zur Entfernung des VXLAN-Headers) wieder in Umlauf gebracht und auf die CPU gestrafft. Die folgenden Ausgaben können von SPF (Show Platform Forward unter Cisco TAC-Aufsicht) generiert werden:

```
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
  checksum = 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

Um zu bestätigen, dass der Empfang/die Rücksendung von der Kontrollebene entkapselt wird, kann auf Kontrollebene eine zusätzliche Paketerfassung in Eingangsrichtung durchgeführt werden:

```

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

```

Das ARP-Paket wird durch den Softwareprozess behandelt und an die Hardware zurückgesendet. Dieses Verhalten kann durch Debuggen bestätigt werden:

```

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

```

Das Paket wird zur endgültigen Suche an die Hardware in VLAN1021 gesendet:

```

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 .....
0030 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
```

Die endgültige Suche basiert auf der MAC-Zieladresse:

```
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
```

Das ARP-Paket wird an den Ausgangsport im Edge-Knoten des Ausgangs weitergeleitet.

ARP-Antwort - Fehlerbehebungsablauf

Die ARP-Antwort kann genauso wie die ARP-Anfrage in diesem Dokument bearbeitet werden.