

Troubleshoot ARP Resolution in SD-Access Fabric

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Introduction

This document describes how to troubleshoot Address Resolution Protocol (ARP) in SD-Access fabric.

Prerequisites

Requirements

Cisco recommends that you have knowledge of these topics:

- Internet Protocol (IP) Forwarding
- Locator/ID Separation Protocol (LISP)
- Address Resolution Protocol (ARP)

Components Used

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

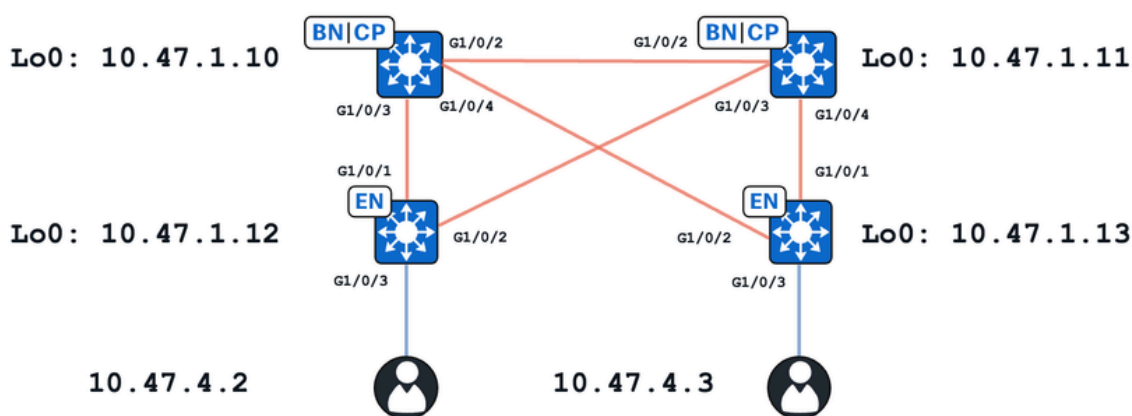
- C9000v on Cisco IOS® XE 17.10.1
- SDA 1.0 (not LISP PubSub)

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

This document can also be used with these hardware and software versions:

- C9200
- C9300
- C9400
- C9500
- C9600
- Cisco IOS® XE 16.12 and later

Topology



In this exercise:

- 10.47.1.10 and 10.47.1.11 are Collocated Borders
- 10.47.1.12 and 10.47.1.13 are Fabric Edge Nodes
- 10.47.4.2 and 10.47.4.3 are endpoints within the SDA Fabric and are in the same VLAN/subnet and same VN (red_vn)

Two main use-cases are presented in this document:

- ARP resolution between 10.47.4.2 and 10.47.4.3 through a unicast path
- ARP resolution between 10.47.4.2 and 10.47.4.3 through a flooding path

Unicast Path Initial State

Within SDA, there are two main methods for ARP resolution within the fabric. What is referred to as the unicast path indicates that there is no configuration of Layer 2 (L2) ARP Flooding or lack of "flood arp nd" configured under the LISP L2 Instance ID (IID) that corresponds to the VLAN in question. In addition to this caveat, to qualify for the unicast ARP path, there is no configuration of "IP local proxy ARP" or no presence of a Layer 3 Only Pool.

If these caveats are met, continue with this troubleshooting section and it is assumed that both endpoints (10.47.4.2 and 10.47.4.3) can reach their respective default gateways that exist on the Fabric Edge switches

which exist as 10.47.4.1

```
<#root>
```

```
Edge-1#
```

```
ping vrf red_vn 10.47.4.2
```

```
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 10.47.4.2, timeout is 2 seconds:
```

```
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 257/292/344 ms
```

```
<#root>
```

```
Edge-2#
```


```
ping vrf red_vn 10.47.4.3
```

```
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 10.47.4.3, timeout is 2 seconds:
```

```
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 221/321/566 ms
```

 Tip: It is recommended to ping default-gateway from the end-host towards edge switch, not the other way round to avoid false conclusions related to ICMP packets being dropped by a firewall on the end-host device.

Next, verify that each Fabric Edge node has their respective endpoint within IP Device-Tracking, (IPDT) the LISP L2 Database, L2 Address Resolution (AR) Database, and L3 Database.

Edge-1:

To verify the endpoint within IPDT, use the command **show device-tracking database interface <interface connecting to endpoint>**

```
<#root>
```

```
Edge-1#
```

```
show device-tracking database interface gi1/0/3
```

```
portDB has 2 entries for interface Gi1/0/3, 2 dynamic
```

```
Codes: L - Local, S - Static, ND - Neighbor Discovery, ARP - Address Resolution Protocol, DH4 - IPv4 DHCP
```

```
Preflevel flags (prlvl):
```

```
0001:MAC and LLA match      0002:Orig trunk           0004:Orig access
0008:Orig trusted trunk     0010:Orig trusted access  0020:DHCP assigned
0040:Cga authenticated      0080:Cert authenticated   0100:Statically assigned
```

```
Network Layer Address          Link Layer Address      Interface  vlan      prlvl      ag
```

```
DH4
```

10.47.4.2

5254.0019.93e9

Gi1/0/3 1026 0024 15s REACHABLE 228 s try 0(6374 s)

To verify the endpoint in the LISP L2 Database, use the command **show lisp eid-table vlan <vlan id> ethernet database <mac address>** use the VLAN and MAC address from the previous command

<#root>

Edge-1#

```
show lisp eid-table vlan 1026 ethernet database 5254.0019.93e9
```

LISP ETR MAC Mapping Database for LISP 0 EID-table Vlan 1026 (IID 8190), LSBs: 0x1
Entries total 1, no-route 0, inactive 0, do-not-register 2

5254.0019.93e9/48, dynamic-eid Auto-L2-group-8190, inherited from default locator-set rloc_222e1707-175

Uptime: 3w5d, Last-change: 3w5d

Domain-ID: local

Service-Insertion: N/A

Locator	Pri/Wgt	Source	State
---------	---------	--------	-------

10.47.1.12	10/10	cfg-intf	site-self, reachable <-- Edge-1's RLOC
------------	-------	----------	--

Map-server	Uptime	ACK	Domain-ID
------------	--------	-----	-----------

10.47.1.10	1w3d	Yes	0
------------	------	-----	---

10.47.1.11	3w5d	Yes	0
------------	------	-----	---

To verify the L2 AR Database use the command **show lisp eid-table vlan <vlan-id> ethernet database address-resolution <mac address>**

<#root>

Edge-1#

```
show lisp eid-table vlan 1026 ethernet database address-resolution 5254.0019.93e9
```

LISP ETR Address Resolution for LISP 0 EID-table Vlan 1026 (IID 8190)

(*) -> entry being deleted

Hardware Address	L3 InstID	Host Address
------------------	-----------	--------------

5254.0019.93e9	4099	10.47.4.2/32 <-- Endpoint MAC address, LISP L3 IID, and IPv4 address, r
----------------	------	---

To verify the LISP L3 Database, use the command **show lisp instance-id <L3 IID> ipv4 database <IPv4 address>/subnet mask** use the LISP L3 IID from the previous command

<#root>

Edge-1#

```
show lisp instance-id 4099 ipv4 database 10.47.4.2/32
```

```
LISP ETR IPv4 Mapping Database for LISP 0 EID-table vrf red_vn (IID 4099), LSBs: 0x1  
Entries total 1, no-route 0, inactive 0, do-not-register 1
```

```
10.47.4.2/32
```

```
, dynamic-eid red-IPv4, inherited from default locator-set rloc_222e1707-175d-4019-a783-060404f8bc2f  
Uptime: 3w5d, Last-change: 3w5d  
Domain-ID: local  
Service-Insertion: N/A  
Locator      Pri/Wgt  Source      State
```

```
10.47.1.12
```

```
10/10  cfg-intf  site-self, reachable
```

```
<-- Edge-1's own RLOC
```

```
Map-server      Uptime      ACK  Domain-ID  
10.47.1.10      1w0d        Yes  0  
10.47.1.11      1w0d        Yes  0
```

Edge-2:

To verify the endpoint within IPDT, use the command **show device-tracking database interface <interface connecting to local endpoint>**

```
<#root>
```

```
Edge-2#
```

```
show device-tracking database interface gi1/0/3
```

```
portDB has 3 entries for interface Gi1/0/3, 3 dynamic
```

```
Codes: L - Local, S - Static, ND - Neighbor Discovery, ARP - Address Resolution Protocol, DH4 - IPv4 DHCP  
Preflevel flags (prlvl):
```

```
0001:MAC and LLA match      0002:Orig trunk      0004:Orig access  
0008:Orig trusted trunk    0010:Orig trusted access  0020:DHCP assigned  
0040:Cga authenticated     0080:Cert authenticated  0100:Statically assigned
```

```
Network Layer Address      Link Layer Address      Interface  vlan      prlvl      ag
```

```
DH4
```

```
10.47.4.3
```

```
5254.001e.ad00
```

```
Gi1/0/3  1026      0024      122s      REACHABLE  124 s try 0(5810 s)
```

To verify the endpoint in the LISP L2 Database, use the command **show lisp eid-table vlan <vlan id> ethernet database <mac address>** use the VLAN and MAC address from the previous command

<#root>

Edge-2#

```
show lisp eid-table vlan 1026 ethernet database 5254.001e.ad00
```

LISP ETR MAC Mapping Database for LISP 0 EID-table Vlan 1026 (IID 8190), LSBs: 0x1
Entries total 1, no-route 0, inactive 0, do-not-register 2

5254.001e.ad00/48, dynamic-eid Auto-L2-group-8190, inherited from default locator-set rloc_691b1fe4-526

Uptime: 3w5d, Last-change: 3w5d

Domain-ID: local

Service-Insertion: N/A

Locator	Pri/Wgt	Source	State
10.47.1.13	10/10	cfg-intf	site-self, reachable <-- Edge-2's RLOC

Map-server	Uptime	ACK	Domain-ID
10.47.1.10	1w2d	Yes	0
10.47.1.11	1w2d	Yes	0

To verify the L2 AR Database use the command **show lisp eid-table vlan <vlan-id> ethernet database address-resolution <mac address>**

<#root>

Edge-2#

```
show lisp eid-table vlan 1026 ethernet database address-resolution 5254.001e.ad00
```

LISP ETR Address Resolution for LISP 0 EID-table Vlan 1026 (IID 8190)

(*) -> entry being deleted

Hardware Address	L3 InstID	Host Address
5254.001e.ad00	4099	10.47.4.3/32 <-- Endpoint MAC address, LISP L3 IID, and IPv4 address, r

To verify the LISP L3 Database, use the command **show lisp instance-id <L3 IID> ipv4 database <IPv4 address>/subnet mask** use the LISP L3 IID from the previous command

<#root>

Edge-2#

```
show lisp instance-id 4099 ipv4 database 10.47.4.3/32
```

LISP ETR IPv4 Mapping Database for LISP 0 EID-table vrf ed_vn (IID 4099), LSBs: 0x1

Entries total 1, no-route 0, inactive 0, do-not-register 2

10.47.4.3/32

, dynamic-eid red-IPv4, inherited from default locator-set rloc_691b1fe4-5264-44c2-bb1b-0903b3eb2c51

Uptime: 1w0d, Last-change: 1w0d

Domain-ID: local

Service-Insertion: N/A

Locator	Pri/Wgt	Source	State
---------	---------	--------	-------

10.47.1.13

```
10/10  cfg-intf  site-self, reachable
```

<-- Edge-2, RLOC

Map-server	Uptime	ACK	Domain-ID
10.47.1.10	1w0d	Yes	0
10.47.1.11	1w0d	Yes	0

Collocated Borders:

Both endpoints ideally are registered from a L2 LISP, L2 AR, and L3 perspective to both Fabric Control-Planes (Border-1 and Border-2). To derive the L2 LISP IID, check a Fabric Edge node and use the command **show vlan id <vlan id>**

<#root>

Edge-1#

```
show vlan id 1026
```

VLAN Name	Status	Ports
1026 red	active	

L2LI0:8190

, Gi1/0/3

<-- L2 LISP IID

VLAN Type	SAID	MTU	Parent	RingNo	BridgeNo	Stp	BrdgMode	Trans1	Trans2
1026 enet	101026	1500	-	-	-	-	-	0	0

Remote SPAN VLAN

Disabled

Primary	Secondary	Type	Ports
---------	-----------	------	-------

Utilize the L2 IID in the command **show lisp instance-id <L2 IID> ethernet server** to verify the server from a L2 LISP perspective

<#root>

Border-1#

```
show lisp instance-id 8190 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 1w3d	no yes#	--	8190	any-mac

10.47.1.12

:21038 8190

5254.0019.93e9/48 <-- RLOC of the FE node, EID prefix that was registered
 1w2d yes#

10.47.1.13

:16056 8190

5254.001e.ad00/48 <-- RLOC of the FE node, EID prefix that was registered

To verify the L2 AR server, use the command **show lisp instance-id <L2 IID> ethernet server address-resolution**

<#root>

Border-1#

show lisp instance-id 8190 ethernet server address-resolution

Address-resolution data for router lisp 0 instance-id 8190

L3 InstID	Host Address	Hardware Address
4099	10.47.4.2/32	5254.0019.93e9 <-- L3 LISP IID, Endpoint IPv4 A
4099	10.47.4.3/32	5254.001e.ad00 <-- L3 LISP IID, Endpoint IPv4 A

To verify the L3 server, use the command **show lisp instance-id <L3 IID> ipv4 server**

<#root>

Border-1#

show lisp instance-id 4099 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	--	4099	0.0.0.0/0
	6d01h	yes#	10.47.1.11:22876	4099	8.8.8.8/32
	1w0d	yes#	10.47.1.10:21610	4099	10.47.2.4/30
	1w0d	yes#	10.47.1.11:22876	4099	10.47.2.12/30
	never	no	--	4099	10.47.4.0/24
	1w0d	yes#	10.47.1.12:21038	4099	10.47.4.2/32


```

1w0d      yes#  10.47.1.13:16056  4099  10.47.4.3/32
1w0d      yes#  10.47.1.11:22876   4099  10.47.6.0/24
1w0d      yes#  10.47.1.11:22876   4099  10.47.7.0/24
1w0d      yes#  10.47.1.11:22876   4099  10.47.9.8/29
never     no    --                4099  10.47.10.0/24
1w0d      yes#  10.47.1.13:16056  4099  10.47.10.2/32

```

Control Planes have a brief history of the registration events for L3, L2, and AR entries, which can be useful when troubleshooting roaming clients or a possible loop where clients are unexpectedly registered by several Fabric Edges in a very short time.

<#root>

Border-1#

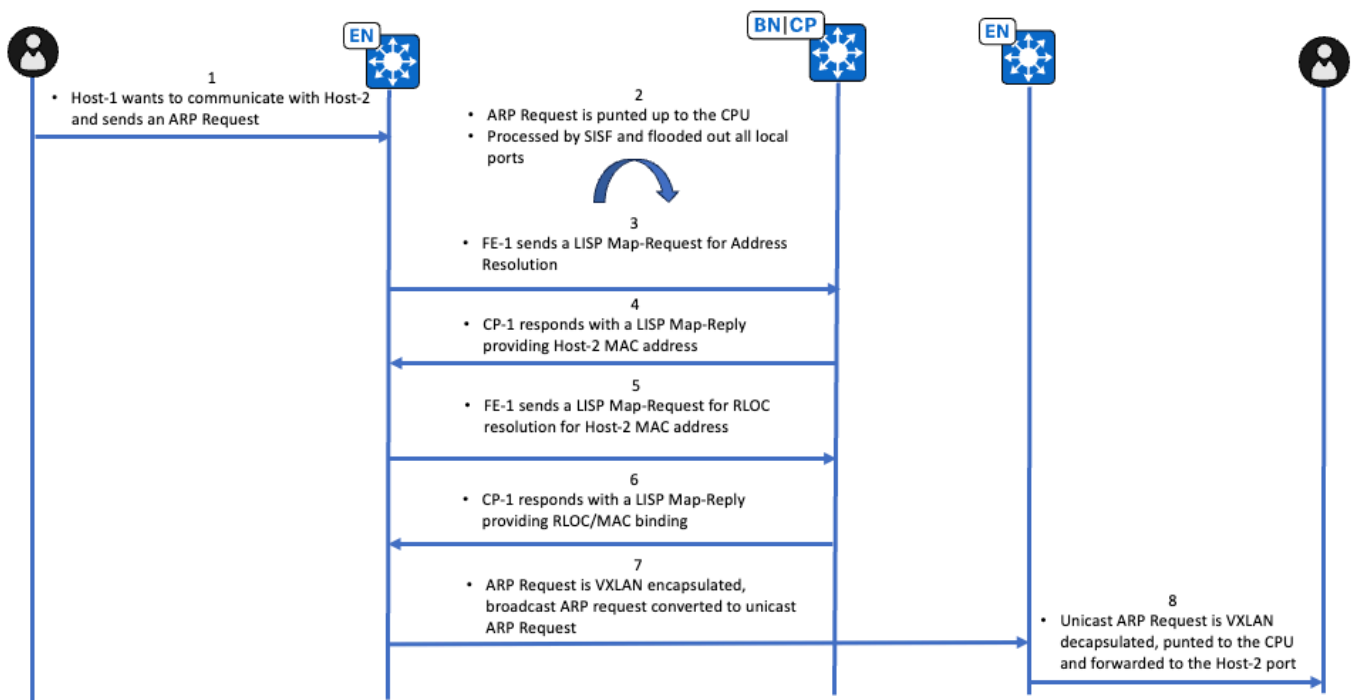
```
show lisp instance-id 8190 ethernet server resolution registration-history | include Timestamp|10.47.4.2
```

```

Timestamp (UTC)      Instance Proto Roam WLC Source
*Oct 9 19:14:39.183  8190 TCP   No   No  10.47.1.12
                        +*10.47.4.2/32 / 5254.0019.93e9 <-- Last registered at Oct 9
*Oct 9 19:14:41.183  8190 TCP   No   No  10.47.1.13
                        +*10.47.4.3/32 / 5254.001e.ad00 <-- Last registered at Oct 9

```

Unicast Path ARP Request High Level Workflow



Unicast Path ARP Request Verification

The endpoint that owns IP Address 10.47.4.2 sends a Broadcast ARP Request, confirm via an Embedded Packet Capture (EPC) on Edge-1

Edge-1 (10.47.1.12)

<#root>

Edge-1#

```
monitor capture 1 interface g1/0/3 in match any
```

Edge-1#

```
monitor capture 1 start
```

Edge-1#

```
monitor capture 1 stop
```

Capture statistics collected at software:

Capture duration - 39 seconds

Packets received - 21

Packets dropped - 0

Packets oversized - 0

Number of Bytes dropped at asic not collected

Capture buffer will exists till exported or cleared

Stopped capture point : 1

Edge-1#

```
show monitor capture 1 buffer brief
```

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

1 0.000000

52:54:00:19:93:e9 -> ff:ff:ff:ff:ff:ff ARP 60 Who has 10.47.4.3? Tell 10.47.4.

Edge-1#

```
show monitor capture 1 buffer detailed
```

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

Frame 1: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface /tmp/epc_ws/wif_to_ts_p

Interface id: 0 (/tmp/epc_ws/wif_to_ts_pipe)

Interface name: /tmp/epc_ws/wif_to_ts_pipe

Encapsulation type: Ethernet (1)

Arrival Time: Oct 19, 2023 23:43:31.893095000 UTC

[Time shift for this packet: 0.000000000 seconds]

Epoch Time: 1697759011.893095000 seconds

[Time delta from previous captured frame: 0.000000000 seconds]

[Time delta from previous displayed frame: 0.000000000 seconds]

[Time since reference or first frame: 0.000000000 seconds]

Frame Number: 1

Frame Length: 60 bytes (480 bits)

Capture Length: 60 bytes (480 bits)

```

[Frame is marked: False]
[Frame is ignored: False]
[Protocols in frame: eth:ethertype:arp]
Ethernet II, Src: 52:54:00:19:93:e9 (
52:54:00:19:93:e9
), Dst: ff:ff:ff:ff:ff:ff (
ff:ff:ff:ff:ff:ff
)
  Destination: ff:ff:ff:ff:ff:ff (ff:ff:ff:ff:ff:ff)
    Address: ff:ff:ff:ff:ff:ff (ff:ff:ff:ff:ff:ff)
      .... ..1. .... .. = LG bit: Locally administered address (this is NOT the factory d
      .... ..1. .... .. = IG bit: Group address (multicast/broadcast)
    Source: 52:54:00:19:93:e9 (52:54:00:19:93:e9)
      Address: 52:54:00:19:93:e9 (52:54:00:19:93:e9)
        .... ..1. .... .. = LG bit: Locally administered address (this is NOT the factory d
        .... ..0. .... .. = IG bit: Individual address (unicast)
    Type: ARP (0x0806)
    Padding: 00000000000000000000000000000000
Address Resolution Protocol (request)
  Hardware type: Ethernet (1)
  Protocol type: IPv4 (0x0800)
  Hardware size: 6
  Protocol size: 4
  Opcode: request (1)
  Sender MAC address: 52:54:00:19:93:e9 (
52:54:00:19:93:e9
)
  Sender IP address:
10.47.4.2
  Target MAC address: 00:00:00:00:00:00 (
00:00:00:00:00:00
)
  Target IP address:
10.47.4.3

```

This ARP Request is punted up to the CPU for further processing. Utilize the FED Punject Capture to gain additional information.

```
<#root>
```

```
Edge-1#
```

```
debug platform software fed switch active punt packet-capture set-filter "arp"
```

```
Edge-1#
```

```
debug platform software fed switch active punt packet-capture start
```

```
Edge-1#
```

```
debug platform software fed switch active punt packet-capture stop
```

Edge-1#

```
show platform software fed switch active punt packet-capture brief
```

```
Punt packet capturing: disabled. Buffer wrapping: disabled
Total captured so far: 8 packets. Capture capacity : 4096 packets
Capture filter : "arp"
```

```
----- Punt Packet Number: 1, Timestamp: 2023/10/19 23:55:03.552 -----
interface : physical: GigabitEthernet1/0/3[if-id: 0x0000000b], pa1:
GigabitEthernet1/0/3 [if-id: 0x0000000b] <-- Physical interface the ARP Request was received from
metadata : cause: 109 [snoop packets], sub-cause: 1,
q-no: 16
, linktype: MCP_LINK_TYPE_IP [1]
<-- Punted for cause snoop packets to CPU queue 16
ether hdr : dest mac:
ffff.ffff.ffff
, src mac:
5254.0019.93e9
ether hdr : ethertype:
0x0806 (ARP)
```

To see what CPU queue 16 is, use the command **show platform software fed switch active punt cpuq 16**

<#root>

Edge-1#

```
show platform software fed switch active punt cpuq 16
```

```
Punt CPU Q Statistics
```

```
=====
```

```
CPU Q Id : 16
CPU Q Name : CPU_Q_PROTO_SNOOPING
Packets received from ASIC : 49054
Send to IOSd total attempts :
```

```
49054 <-- Same number as received from ASIC
```

```
Send to IOSd failed count :
```

```
0 <-- No failures
```

Ideally there are no drops in the Proto Snooping Queue in the CPU policer (Queue 16), use the command **show platform hardware fed switch active qos queue stats internal cpu policer**

```
<#root>
```

```
Edge-1#
```

```
show platform hardware fed switch active qos queue stats internal cpu policer | include QId|Proto
```

QId	PlcIdx	Queue Name	Enabled	Rate	Rate	Drop(Bytes)	Drop(Frames)
16	12	Proto Snooping	No	2000	2000	0	0

```
<-- No drops
```

Next, the punted ARP Request is processed by Punt Service. You can see this behavior with the debug, **debug platform software infrastructure punt**

```
<#root>
```

```
Edge-1#
```

```
debug platform software infrastructure punt
```

```
*Oct 20 00:07:01.509: PUNT RX: mcprp_process_receive_packet: pak->vlan_id: 1026
```

```
*Oct 20 00:07:01.509: Punt: IP proto src 147.233.
```

```
10.47
```

```
, dst
```

```
4.2
```

```
.0.0, from table 0, intf Gi1/0/3, encap ARPA, size 60, cause snoop packets(L3)
```

```
<-- The IP address is obscured, but it is 10.47.4.2
```

```
*Oct 20 00:07:01.509: punt cause:snoop packets invoking reg_invoke_mcprp_punt_feature_msg
```

```
*Oct 20 00:07:01.509: punt cause:snoop packets MCPRP_PUNT_PAK_PROC_OK_DONE
```



Caution: This debug is chatty, use with caution.

After Punt Service processes the packet, it hands the packet to the Proto Snoop and Proto ARP snoop process. This creates an entry in the ARP snooping table and the packet is sent to Device-Tracking/SISF. To see this, **debug arp** as well as **debug platform fhs all**

```
<#root>
```

```
Edge-1#
```


```
debug arp
```

```
Edge-1#
```

```
debug platform fhs all
```

```
*Oct 20 00:12:06.908:
```

```
ARP packet received from ARP snoopers(Gi1/0/3 10.47.4.2 (5254.0019.93e9) VLAN:1026)
```

 Caution: These debugs are chatty, use with caution

Use the command **show platform arpsnooping client <MAC address>** to see what happens to the ARP request

<#root>

Edge-1#

```
show platform arpsnooping client 5254.0019.93e9
```

```
PLAT_DAI      : Platform DAI shim
FWDPLANE     : Dataplane forwarding
BRIDGE       : Packet to be bridged
ARPSN        : Arp Snooping
Packet Trace for client MAC 5254.0019.93E9:
```

Timestamp	Sender Mac	Sender IP	Target Mac	Target IP	Opcode
2023/10/24 14:37:15.045	5254.0019.93e9	10.47.4.2	0000.0000.0000	10.47.4.3	ARP_REQUEST
2023/10/24 14:37:15.045	5254.0019.93e9	10.47.4.2	0000.0000.0000	10.47.4.3	ARP_REQUEST
2023/10/24 14:37:15.045	5254.0019.93e9	10.47.4.2	0000.0000.0000	10.47.4.3	ARP_REQUEST

```
INJECT:BD_DPIDX_TO_FWDPLANE
```

As IPDT/SISF processes the packet, it verifies the contents of the ARP Request and create a temporary entry while it awaits resolution via LISP.

<#root>

Edge-1#

```
show device-tracking messages detailed 255 | i 5254.0019.93e9
```

```
[Tue Oct 24 14:37:12.000] VLAN 1026, From Gi1/0/3 seclvl [guard], MAC 5254.0019.93e9: ARP::REQ,
[Tue Oct 24 14:37:13.000] VLAN 1026, From Gi1/0/3 seclvl [guard], MAC 5254.0019.93e9: ARP::REQ,
```

If you use debug device-tracking you see that that there is an entry pointing towards 0000.0000.00fd in device-tracking. All this means is that the host behind Gi1/0/3 is querying for a host that has yet to be resolved, it is in a transient state (or permanent in case it is querying for a host that does not exist, this is not necessarily a bad thing)

<#root>

Edge-1

```
#debug device-tracking
```

```
Device-tracking - General debugging is on
*Oct 24 14:55:02.967: SISF[POL]: vlan 1026 matches vlan list on policy IPDT_POLICY for target Gi1/0/3
*Oct 24 14:55:02.967: SISF[POL]: Found matching policy IPDT_POLICY for feature Device-tracking on Gi1/0/3
```

```
*Oct 24 14:55:02.967:SISF[GLN]: Checking if ARP ownership can be taken by device-tracking
*Oct 24 14:55:02.967:SISF[GLN]: Not an ARP reply, do not take over
*Oct 24 14:55:02.967:SISF[POL]: Found matching policy LISP-AR-RELAY-VLAN for feature Address Resolution
*Oct 24 14:55:02.967: SISF[MAC]:
```

```
Creating new MAC entry for 0000.0000.00fd on interface          if none exists
```

```
*Oct 24 14:55:02.967: SISF[MAC]: Number of MAC entries in MAC-CREATING state incremented to 1
*Oct 24 14:55:02.968: SISF[BT ]: Attaching 0000.0000.00fd entry in MacAdrDB for 10.47.4.3
*Oct 24 14:55:02.968: SISF[GLN]: Binding entry event 1 for 10.47.4.3
```

SISF triggers ARP Resolution using LISP because of the LISP-AR-RELAY-VLAN policy, after this LISP Control-Plane processes can take over.

```
<#root>
```

```
Edge-1#
```

```
debug lisp control-plane all
```

```
Edge-1#
```

```
debug l2lisp all
```

```
*Oct 24 15:10:27.677: LISP Client 'SISF client':
```

```
SISF request to resolve 10.47.4.3 in Vlan 1026.
```

Edge-1 sends a LISP Map-Request to resolve the MAC address of 10.47.4.3 via the LISP Control-Plane(s)

```
<#root>
```

```
Edge-1#
```

```
debug lisp control-plane all
```

```
Edge-1#
```

```
debug l2lisp all
```

```
*Oct 24 15:10:27.681: LISP[REMT ]-0: Map Request: Delay is over for IID 8190 EID 10.47.4.3/32, requester
```

```
*Oct 24 15:10:27.681: LISP[REMT ]-0 IID 8190: Schedule processing of Map-Requests from 'remote EID pref
```

```
*Oct 24 15:10:27.681: LISP[REMT ]-0: Map Request:
```

```
Sending request for IID 8190 EID 10.47.4.3/32, requester 'AR'.
```

A bidirectional Embedded Packet Capture (EPC) done at the CPU (control-plane) of Edge-1 demonstrates the incoming ARP request and the subsequent LISP Map-Request

```
<#root>
```

```
Edge-1#
```

```
monitor capture 1 control-plane both match any
```

Edge-1#

```
monitor capture 1 start
```

Started capture point : 1

Edge-1#

```
monitor capture 1 stop
```

Edge-1#

```
show monitor capture 1 buffer display-filter "arp.dst.proto_ipv4==10.47.4.3 or lisp"
```

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

```
60 10.110293 52:54:00:19:93:e9 -> ff:ff:ff:ff:ff:ff ARP 60 Who has 10.47.4.3? Tell 10.47.4.2
61 10.111714 10.47.4.3 -> 10.47.4.3 LISP 114 Encapsulated Map-Request for Unknown LCAF Type (5
```

You can take a more detailed view of the LISP Map-Request

<#root>

Edge-1#

```
show monitor capture 1 buffer display-filter "frame.number==61" detailed
```

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

Frame 61: 114 bytes on wire (912 bits), 114 bytes captured (912 bits) on interface /tmp/epc_ws/wif_to_t

```
Interface id: 0 (/tmp/epc_ws/wif_to_ts_pipe)
Interface name: /tmp/epc_ws/wif_to_ts_pipe
Encapsulation type: Ethernet (1)
```

```
Arrival Time: Oct 24, 2023 15:20:08.948469000 UTC
[Time shift for this packet: 0.000000000 seconds]
Epoch Time: 1698160808.948469000 seconds
[Time delta from previous captured frame: 0.001421000 seconds]
[Time delta from previous displayed frame: 0.000000000 seconds]
[Time since reference or first frame: 10.111714000 seconds]
```

```
Frame Number: 61
Frame Length: 114 bytes (912 bits)
Capture Length: 114 bytes (912 bits)
[Frame is marked: False]
[Frame is ignored: False]
[Protocols in frame: eth:ethertype:ip:udp:lisp:ip:udp:lisp]
```

Ethernet II, Src: 00:00:00:00:00:00 (

00:00:00:00:00:00

), Dst: 00:00:00:00:00:00 (

00:00:00:00:00:00

)

<-- Ignore the SMAC/DMAC this is done up at the CPU, not final MAC addresses

```
Destination: 00:00:00:00:00:00 (00:00:00:00:00:00)
Address: 00:00:00:00:00:00 (00:00:00:00:00:00)
.... ..0. .... = LG bit: Globally unique address (factory default)
.... ..0. .... = IG bit: Individual address (unicast)
```



```
Source: 00:00:00:00:00:00 (00:00:00:00:00:00)
  Address: 00:00:00:00:00:00 (00:00:00:00:00:00)
    .... ..0. .... = LG bit: Globally unique address (factory default)
    .... ..0. .... = IG bit: Individual address (unicast)
Type: IPv4 (0x0800)
Internet Protocol Version 4,
Src: 10.47.1.12, Dst: 10.47.1.10 <-- Edge-1 RLOC and one of the collocated border RLOC, respectively

0100 .... = Version: 4
.... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
  1100 00.. = Differentiated Services Codepoint: Class Selector 6 (48)
  .... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
Total Length: 100
Identification: 0x599c (22940)
Flags: 0x0000
  0... .... = Reserved bit: Not set
  .0.. .... = Don't fragment: Not set
  ..0. .... = More fragments: Not set
Fragment offset: 0
Time to live: 255
Protocol: UDP (17)
Header checksum: 0x4ab9 [validation disabled]
[Header checksum status: Unverified]
Source: 10.47.1.12
Destination: 10.47.1.10
User Datagram Protocol, Src Port: 4342, Dst Port: 4342
Source Port: 4342
Destination Port: 4342
Length: 80
Checksum: 0x6393 [unverified]
[Checksum Status: Unverified]
[Stream index: 0]
[Timestamps]
  [Time since first frame: 0.000000000 seconds]
  [Time since previous frame: 0.000000000 seconds]
Locator/ID Separation Protocol
1000 .... = Type: Encapsulated Control Message (8)
.... 0... = S bit (LISP-SEC capable): Not set
.... .0.. = D bit (DDT-originated): Not set
.... ..00 0000 0000 0000 0000 0000 = Reserved bits: 0x00000000
Internet Protocol Version 4,
Src: 10.47.4.3, Dst: 10.47.4.3
```

<-- MAP Request to resolve the MAC address tied to 10.47.4.3

```
0100 .... = Version: 4
.... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
  1100 00.. = Differentiated Services Codepoint: Class Selector 6 (48)
  .... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
Total Length: 68
Identification: 0x599b (22939)
Flags: 0x0000
  0... .... = Reserved bit: Not set
  .0.. .... = Don't fragment: Not set
  ..0. .... = More fragments: Not set
Fragment offset: 0
Time to live: 255
Protocol: UDP (17)
```

```

Header checksum: 0x44ea [validation disabled]
[Header checksum status: Unverified]
Source: 10.47.4.3
Destination: 10.47.4.3
User Datagram Protocol, Src Port: 4342, Dst Port: 4342
Source Port: 4342
Destination Port: 4342
Length: 48
Checksum: 0x9622 [unverified]
[Checksum Status: Unverified]
[Stream index: 1]
[Timestamps]
  [Time since first frame: 0.000000000 seconds]
  [Time since previous frame: 0.000000000 seconds]
Locator/ID Separation Protocol
0001 .... = Type: Map-Request (1)
.... 0000 00.. = Flags: 0x00
  .... 0... = A bit (Authoritative): Not set
  .... .0.. = M bit (Map-Reply present): Not set
  .... ..0. = P bit (Probe): Not set
  .... ...0 = S bit (Solicit-Map-Request): Not set
  .... .... 0... = p bit (Proxy ITR): Not set
  .... .... ..0.. = s bit (SMR-invoked): Not set
  .... .... ..00 0000 000. = Reserved bits: 0x000
  .... .... .... ..0 0000 = ITR-RLOC Count: 0
Record Count: 1
Nonce: 0xcffee30fb39a05b7
Source EID AFI: Reserved (0)
Source EID: not set
ITR-RLOC 1: 10.47.1.12
  ITR-RLOC AFI: IPv4 (1)
  ITR-RLOC Address: 10.47.1.12
Map-Request Record 1: Unknown LCAF Type (53)/32
  Reserved: 0x00
  Prefix Length: 32
  Prefix AFI: LISP Canonical Address Format (LCAF) (16387)
  Prefix: Unknown LCAF Type (53)
    LCAF: Unknown (53)
      LCAF Header: 00003520000a
        Reserved bits: 0x00
        Flags: 0x00
        Type: Unknown (53)
        Reserved bits: 0x20
        Length: 10
      [Expert Info (Error/Protocol): LCAF type 53 is not defined in draft-ietf-lisp-lcaf-05]
      [LCAF type 53 is not defined in draft-ietf-lisp-lcaf-05]
      [Severity level: Error]
      [Group: Protocol]

```

Collocated Border(s) (10.47.1.10 and 10.47.1.11)

Next, the LISP Control-Plane responds to Edge-1 with a LISP Map-Reply. This can be seen in debugs as well as CPU EPC.

```
<#root>
```

```
Border-2#
```

```
show monitor capture 1 buffer display-filter lisp
```

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

```
113 12.767420 10.47.4.3 -> 10.47.4.3 LISP 114 Encapsulated Map-Request for Unknown LCAF Type (5)
114 12.774428 10.47.1.11 -> 10.47.1.12 LISP 96 Map-Reply for Unknown LCAF Type (53)/32
```

As we look at the packets in more detail, we can see the LISP Map-Request and the subsequent LISP Map-Reply

<#root>

Border-2#

```
show monitor capture 1 buffer display-filter frame.number==113 detailed
```

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

Frame 113: 114 bytes on wire (912 bits), 114 bytes captured (912 bits) on interface /tmp/epc_ws/wif_to_

```
Interface id: 0 (/tmp/epc_ws/wif_to_ts_pipe)
Interface name: /tmp/epc_ws/wif_to_ts_pipe
```

```
Encapsulation type: Ethernet (1)
```

```
Arrival Time: Oct 24, 2023 15:41:06.566253000 UTC
```

```
[Time shift for this packet: 0.000000000 seconds]
```

```
Epoch Time: 1698162066.566253000 seconds
```

```
[Time delta from previous captured frame: 0.013424000 seconds]
```

```
[Time delta from previous displayed frame: 0.000000000 seconds]
```

```
[Time since reference or first frame: 12.767420000 seconds]
```

```
Frame Number: 113
```

```
Frame Length: 114 bytes (912 bits)
```

```
Capture Length: 114 bytes (912 bits)
```

```
[Frame is marked: False]
```

```
[Frame is ignored: False]
```

```
[Protocols in frame: eth:ethertype:ip:udp:lisp:ip:udp:lisp]
```

```
Ethernet II, Src: 52:54:00:04:84:a3 (
```

```
52:54:00:04:84:a3
```

```
), Dst: 52:54:00:1c:7d:e0 (
```

```
52:54:00:1c:7d:e0
```

```
)
```

```
<-- True MAC addresses
```

```
Destination: 52:54:00:1c:7d:e0 (52:54:00:1c:7d:e0)
```

```
Address: 52:54:00:1c:7d:e0 (52:54:00:1c:7d:e0)
```

```
.... ..1. .... = LG bit: Locally administered address (this is NOT the factory d
```

```
.... ..0 .... = IG bit: Individual address (unicast)
```

```
Source: 52:54:00:04:84:a3 (52:54:00:04:84:a3)
```

```
Address: 52:54:00:04:84:a3 (52:54:00:04:84:a3)
```

```
.... ..1. .... = LG bit: Locally administered address (this is NOT the factory d
```

```
.... ..0 .... = IG bit: Individual address (unicast)
```

```
Type: IPv4 (0x0800)
```

```
Internet Protocol Version 4,
```

```
Src: 10.47.1.12, Dst: 10.47.1.11 <-- Edge-1 RLOC and Border-2 RLOC, respectively
```

```
0100 .... = Version: 4
```

```
.... 0101 = Header Length: 20 bytes (5)
```

```
Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
```

```
1100 00.. = Differentiated Services Codepoint: Class Selector 6 (48)
```

```
.... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
Total Length: 100
Identification: 0x5e19 (24089)
Flags: 0x0000
  0... .. = Reserved bit: Not set
  .0.. .. = Don't fragment: Not set
  ..0. .. = More fragments: Not set
Fragment offset: 0
Time to live: 255
Protocol: UDP (17)
Header checksum: 0x463b [validation disabled]
[Header checksum status: Unverified]
Source: 10.47.1.12
Destination: 10.47.1.11
User Datagram Protocol, Src Port: 4342, Dst Port: 4342
Source Port: 4342
Destination Port: 4342
Length: 80
Checksum: 0x6392 [unverified]
[Checksum Status: Unverified]
[Stream index: 1]
[Timestamps]
  [Time since first frame: 0.000000000 seconds]
  [Time since previous frame: 0.000000000 seconds]
Locator/ID Separation Protocol
1000 .... = Type: Encapsulated Control Message (8)
.... 0... = S bit (LISP-SEC capable): Not set
.... .0.. = D bit (DDT-originated): Not set
.... ..00 0000 0000 0000 0000 0000 0000 = Reserved bits: 0x00000000
Internet Protocol Version 4,
Src: 10.47.4.3, Dst: 10.47.4.3 <-- LISP MAP Request for 10.47.4.3

0100 .... = Version: 4
.... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
  1100 00.. = Differentiated Services Codepoint: Class Selector 6 (48)
  .... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
Total Length: 68
Identification: 0x5e18 (24088)
Flags: 0x0000
  0... .. = Reserved bit: Not set
  .0.. .. = Don't fragment: Not set
  ..0. .. = More fragments: Not set
Fragment offset: 0
Time to live: 255
Protocol: UDP (17)
Header checksum: 0x406d [validation disabled]
[Header checksum status: Unverified]
Source: 10.47.4.3
Destination: 10.47.4.3
User Datagram Protocol, Src Port: 4342, Dst Port: 4342
Source Port: 4342
Destination Port: 4342
Length: 48
Checksum: 0xe9a8 [unverified]
[Checksum Status: Unverified]
[Stream index: 2]
[Timestamps]
  [Time since first frame: 0.000000000 seconds]
  [Time since previous frame: 0.000000000 seconds]
Locator/ID Separation Protocol
0001 .... = Type: Map-Request (1)
```

```

.... 0000 00.. .... .... = Flags: 0x00
.... 0... .... .... = A bit (Authoritative): Not set
.... .0.. .... .... = M bit (Map-Reply present): Not set
.... ..0. .... .... = P bit (Probe): Not set
.... ...0 .... .... = S bit (Solicit-Map-Request): Not set
.... .... 0... .... = p bit (Proxy ITR): Not set
.... .... .0.. .... = s bit (SMR-invoked): Not set
.... .... ..00 0000 000. .... = Reserved bits: 0x0000
.... .... .... ..0 0000 = ITR-RLLOC Count: 0
Record Count: 1
Nonce: 0x50c5f2b60b41ca1c
Source EID AFI: Reserved (0)
Source EID: not set
ITR-RLLOC 1: 10.47.1.12
    ITR-RLLOC AFI: IPv4 (1)
    ITR-RLLOC Address: 10.47.1.12
Map-Request Record 1: Unknown LCAF Type (53)/32
    Reserved: 0x00
    Prefix Length: 32
    Prefix AFI: LISP Canonical Address Format (LCAF) (16387)
    Prefix: Unknown LCAF Type (53)
        LCAF: Unknown (53)
            LCAF Header: 00003520000a
                Reserved bits: 0x00
                Flags: 0x00
                Type: Unknown (53)
                Reserved bits: 0x20
                Length: 10
            [Expert Info (Error/Protocol): LCAF type 53 is not defined in draft-ietf-lisp-lcaf-05]
            [LCAF type 53 is not defined in draft-ietf-lisp-lcaf-05]
            [Severity level: Error]
            [Group: Protocol]

```

We can also look at the LISP Map-Reply that is sent back

<#root>

Border-2#

```
show monitor capture 1 buffer display-filter frame.number==114 detailed
```

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

```

Frame 114: 96 bytes on wire (768 bits), 96 bytes captured (768 bits) on interface /tmp/epc_ws/wif_to_ts
  Interface id: 0 (/tmp/epc_ws/wif_to_ts_pipe)
    Interface name: /tmp/epc_ws/wif_to_ts_pipe
  Encapsulation type: Ethernet (1)
  Arrival Time: Oct 24, 2023 15:41:06.573261000 UTC
  [Time shift for this packet: 0.000000000 seconds]
  Epoch Time: 1698162066.573261000 seconds
  [Time delta from previous captured frame: 0.007008000 seconds]
  [Time delta from previous displayed frame: 0.000000000 seconds]
  [Time since reference or first frame: 12.774428000 seconds]
  Frame Number: 114
  Frame Length: 96 bytes (768 bits)
  Capture Length: 96 bytes (768 bits)
  [Frame is marked: False]
  [Frame is ignored: False]
  [Protocols in frame: eth:ethertype:ip:udp:lisp]

```

Ethernet II, Src: 00:00:00:00:00:00 (
00:00:00:00:00:00
), Dst: 00:00:00:00:00:00 (
00:00:00:00:00:00
)

<-- CPU Inject does not properly show MAC addresses

Destination: 00:00:00:00:00:00 (00:00:00:00:00:00)
Address: 00:00:00:00:00:00 (00:00:00:00:00:00)
.... ..0. = LG bit: Globally unique address (factory default)
.... ...0 = IG bit: Individual address (unicast)
Source: 00:00:00:00:00:00 (00:00:00:00:00:00)
Address: 00:00:00:00:00:00 (00:00:00:00:00:00)
.... ..0. = LG bit: Globally unique address (factory default)
.... ...0 = IG bit: Individual address (unicast)

Type: IPv4 (0x0800)

Internet Protocol Version 4,

Src: 10.47.1.11, Dst: 10.47.1.12 <-- Border-2 RLOC and Edge-1 RLOC, respectively

0100 = Version: 4
.... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
1100 00.. = Differentiated Services Codepoint: Class Selector 6 (48)
.... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
Total Length: 82
Identification: 0xe231 (57905)
Flags: 0x0000
0... = Reserved bit: Not set
.0.. = Don't fragment: Not set
..0. = More fragments: Not set
Fragment offset: 0
Time to live: 255
Protocol: UDP (17)
Header checksum: 0xc234 [validation disabled]
[Header checksum status: Unverified]
Source: 10.47.1.11
Destination: 10.47.1.12

User Datagram Protocol, Src Port: 4342, Dst Port: 4342

Source Port: 4342
Destination Port: 4342
Length: 62
Checksum: 0xe1d6 [unverified]
[Checksum Status: Unverified]
[Stream index: 1]
[Timestamps]
[Time since first frame: 0.007008000 seconds]
[Time since previous frame: 0.007008000 seconds]

Locator/ID Separation Protocol

0010 = Type: Map-Reply (2)
.... 0... = P bit (Probe): Not set
.... .0.. = E bit (Echo-Nonce locator reachability algorithm enabled): Not set
.... ..0. = S bit (LISP-SEC capable): Not set
.... ...0 0000 0000 0000 0000 = Reserved bits: 0x00000
Record Count: 1
Nonce: 0x50c5f2b60b41ca1c
Mapping Record 1, EID Prefix: Unknown LCAF Type (53)/32, TTL: 1440, Action: No-Action, Not Authorit
Record TTL: 1440

```

Locator Count: 1
EID Mask Length: 32
000. .... .... = Action: No-Action (0)
...0 .... .... = Authoritative bit: Not set
.... .000 0000 0000 = Reserved: 0x000
0000 .... .... = Reserved: 0x0
.... 0000 0000 0000 = Mapping Version: 0
EID Prefix AFI: LISP Canonical Address Format (LCAF) (16387)
EID Prefix: Unknown LCAF Type (53)
  LCAF: Unknown (53)
    LCAF Header: 00003520000a
      Reserved bits: 0x00
      Flags: 0x00
      Type: Unknown (53)
      Reserved bits: 0x20
      Length: 10
    [Expert Info (Error/Protocol): LCAF type 53 is not defined in draft-ietf-lisp-lcaf-05]
    [LCAF type 53 is not defined in draft-ietf-lisp-lcaf-05]
    [Severity level: Error]
    [Group: Protocol]
Locator Record 1, RLOC: 52:54:00:1e:ad:00, Unreachable, Priority/Weight: 1/100, Multicast Priority
  Priority: 1
  Weight: 100
  Multicast Priority: 1
  Multicast Weight: 100
  Flags: 0x0000
    0000 0000 0000 0... = Reserved: 0x0000
    .... .... .... .0.. = Local: Not set
    .... .... .... ..0. = Probe: Not set
    .... .... .... ...0 = Reachable: Not set
  AFI: 802 (includes all 802 media plus Ethernet) (6)
  Locator: 52:54:00:1e:ad:00

```

<#root>

Border-2#

```
debug lisp control-plane all
```

All LISP control debugging is on at verbose level

Border-2#

```
debug l2lisp all
```

All L2Lisp debugging is on

```
*Oct 24 16:02:17.854: LISP[TRNSP]-0: Processing received Encap-Control(8) message on GigabitEthernet1/0/3
```

```
*Oct 24 16:02:17.854: LISP[TRNSP]-0: Processing received Map-Request(1) message on GigabitEthernet1/0/3
```

```
*Oct 24 16:02:17.855: LISP[MR ]-0: Received Map-Request with 1 records, first EID IID 8190 10.47.4.3/
```

```
*Oct 24 16:02:17.855: LISP[MR ]-0 IID 8190
```

```
Eth-ARP: MS EID 10.47.4.3/32: Sending proxy reply to 10.47.1.12.
```

Now that Edge-1 has received a LISP Map-Reply for the Address Resolution (AR) Request saying that 10.47.4.3 is 5254.001e.ad00, Edge-1 generates another LISP Map-Request to determine the RLOC for the endpoint MAC Address

<#root>

Edge-1#

```
debug lisp control-plane all
```

Edge-1#

```
debug l2lisp all
```

```
*Oct 24 16:19:54.843: LISP[REMT ]-0: Received Map-Reply with nonce 0x37F890B9-0xAC60D2B9, 1 records.
```

```
*Oct 24 16:19:54.843: LISP[MS ]-0: This is a Address Resolution message.
```

```
*Oct 24 16:19:54.843: LISP[REMT ]-0: Map-Reply nonce matches pending request for IID 8190 EID 10.47.4.3.
```

```
*Oct 24 16:19:54.843: LISP[REMT ]-0:
```

```
Processing Map-Reply mapping record for IID 8190 Eth-ARP 10.47.4.3/32 LCAF 53, ttl 1440, action none, no
```

```
*Oct 24 16:19:54.843: LISP[REMT ]-0:
```

```
5254.001e.ad00 pri/wei/dID/mID/met/si_type/si_id/si_flg/afn_id=1/100/0/0/4294967295/none/0/UNSPEC/UNSPEC
```

<snip>

```
*Oct 24 17:11:24.056: LISP[REMT ]-0 IID 8190: Schedule processing of Map-Requests from 'remote EID pref
```

```
*Oct 24 17:11:24.056: LISP[REMT ]-0:
```

```
Map Request: Sending request for IID 8190 EID 5254.001e.ad00/48, requester 'remote EID prefix'..>
```

LISP Control-Plane receives the LISP Map-Request, which is for the MAC address of 10.47.4.3, consults the Ethernet server table for L2 LISP IID 8190 and send a LISP Map-Reply with the MAC-RLOC binding

<#root>

Border-1#

```
show monitor capture 1 buff display-filter lisp brief
```

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

```
250 28.656076 0.0.0.0 -> 0.0.0.0 LISP 176 Encapsulated Map-Request for [8190] 52:54:00:1e:
```

```
251 28.658851
```

```
10.47.1.10 -> 10.47.1.12 LISP 96 Map-Reply for [8190] 52:54:00:1e:ad:00/48
```

We can take a closer look at the LISP Map-Request and Map-Reply

<#root>

Border-1#

```
show monitor capture 1 buffer display-filter frame.number==250 detailed
```

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

```
Frame 250: 176 bytes on wire (1408 bits), 176 bytes captured (1408 bits) on interface /tmp/epc_ws/wif_t
```

```
Interface id: 0 (/tmp/epc_ws/wif_to_ts_pipe)
```

```
Interface name: /tmp/epc_ws/wif_to_ts_pipe
```

```
Encapsulation type: Ethernet (1)
```

```
Arrival Time: Oct 24, 2023 17:37:11.647755000 UTC
```

```
[Time shift for this packet: 0.000000000 seconds]
```

```
Epoch Time: 1698169031.647755000 seconds
```



```

[Time delta from previous captured frame: 0.315724000 seconds]
[Time delta from previous displayed frame: 0.000000000 seconds]
[Time since reference or first frame: 28.656076000 seconds]
Frame Number: 250
Frame Length: 176 bytes (1408 bits)
Capture Length: 176 bytes (1408 bits)
[Frame is marked: False]
[Frame is ignored: False]
[Protocols in frame: eth:ethertype:ip:udp:lisp:ip:udp:lisp]
Ethernet II, Src: 52:54:00:04:84:b1 (52:54:00:04:84:b1), Dst: 52:54:00:0a:42:f3 (52:54:00:0a:42:f3)
  Destination: 52:54:00:0a:42:f3 (52:54:00:0a:42:f3)
    Address: 52:54:00:0a:42:f3 (52:54:00:0a:42:f3)
      .... ..1. .... = LG bit: Locally administered address (this is NOT the factory default)
      .... ..0. .... = IG bit: Individual address (unicast)
  Source: 52:54:00:04:84:b1 (52:54:00:04:84:b1)
    Address: 52:54:00:04:84:b1 (52:54:00:04:84:b1)
      .... ..1. .... = LG bit: Locally administered address (this is NOT the factory default)
      .... ..0. .... = IG bit: Individual address (unicast)
  Type: IPv4 (0x0800)
Internet Protocol Version 4, Src: 10.47.1.12, Dst: 10.47.1.10 <-- Edge-1 RLOC and Border-1 RLOC, respectively

  0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
    1100 00.. = Differentiated Services Codepoint: Class Selector 6 (48)
    .... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
  Total Length: 162
  Identification: 0x75e5 (30181)
  Flags: 0x0000
    0... .... = Reserved bit: Not set
    .0.. .... = Don't fragment: Not set
    ..0. .... = More fragments: Not set
  Fragment offset: 0
  Time to live: 255
  Protocol: UDP (17)
  Header checksum: 0x2e32 [validation disabled]
  [Header checksum status: Unverified]
  Source: 10.47.1.12
  Destination: 10.47.1.10
User Datagram Protocol, Src Port: 4342, Dst Port: 4342
  Source Port: 4342
  Destination Port: 4342
  Length: 142
  Checksum: 0x46f1 [unverified]
  [Checksum Status: Unverified]
  [Stream index: 4]
  [Timestamps]
    [Time since first frame: 0.000000000 seconds]
    [Time since previous frame: 0.000000000 seconds]
Locator/ID Separation Protocol
  1000 .... = Type: Encapsulated Control Message (8)
  .... 0... = S bit (LISP-SEC capable): Not set
  .... .0.. = D bit (DDT-originated): Not set
  .... ..00 0000 0000 0000 0000 0000 0000 = Reserved bits: 0x00000000
Internet Protocol Version 4, Src: 0.0.0.0, Dst: 0.0.0.0
  0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
    1100 00.. = Differentiated Services Codepoint: Class Selector 6 (48)
    .... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)

```

```

Total Length: 130
Identification: 0x75e4 (30180)
Flags: 0x0000
  0... .. = Reserved bit: Not set
  .0.. .. = Don't fragment: Not set
  ..0. .. = More fragments: Not set
Fragment offset: 0
Time to live: 255
Protocol: UDP (17)
Header checksum: 0x44c7 [validation disabled]
[Header checksum status: Unverified]
Source: 0.0.0.0
Destination: 0.0.0.0
User Datagram Protocol, Src Port: 4342, Dst Port: 4342
Source Port: 4342
Destination Port: 4342
Length: 110
Checksum: 0x18bb [unverified]
[Checksum Status: Unverified]
[Stream index: 5]
[Timestamps]
  [Time since first frame: 0.000000000 seconds]
  [Time since previous frame: 0.000000000 seconds]
Locator/ID Separation Protocol
0001 .... = Type: Map-Request (1)
.... 0100 00.. = Flags: 0x10
.... 0... = A bit (Authoritative): Not set
.... .1.. = M bit (Map-Reply present): Set
.... ..0. = P bit (Probe): Not set
.... ...0 = S bit (Solicit-Map-Request): Not set
.... .... 0... = p bit (Proxy ITR): Not set
.... .... .0.. = s bit (SMR-invoked): Not set
.... .... ..00 0000 000. = Reserved bits: 0x000
.... .... .... .0 0000 = ITR-RLoc Count: 0
Record Count: 1
Nonce: 0x86438e956066d3ca
Source EID AFI: LISP Canonical Address Format (LCAF) (16387)
Source EID: [8190] 00:00:0c:9f:f3:41
  LCAF: Instance ID: 8190, Address: 00:00:0c:9f:f3:41
    LCAF Header: 00000220000c
      Reserved bits: 0x00
      Flags: 0x00
      Type: Instance ID (2)
      Reserved bits: 0x20
      Length: 12
      Instance ID: 8190
      Address AFI: 802 (includes all 802 media plus Ethernet) (6)
      Address: 00:00:0c:9f:f3:41 (00:00:0c:9f:f3:41)
ITR-RLoc 1: 10.47.1.12
  ITR-RLoc AFI: IPv4 (1)
  ITR-RLoc Address: 10.47.1.12
Map-Request Record 1: [8190]

```

52:54:00:1e:ad:00/48 <-- Map-Request for this specific MAC address

```

Reserved: 0x00
Prefix Length: 48
Prefix AFI: LISP Canonical Address Format (LCAF) (16387)
Prefix: [8190] 52:54:00:1e:ad:00
  LCAF: Instance ID: 8190, Address: 52:54:00:1e:ad:00
    LCAF Header: 00000220000c
      Reserved bits: 0x00

```

Flags: 0x00
Type: Instance ID (2)
Reserved bits: 0x20
Length: 12
Instance ID: 8190
Address AFI: 802 (includes all 802 media plus Ethernet) (6)
Address: 52:54:00:1e:ad:00 (52:54:00:1e:ad:00)

Map-Reply Record

Mapping Record 1, EID Prefix: [8190] 00:00:0c:9f:f3:41/48, TTL: 1440, Action: No-Action, Author

Record TTL: 1440
Locator Count: 1
EID Mask Length: 48
000. = Action: No-Action (0)
...1 = Authoritative bit: Set
.... .000 0000 0000 = Reserved: 0x000
0000 = Reserved: 0x0
.... 0000 0000 0000 = Mapping Version: 0
EID Prefix AFI: LISP Canonical Address Format (LCAF) (16387)
EID Prefix: [8190] 00:00:0c:9f:f3:41
LCAF: Instance ID: 8190, Address: 00:00:0c:9f:f3:41
LCAF Header: 00000220000c
Reserved bits: 0x00
Flags: 0x00
Type: Instance ID (2)
Reserved bits: 0x20
Length: 12
Instance ID: 8190
Address AFI: 802 (includes all 802 media plus Ethernet) (6)
Address: 00:00:0c:9f:f3:41 (00:00:0c:9f:f3:41)

Locator Record 1, Local RLOC: 10.47.1.12, Reachable, Priority/Weight: 10/10, Multicast Prio

Priority: 10
Weight: 10
Multicast Priority: 10
Multicast Weight: 10
Flags: 0x0005
0000 0000 0000 0... = Reserved: 0x0000
....1.. = Local: Set
....0. = Probe: Not set
....1 = Reachable: Set
AFI: IPv4 (1)
Locator: 10.47.1.12

<#root>

Border-1#

show monitor capture 1 buffer display-filter frame.number==251 detailed

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

Frame 251: 96 bytes on wire (768 bits), 96 bytes captured (768 bits) on interface /tmp/epc_ws/wif_to_ts

Interface id: 0 (/tmp/epc_ws/wif_to_ts_pipe)
Interface name: /tmp/epc_ws/wif_to_ts_pipe
Encapsulation type: Ethernet (1)
Arrival Time: Oct 24, 2023 17:37:11.650530000 UTC
[Time shift for this packet: 0.000000000 seconds]
Epoch Time: 1698169031.650530000 seconds
[Time delta from previous captured frame: 0.002775000 seconds]
[Time delta from previous displayed frame: 0.000000000 seconds]
[Time since reference or first frame: 28.658851000 seconds]

Frame Number: 251
Frame Length: 96 bytes (768 bits)
Capture Length: 96 bytes (768 bits)
[Frame is marked: False]
[Frame is ignored: False]
[Protocols in frame: eth:ethertype:ip:udp:lisp]
Ethernet II, Src: 00:00:00:00:00:00 (00:00:00:00:00:00), Dst: 00:00:00:00:00:00 (00:00:00:00:00:00)
Destination: 00:00:00:00:00:00 (00:00:00:00:00:00)
Address: 00:00:00:00:00:00 (00:00:00:00:00:00)
.... ..0. = LG bit: Globally unique address (factory default)
.... ...0 = IG bit: Individual address (unicast)
Source: 00:00:00:00:00:00 (00:00:00:00:00:00)
Address: 00:00:00:00:00:00 (00:00:00:00:00:00)
.... ..0. = LG bit: Globally unique address (factory default)
.... ...0 = IG bit: Individual address (unicast)
Type: IPv4 (0x0800)
Internet Protocol Version 4,

Src: 10.47.1.10, Dst: 10.47.1.12 <-- Border-1 RLOC, Edge-1 RLOC, respectively

0100 = Version: 4
.... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0xc0 (DSCP: CS6, ECN: Not-ECT)
1100 00.. = Differentiated Services Codepoint: Class Selector 6 (48)
.... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
Total Length: 82
Identification: 0x12a9 (4777)
Flags: 0x0000
0... = Reserved bit: Not set
.0.. = Don't fragment: Not set
..0. = More fragments: Not set
Fragment offset: 0
Time to live: 255
Protocol: UDP (17)
Header checksum: 0x91be [validation disabled]
[Header checksum status: Unverified]
Source: 10.47.1.10
Destination: 10.47.1.12
User Datagram Protocol, Src Port: 4342, Dst Port: 4342
Source Port: 4342
Destination Port: 4342
Length: 62
Checksum: 0xd63e [unverified]
[Checksum Status: Unverified]
[Stream index: 4]
[Timestamps]
[Time since first frame: 0.002775000 seconds]
[Time since previous frame: 0.002775000 seconds]
Locator/ID Separation Protocol
0010 = Type: Map-Reply (2)
.... 0... = P bit (Probe): Not set
.... .0.. = E bit (Echo-Nonce locator reachability algorithm enabled): Not set
.... ..0. = S bit (LISP-SEC capable): Not set
.... ...0 0000 0000 0000 0000 = Reserved bits: 0x000000
Record Count: 1
Nonce: 0x86438e956066d3ca
Mapping Record 1, EID Prefix: [8190] 52:54:00:1e:ad:00/48, TTL: 1440, Action: No-Action, Not Author
Record TTL: 1440
Locator Count: 1
EID Mask Length: 48
000. = Action: No-Action (0)
...0 = Authoritative bit: Not set
.... .000 0000 0000 = Reserved: 0x0000

```

0000 .... .... .... = Reserved: 0x0
.... 0000 0000 0000 = Mapping Version: 0
EID Prefix AFI: LISP Canonical Address Format (LCAF) (16387)
EID Prefix: [8190] 52:54:00:1e:ad:00
  LCAF: Instance ID: 8190, Address: 52:54:00:1e:ad:00
    LCAF Header: 00000220000c
      Reserved bits: 0x00
      Flags: 0x00
      Type: Instance ID (2)
      Reserved bits: 0x20
      Length: 12
      Instance ID: 8190
      Address AFI: 802 (includes all 802 media plus Ethernet) (6)
      Address: 52:54:00:1e:ad:00 (52:54:00:1e:ad:00)
Locator Record 1, RLOC: 10.47.1.13, Reachable, Priority/Weight: 10/10, Multicast Priority/Weight:
  Priority: 10
  Weight: 10
  Multicast Priority: 10
  Multicast Weight: 10
  Flags: 0x0001
    0000 0000 0000 0... = Reserved: 0x0000
    .... .... .... .0.. = Local: Not set
    .... .... .... ..0. = Probe: Not set
    .... .... .... ...1 = Reachable: Set
  AFI: IPv4 (1)

```

Locator: 10.47.1.13 <-- This RLOC owns the MAC address

<#root>

Border-1#

```
debug lisp control-plane all
```

Border-1#

```
debug l2lisp all
```

```
*Oct 24 18:03:00.361: LISP[TRNSP]-0: Processing received Map-Request(1) message on GigabitEthernet1/0/3
```

```
*Oct 24 18:03:00.361: LISP[MR ]-0: Received Map-Request with 1 records, first EID IID 8190 5254.001e.
```

```
*Oct 24 18:03:00.361: LISP[MR ]-0
```

```
IID 8190 MAC: MS EID 5254.001e.ad00/48: Sending proxy reply to 10.47.1.12.
```

Edge-1 receives the LISP Map-Reply from Border-1

<#root>

Edge-1#

```
debug lisp control-plane all
```

Edge-1#

debug l2lisp all

```
*Oct 24 17:11:24.558: LISP[TRNSP]-0: Processing received Map-Reply(2) message on GigabitEthernet1/0/1 f
*Oct 24 17:11:24.558: LISP[REMT ]-0: Received Map-Reply with nonce 0x38A78BA8-0xC378149D, 1 records.
*Oct 24 17:11:24.558: LISP[REMT ]-0: Map-Reply nonce matches pending request for IID 8190 EID 5254.001e
*Oct 24 17:11:24.558: LISP[REMT ]-0:
```

Processing Map-Reply mapping record for IID 8190 MAC 5254.001e.ad00/48 LCAF 2, ttl 1440, action none, no

```
*Oct 24 17:11:24.559: LISP[REMT ]-0:
```

10.47.1.13

pri/wei/dID/mID/met/si_type/si_id/si_flg/afn_id=10/10/0/0/4294967295/none/0/UNSPEC/UNSPEC 1pR.

The entire ARP Request through LISP/SISF exchange can be viewed on Edge-1 via CPU EPC

<#root>

Edge-1#

show monitor capture 1 buffer display-filter "arp.dst.proto_ipv4==10.47.4.3 or lisp"

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

120 18.415474 52:54:00:19:93:e9 -> ff:ff:ff:ff:ff:ff ARP 60 Who has 10.47.4.3? Tell 10.47.4.2

<-- Broadcast ARP Request punted up to the CPU

121 18.416092 10.47.4.3 -> 10.47.4.3 LISP 114 Encapsulated Map-Request for Unknown LCAF Type (

<-- LISP Map-Request to obtain the MAC address of 10.47.4.3

135 19.598041 10.47.1.11 -> 10.47.1.12 LISP 96 Map-Reply for Unknown LCAF Type (53)/32

<-- LISP Map-Reply providing the MAC address of 10.47.4.3

136 19.613072 0.0.0.0 -> 0.0.0.0 LISP 176 Encapsulated Map-Request for [8190] 52:54:00:1e:

<-- LISP Map-Request to obtain the RLOC for MAC address 5254.001e.ad00

138 20.119722 10.47.1.10 -> 10.47.1.12 LISP 96 Map-Reply for [8190] 52:54:00:1e:ad:00/48

<-- LISP Map-Reply for the RLOC that owns MAC address 5254.001e.ad00

143 20.477618 52:54:00:19:93:e9 -> 52:54:00:1e:ad:00 ARP 60 Who has 10.47.4.3? Tell 10.47.4.2

<-- Unicast ARP Request injected down from the CPU

Once the control-plane on Edge-1 has converged, there is a map-cache entry as well as a SISF Remote Entry (RMT)

<#root>

Edge-1#

```
show lisp instance-id 8190 ethernet map-cache 5254.001e.ad00
```

```
LISP MAC Mapping Cache for LISP 0 EID-table Vlan 1026 (IID 8190), 1 entries
```

```
5254.001e.ad00/48
```

```
, uptime: 00:06:26, expires: 23:53:34, via map-reply, complete
Sources: map-reply
State: complete, last modified: 00:06:26, map-source: 10.47.1.13
Active, Packets out: 11(0 bytes), counters are not accurate (~ 00:00:00 ago)
Encapsulating dynamic-EID traffic
Locator      Uptime      State      Pri/Wgt      Encap-IID
```

```
10.47.1.13
```

```
00:06:26 up      10/10      -
Last up-down state change:      00:06:26, state change count: 1
Last route reachability change: 2w0d, state change count: 1
Last priority / weight change:  never/never
RLOC-probing loc-status algorithm:
Last RLOC-probe sent:           00:06:25 (rtt 1104ms)
```

```
Edge-1#
```

```
show device-tracking database address 10.47.4.3
```

```
Codes: L - Local, S - Static, ND - Neighbor Discovery, ARP - Address Resolution Protocol, DH4 - IPv4 DHCP
Preflevel flags (prlvl):
```

```
0001:MAC and LLA match      0002:Orig trunk      0004:Orig access
0008:Orig trusted trunk    0010:Orig trusted access  0020:DHCP assigned
0040:Cga authenticated     0080:Cert authenticated  0100:Statically assigned
```

```
Network Layer Address      Link Layer Address      Interface  vlan      prlvl      ag
```

```
RMT
```

```
10.47.4.3
```

```
5254.001e.ad00
```

```
L2LI0      1026      0005      7mn      STALE      try 0 731 s
```

Next, the unicast ARP Request is injected down from the CPU. Remember, CPU injected packets cannot be captured in the egress direction with EPC on physical interfaces, Switchport Port Analyzer (SPAN) or an ingress EPC on the receiving Fabric Edge node can be used to confirm receipt of the VXLAN encapsulated unicast ARP Request

Edge-2 (10.47.1.13)

First, verify that the LISP or Tunnel interface is listed in the VLAN ID output for VLAN 1026

```
<#root>
```

```
Edge-2#
```

```
show vlan id 1026
```

```
VLAN Name                Status    Ports
-----
1026 red                  active
L2L10:8190
, Gi1/0/3
<-- L2 LISP IID is associated

VLAN Type  SAID      MTU   Parent  RingNo  BridgeNo  Stp   BrdgMode  Trans1  Trans2
-----
1026 enet   101026    1500  -       -       -         -     -         0       0

Remote SPAN VLAN
-----
Disabled

Primary Secondary Type          Ports
-----
```

Now, an ingress EPC on Edge-2 demonstrates the VXLAN encapsulated ARP Reply received. Since the unicast ARP Request is VXLAN encapsulated, you can leverage an IP ACL to match against Edge-1 RLOC send towards Edge-2 RLOC (10.47.1.12 towards 10.47.1.13, respectively) to help filter the traffic.

```
<#root>
```

```
Edge-2(config)#
```

```
ip access-list extended tac
```

```
Edge-2(config-ext-nacl)#
```

```
permit ip host 10.47.1.12 host 10.47.1.13
```

```
Edge-2#
```

```
monitor capture 1 interface g1/0/1 in access-list tac
```

```
Edge-2#
```

```
monitor capture 1 interface g1/0/2 in access-list tac
```

```
Edge-2#
```

```
monitor capture 1 start
```

```
Started capture point : 1
```

```
Edge-2#
```

```
monitor capture 1 stop
```

```
Capture statistics collected at software:
```

```
  Capture duration - 20 seconds
  Packets received - 10
  Packets dropped - 0
  Packets oversized - 0
```


Number of Bytes dropped at asic not collected

Capture buffer will exist till exported or cleared

Stopped capture point : 1

Edge-2#

```
show monitor capture 1 buffer brief
```

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

```
1 0.000000
```

```
52:54:00:19:93:e9 -> 52:54:00:1e:ad:00 ARP 110 Who has 10.47.4.3? Tell 10.47.4.2
```

Upon closer inspection of this ARP Request, you can see there is VXLAN encapsulation, UDP header, and other headers, as an ARP frame is small, 60 bytes normally.

<#root>

Edge-2#

```
show monitor capture 1 buffer display-filter frame.number==1 detailed
```

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

Frame 1: 110 bytes on wire (880 bits), 110 bytes captured (880 bits) on interface /tmp/epc_ws/wif_to_ts.

Interface id: 0 (/tmp/epc_ws/wif_to_ts_pipe)

Interface name: /tmp/epc_ws/wif_to_ts_pipe

Encapsulation type: Ethernet (1)

Arrival Time: Oct 24, 2023 18:57:34.642468000 UTC

[Time shift for this packet: 0.000000000 seconds]

Epoch Time: 1698173854.642468000 seconds

[Time delta from previous captured frame: 0.000000000 seconds]

[Time delta from previous displayed frame: 0.000000000 seconds]

[Time since reference or first frame: 0.000000000 seconds]

Frame Number: 1

Frame Length: 110 bytes (880 bits)

Capture Length: 110 bytes (880 bits)

[Frame is marked: False]

[Frame is ignored: False]

[Protocols in frame: eth:ethertype:ip:udp:vxlan:eth:ethertype:arp]

Ethernet II, Src: 52:54:00:0a:42:11 (52:54:00:0a:42:11), Dst: 52:54:00:17:fe:65 (52:54:00:17:fe:65)

Destination: 52:54:00:17:fe:65 (52:54:00:17:fe:65)

Address: 52:54:00:17:fe:65 (52:54:00:17:fe:65)

.... ..1. = LG bit: Locally administered address (this is NOT the factory d

.... ..0 = IG bit: Individual address (unicast)

Source: 52:54:00:0a:42:11 (52:54:00:0a:42:11)

Address: 52:54:00:0a:42:11 (52:54:00:0a:42:11)

.... ..1. = LG bit: Locally administered address (this is NOT the factory d

.... ..0 = IG bit: Individual address (unicast)

Type: IPv4 (0x0800)

Internet Protocol Version 4,

Src: 10.47.1.12, Dst: 10.47.1.13 <-- Edge-1 RLOC and Edge-2 RLOC, respectively

0100 = Version: 4

.... 0101 = Header Length: 20 bytes (5)

Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)

```
0000 00.. = Differentiated Services Codepoint: Default (0)
.... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
Total Length: 96
Identification: 0x798a (31114)
Flags: 0x4000, Don't fragment
  0... .... = Reserved bit: Not set
  .1.. .... = Don't fragment: Set
  ..0. .... = More fragments: Not set
Fragment offset: 0
Time to live: 253
Protocol: UDP (17)
Header checksum: 0xed8b [validation disabled]
[Header checksum status: Unverified]
Source: 10.47.1.12
Destination: 10.47.1.13
User Datagram Protocol, Src Port: 65354, Dst Port: 4789
Source Port: 65354
Destination Port: 4789
Length: 76
[Checksum: [missing]]
[Checksum Status: Not present]
[Stream index: 0]
[Timestamps]
  [Time since first frame: 0.000000000 seconds]
  [Time since previous frame: 0.000000000 seconds]
```

```
Virtual eXtensible Local Area Network
Flags: 0x8800, GBP Extension, VXLAN Network ID (VNI)
  1... .... = GBP Extension: Defined
  .... ..0.. .... = Don't Learn: False
  .... 1... .... = VXLAN Network ID (VNI): True
  .... .... 0... = Policy Applied: False
  .000 .000 0.00 .000 = Reserved(R): 0x0000
Group Policy ID: 0
VXLAN Network Identifier (VNI):
```

8190 <-- LISP L2 IID

```
Reserved: 0
Ethernet II, Src: 52:54:00:19:93:e9 (
52:54:00:19:93:e9
), Dst: 52:54:00:1e:ad:00 (
52:54:00:1e:ad:00
)
```

<-- True source and destination endpoint MAC address

```
Destination: 52:54:00:1e:ad:00 (52:54:00:1e:ad:00)
Address: 52:54:00:1e:ad:00 (52:54:00:1e:ad:00)
  .... ..1. .... = LG bit: Locally administered address (this is NOT the factory d
  .... ..0. .... = IG bit: Individual address (unicast)
Source: 52:54:00:19:93:e9 (52:54:00:19:93:e9)
Address: 52:54:00:19:93:e9 (52:54:00:19:93:e9)
  .... ..1. .... = LG bit: Locally administered address (this is NOT the factory d
  .... ..0. .... = IG bit: Individual address (unicast)
Type: ARP (0x0806)
Trailer: 00000000000000000000000000000000
Address Resolution Protocol (request)
Hardware type: Ethernet (1)
Protocol type: IPv4 (0x0800)
Hardware size: 6
```

```
Protocol size: 4
Opcode: request (1)
Sender MAC address: 52:54:00:19:93:e9 (
52:54:00:19:93:e9
)
Sender IP address:
10.47.4.2
Target MAC address: 00:00:00:00:00:00 (
00:00:00:00:00:00
)
Target IP address:
10.47.4.3
```

Edge-2 pops the VXLAN encapsulation off and punt the unicast ARP Request up to the CPU for further processing. This can be seen via a FED Punject capture.

```
<#root>
```

```
Edge-2#
```

```
debug platform software fed switch active punt packet-capture start
```

```
Punt packet capturing started.
```

```
Edge-2#
```

```
debug platform software fed switch active punt packet-capture stop
```

```
Punt packet capturing stopped. Captured 21 packet(s)
```

```
Edge-2#
```

```
show platform software fed sw active punt packet-capture display-filter "arp" brief
```

```
Punt packet capturing: disabled. Buffer wrapping: disabled
Total captured so far: 21 packets. Capture capacity : 4096 packets
```

```
----- Punt Packet Number: 6, Timestamp: 2023/10/24 19:14:32.930 -----
interface : physical: [if-id: 0x00000000], pal:
```

```
L2LISP0
```

```
[if-id: 0x00000017]
metadata : cause: 109 [snoop packets], sub-cause: 1,
```

```
q-no: 16,
```

```
linktype: MCP_LINK_TYPE_IP [1]
ether hdr :
```

```
dest mac: 5254.001e.ad00, src mac: 5254.0019.93e9
```

```
ether hdr : ethertype: 0x0806 (ARP)
```

The ARP Request is sent to the ARP Snooper process.

```
<#root>
```

```
Edge-2#debug platform software infrastructure punt
```

```
*Oct 24 19:18:38.916: PUNT RX: mcprp_process_receive_packet: pak->vlan_id: 1026
```

```
*Oct 24 19:18:38.916: Punt: IP proto src 147.233.
```

```
10.47, dst 4.2.
```

```
0.0, from table 0, intf L2LI0, encap LISP, size 60
```

```
,
```


```
cause snoop packets(L3)
```

```
<-- You can see the 10.47.4.2
```

```
*Oct 24 19:18:38.916: punt cause:snoop packets invoking reg_invoke_mcprp_punt_feature_msg
```

```
*Oct 24 19:18:38.916: punt cause:snoop packets
```

```
MCPRP_PUNT_PAK_PROC_OK_DONE
```

 **Caution:** This debug is chatty, use with caution.

Since this ARP Request comes from a L2 LISP/Tunnel interface, Edge-2 never learns 10.47.4.2 as a local endpoint of a dynamic EID in LISP

```
<#root>
```

```
Edge-2#s
```

```
how platform arpsnooping client 5254.0019.93e9
```

```
PLAT_DAI : Platform DAI shim
```

```
FWDPLANE : Dataplane forwarding
```

```
BRIDGE : Packet to be bridged
```

```
ARPSN : Arp Snooping
```

```
Packet Trace for client MAC 5254.0019.93E9:
```

Timestamp	Sender Mac	Sender IP	Target Mac	Target IP	Opcode
2023/10/24 15:57:01.129	5254.0019.93e9	10.47.4.2	0000.0000.0000	10.47.4.3	ARP_REQUEST
2023/10/24 15:57:01.129	5254.0019.93e9	10.47.4.2	0000.0000.0000	10.47.4.3	ARP_REQUEST
2023/10/24 15:57:01.129	5254.0019.93e9	10.47.4.2	0000.0000.0000	10.47.4.3	ARP_REQUEST

```
PLATF_DAI:SHUNTED
```

Now, the ARP Request is injected from the CPU down into VLAN 1026, specifically Gi1/0/3, where 10.47.4.3 is connected to.

```
<#root>
```

Edge-2#

```
show mac address-table address 5254.001e.ad00
```

Mac Address Table

```
-----  
Vlan    Mac Address      Type      Ports  
----    -  
1026    5254.001e.ad00  DYNAMIC   Gi1/0/3  
Total Mac Addresses for this criterion: 1
```

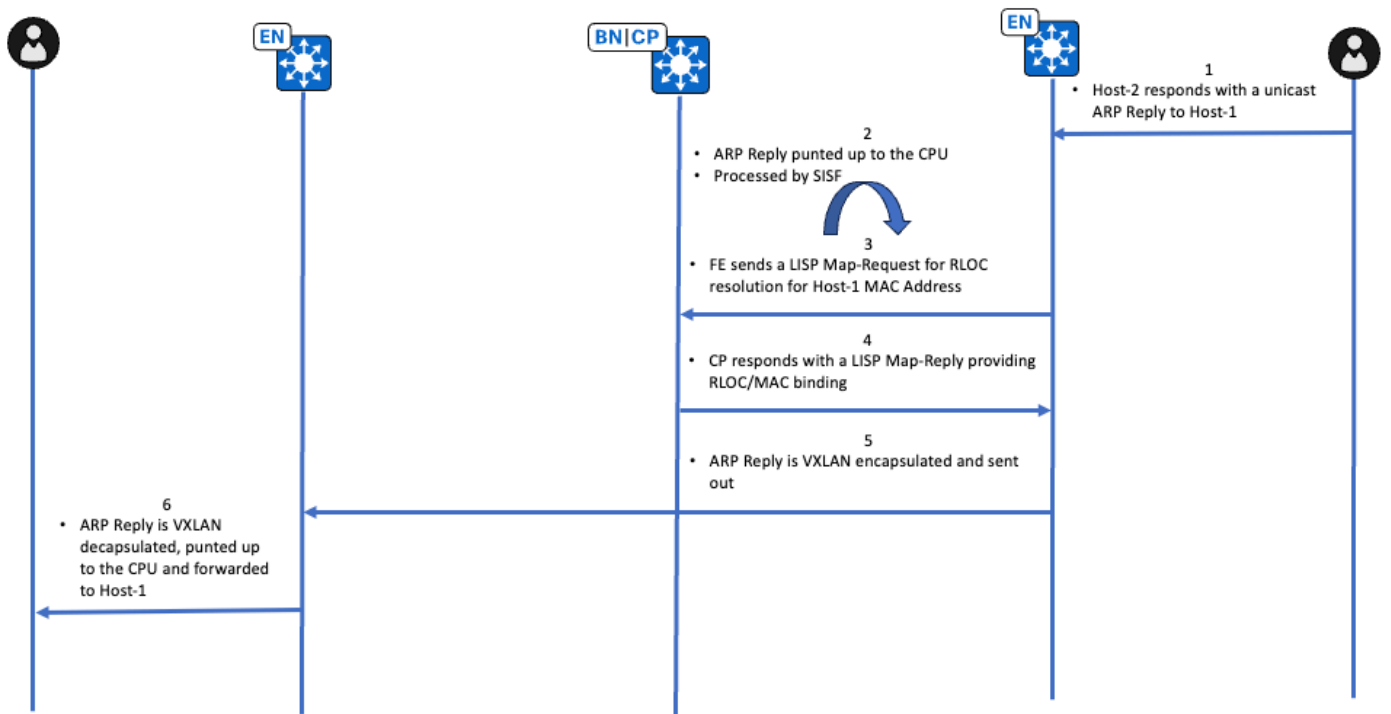
Edge-2#

```
show platform arpsnooping client 5254.001e.ad00
```

```
PLAT_DAI      : Platform DAI shim  
FWDPLANE     : Dataplane forwarding  
BRIDGE       : Packet to be bridged  
ARPSN       : Arp Snooping  
Packet Trace for client MAC 5254.001E.AD00:
```

Timestamp	Sender Mac	Sender IP	Target Mac	Target IP	Opcode
2023/10/24 15:57:01.129	5254.0019.93e9	10.47.4.2	0000.0000.0000	10.47.4.3	ARP_REQUEST
2023/10/24 15:57:01.129	5254.0019.93e9	10.47.4.2	0000.0000.0000	10.47.4.3	ARP_REQUEST

Unicast Path ARP Reply High Level Workflow



Unicast Path ARP Reply Verification

Edge-2 (10.47.1.13)

Endpoint that owns 10.47.4.3 responds with an unicast ARP Reply, the ARP Reply is punted up to the CPU

due to the presence of IPDT. Initial verification occurs via EPC on the interface facing the endpoint.

```
<#root>
```

```
Edge-2#
```

```
show monitor capture 1 buffer display-filter arp
```

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

```
2 88.712035
```

```
52:54:00:1e:ad:00 -> 00:00:0c:9f:f3:41 ARP 60 10.47.4.3 is at 52:54:00:1e:ad:00
```

Next, verify the punt action with a FED Punject

```
<#root>
```

```
Edge-2#
```

```
debug platform software fed sw active punt packet-capture start
```

```
Punt packet capturing started.
```

```
Edge-2#
```

```
debug platform software fed sw active punt packet-capture stop
```

```
Punt packet capturing stopped. Captured 22 packet(s)
```

```
Edge-2#
```

```
show platform software fed sw active punt packet-capture display-filter "arp" brief
```

```
Punt packet capturing: disabled. Buffer wrapping: disabled
```

```
Total captured so far: 22 packets. Capture capacity : 4096 packets
```

```
----- Punt Packet Number: 6, Timestamp: 2023/10/24 20:32:35.634 -----  
interface : physical: [if-id: 0x00000000], pa1:
```

```
L2LISP0
```

```
[if-id: 0x00000017]
```

```
metadata : cause: 109 [
```

```
snoop packets]
```

```
, sub-cause: 1,
```

```
q-no: 16
```

```
, linktype: MCP_LINK_TYPE_IP [1]
```

```
<-- Punted for Snoop Packets to CPU queue 16
```

```
ether hdr :
```

```
dest mac: 5254.001e.ad00
```

```
,
```

```
src mac: 5254.0019.93e9
```

```
ether hdr : ethertype: 0x0806 (ARP)
```

Next, the ARP reply is passed to ARP Snooper and Device-Tracking

```
<#root>
```

```
Edge-2#
```

```
debug platform software infrastructure punt
```

```
*Oct 24 19:18:39.101: PUNT RX: mcprp_process_receive_packet: pak->vlan_id: 1026
```

```
*Oct 24 19:18:39.101: Punt: IP proto src 173.0.
```

```
10.47
```

```
, dst
```

```
4.3
```

```
.82.84, from table 0, intf Gi1/0/3, encap ARPA, size 60, cause snoop packets(L3)
```

```
<-- 10.47.4.3 is obscured
```

```
*Oct 24 19:18:39.101: punt cause:snoop packets invoking reg_invoke_mcprp_punt_feature_msg
```

```
*Oct 24 19:18:39.101: punt cause:snoop packets MCPRP_PUNT_PAK_PROC_OK_DONE
```

```
<#root>
```


```
Edge-2#
```

```
debug platform fhs
```

```
Edge-2#
```

```
debug platform fhs all
```

```
ARP packet received from ARP snooper(Gi1/0/3 10.47.4.3 (5254.001e.ad00) VLAN:10
```

 **Caution:** These debugs are chatty, use with caution.

```
<#root>
```

```
Edge-2#
```

```
debug device-tracking
```

```
*Oct 24 20:42:22.554: SISF[CLA]: Interest on target vlan 1026
```

```
*Oct 24 20:42:22.554: SISF[CLA]: feature Device-tracking
```

```
*Oct 24 20:42:22.554: SISF[CLA]: feature Address Resolution Relay
```

```
*Oct 24 20:42:22.555: SISF[SWI]:
```

```
Gi1/0/3 vlan 1026 Feature_0 Device-tracking priority 128
```

```
*Oct 24 20:42:22.555: SISF[SWI]:
```

```
Gi1/0/3 vlan 1026 Feature_1 Address Resolution Relay priority 81
```

```

*Oct 24 20:42:22.555: SISF[PRS]:
  ARP-REPLY target set to 10.47.4.2
*Oct 24 20:42:22.556: SISF[SWI]: Gi1/0/3 vlan 1026 Feature Device-tracking rc: OK
*Oct 24 20:42:22.556: SISF[ARR]: Gi1/0/3 vlan 1026 Receive a msg in AR
*Oct 24 20:42:22.557: SISF[ARR]:
  Gi1/0/3 vlan 1026 Not ARP Request or NS, return OK
*Oct 24 20:42:22.557: SISF[SWI]: Gi1/0/3 vlan 1026 Feature Address Resolution Relay rc: OK
*Oct 24 20:42:22.557: SISF[SWI]: Gi1/0/3 vlan 1026 Features execution OK

```

Since the ARP reply already points to a real destination MAC address (not like a placeholder as seen temporarily on Edge-1) Edge-2 can trigger a LISP Map-Request to resolve RLOC-MAC association.

```
<#root>
```

```
Edge-2#
```

```
debug lisp control-plane all
```

```
Edge-2#
```

```
debug l2lisp all
```

```

*Oct 24 20:47:34.400: LISP[REMT ]-0 IID 8190: Schedule processing of Map-Requests from 'remote EID prefix'
*Oct 24 20:47:34.401: LISP[REMT ]-0:
  Map Request: Sending request for IID 8190 EID 5254.0019.93e9/48, requester 'remote EID prefix'.
*Oct 24 20:47:35.166: LISP[TRNSP]-0: Processing received Map-Reply(2) message on GigabitEthernet1/0/1 f
*Oct 24 20:47:35.166: LISP[REMT ]-0:
  Received Map-Reply with nonce 0x5879579E-0xCAFC0AA5, 1 records.
*Oct 24 20:47:35.166: LISP[REMT ]-0:
  Processing Map-Reply mapping record for IID 8190 MAC 5254.0019.93e9/48 LCAF 2, ttl 1440, action none, no
*Oct 24 20:47:35.166: LISP[REMT ]-0:
  10.47.1.12
  pri/wei/dID/mID/met/si_type/si_id/si_flg/afn_id=10/10/0/0/4294967295/none/0/UNSPEC/UNSPEC 1pR.

```

Use the command **show lisp instance-id <L2 IID> ethernet map-cache <destination MAC address>** to verify which RLOC this ARP Reply is be sent towards with VXLAN encapsulation

```
<#root>
```

```
Edge-2#
```

```
show lisp instance-id 8190 ethernet map-cache 5254.0019.93e9
```

```
LISP MAC Mapping Cache for LISP 0 EID-table Vlan 1026 (IID 8190), 1 entries
```


5254.0019.93e9/48

```
, uptime: 00:03:45, expires: 23:56:15, via map-reply, complete
Sources: map-reply
State: complete, last modified: 00:03:45, map-source: 10.47.1.12
Active, Packets out: 6(0 bytes), counters are not accurate (~ 00:00:59 ago)
Encapsulating dynamic-EID traffic
Locator      Uptime      State      Pri/Wgt      Encap-IID
```

10.47.1.12

```
00:03:45 up      10/10      -
  Last up-down state change:      00:03:45, state change count: 1
  Last route reachability change: 2w0d, state change count: 1
  Last priority / weight change:  never/never
  RLOC-probing loc-status algorithm:
    Last RLOC-probe sent:      00:03:45 (rtt 861ms)
```

After LISP resolution, the ARP Reply can be injected from the CPU towards 10.47.1.12 RLOC in the underlay

<#root>

Edge-2#

```
show ip cef 10.47.1.12
```

```
10.47.1.12/32
  nexthop 10.47.1.2 GigabitEthernet1/0/2
  nexthop 10.47.1.6 GigabitEthernet1/0/1
```

The entire flow can be seen on Edge-2 CPU via EPC, the difference between an ARP Reply and ARP Request is that there is no LISP AR Resolution in this flow.

<#root>

Edge-2#

```
show monitor capture 1 buffer display-filter "arp.src.proto_ipv4==10.47.4.3 or lisp"
```

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

```
62  9.355185 52:54:00:1e:ad:00 -> 52:54:00:19:93:e9 ARP 60 10.47.4.3 is at 52:54:00:1e:ad:00
<-- ARP Reply punted up to the CPU
63  9.355486      0.0.0.0 -> 0.0.0.0      LISP 176 Encapsulated Map-Request for [8190] 52:54:00:19:
<-- LISP Map-Request to resolve RLOC-MAC association
88  12.058412 10.47.1.10 -> 10.47.1.13  LISP 96 Map-Reply for [8190] 52:54:00:19:93:e9/48
<-- LISP Map-Reply providing the RLOC-MAC association
90  12.072455 52:54:00:1e:ad:00 -> 52:54:00:19:93:e9 ARP 110 10.47.4.3 is at 52:54:00:1e:ad:00
<-- VXLAN Encapsulated ARP Reply that is injected by the CPU
```

 **Tip:** FED Punject capture does not capture ARP replies injected, use FED inject verbose traces

You can use the command **show platform arpsnooping client <source MAC address>** to see the actions taken on Edge-2 in relation to the ARP Reply

<#root>

Edge-2#

```
show platform arpsnooping client 5254.001e.ad00
```

```
PLAT_DAI      : Platform DAI shim
FWDPLANE     : Dataplane forwarding
BRIDGE       : Packet to be bridged
ARPSN        : Arp Snooping
Packet Trace for client MAC 5254.001E.AD00:
```

Timestamp	Sender Mac	Sender IP	Target Mac	Target IP	Opcode
2023/10/24 20:47:38.151	5254.001e.ad00	10.47.4.3	5254.0019.93e9	10.47.4.2	ARP_REPLY
PLATF_DAI:RECEIVED INPUT					
2023/10/24 20:47:38.151	5254.001e.ad00	10.47.4.3	5254.0019.93e9	10.47.4.2	ARP_REPLY
2023/10/24 20:47:38.152	5254.001e.ad00	10.47.4.3	5254.0019.93e9	10.47.4.2	ARP_REPLY
PLATF_DAI:TO_ARPSND					
2023/10/24 20:47:38.152	5254.001e.ad00	10.47.4.3	5254.0019.93e9	10.47.4.2	ARP_REPLY
2023/10/24 20:47:38.152	5254.001e.ad00	10.47.4.3	5254.0019.93e9	10.47.4.2	ARP_REPLY
INJECT:INJ_VLAN_IFINPUT_TO_BDI					
2023/10/24 20:47:38.152	5254.001e.ad00	10.47.4.3	5254.0019.93e9	10.47.4.2	ARP_REPLY
INJECT:BD_DPIDX_TO_FWDPLANE					

Edge-1 (10.47.1.12)

Edge-1 receives the VXLAN encapsulated ARP Reply, pop VXLAN header off and punt the ARP Reply up to the CPU for further processing.

<#root>

Edge-1#

```
debug platform software infrastructure punt
```

```
*Oct 24 21:42:11.303: PUNT RX: mcprp_process_receive_packet: pak->vlan_id: 1026
*Oct 24 21:42:11.303: Punt: IP proto src 173.0.
```

10.47

, dst

4.3

.82.84, from table 0,

intf L2LI0

, encaps LISP, size 60, cause snoop packets(L3)

<-- Can see 10.47.4.3 IP address that has been obscured

*Oct 24 21:42:11.303: punt cause:snoop packets invoking reg_invoke_mcprp_punt_feature_msg

*Oct 24 21:42:11.303: punt cause:snoop packets MCPRP_PUNT_PAK_PROC_OK_DONE

You can use the command **show platform arpsnooping client <source MAC address>** to get additional information about how the ARP Reply is handled on Edge-1

<#root>

Edge-1#

show platform arpsnooping client 5254.001e.ad00

PLAT_DAI : Platform DAI shim
FWDPLANE : Dataplane forwarding
BRIDGE : Packet to be bridged
ARPSN : Arp Snooping
Packet Trace for client MAC 5254.001E.AD00:

Timestamp	Sender Mac	Sender IP	Target Mac	Target IP	Opcode
2023/10/24 20:40:33.741	5254.001e.ad00	10.47.4.3	5254.0019.93e9	10.47.4.2	ARP_REPLY
2023/10/24 20:40:33.741	5254.001e.ad00	10.47.4.3	5254.0019.93e9	10.47.4.2	ARP_REPLY
2023/10/24 20:40:33.741	5254.001e.ad00	10.47.4.3	5254.0019.93e9	10.47.4.2	ARP_REPLY

PLATF_DAI:SHUNTED

2023/10/24 20:40:33.741	5254.001e.ad00	10.47.4.3	5254.0019.93e9	10.47.4.2	ARP_REPLY
2023/10/24 20:40:33.741	5254.001e.ad00	10.47.4.3	5254.0019.93e9	10.47.4.2	ARP_REPLY

INJECT:BD_DPIDX_TO_FWDPLANE

Edge-1 takes the punted ARP Reply and send the ARP Reply into VLAN 1026, to the port where the endpoint 10.47.4.2 lives

<#root>

Edge-1#

show mac address-table address 5254.0019.93e9

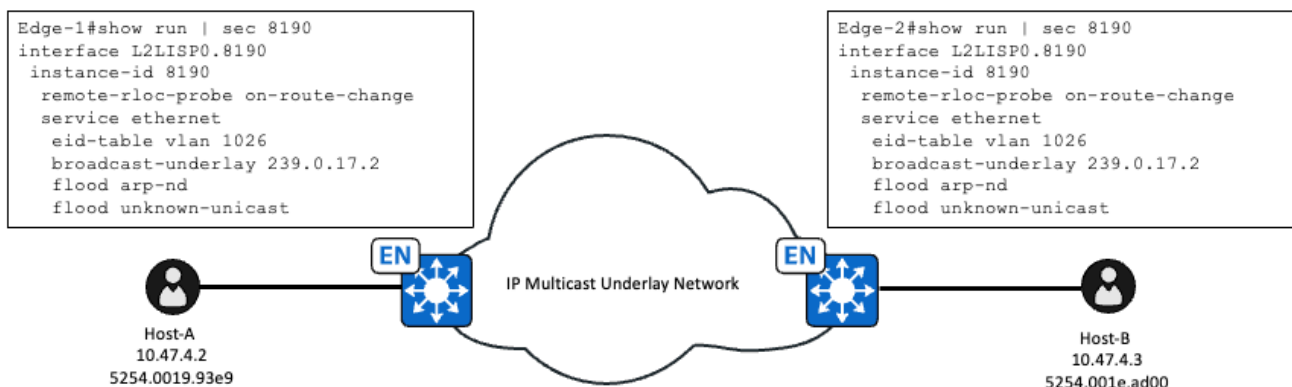
Mac Address Table

Vlan	Mac Address	Type	Ports
-----	-----	-----	-----
1026	5254.0019.93e9	DYNAMIC	Gi1/0/3
Total Mac Addresses for this criterion: 1			

ARP Flooding (L2 Flooding) Path

With L2 Flooding, ARP resolution can also occur where all Fabric Edge nodes in the fabric as well as L2 Handoff/IP Directed Broadcast enabled Borders join a common underlay multicast group. Every single time a packet/frame that is eligible to be flooded arrives to an Edge node, it is VXLAN encapsulated with the destination IP address of the underlay multicast group. L2 Flooding can apply to ARP resolution in certain scenarios:

- The command **flood arp-nd** is configured under the L2 LISP instance for the VLAN, **broadcast** ARP frames are flooded to all Fabric Edges using the broadcast-underlay multicast group.
- The command **flood arp-nd** is configured by Cisco Catalyst Center when L2 flooding is enabled in a pool, and the pool is not marked as a wireless pool
- Underlay multicast must be configured either through LAN Automation or manual configuration. None of the fabric multicast workflows configure underlay multicast automatically.



Once underlay multicast is configured and **flood arp-nd** is enabled, this changes how the ARP Request is handled, which originally used LISP/SISF based resolution. Once **flood arp-nd** is configured under the L2 LISP instance, this disables the LISP-ARP-RELAY-VLAN IPDT policy for the VLAN, and is not used.

<#root>

Edge-1#

show device-tracking policies vlan 1026

Target	Type	Policy	Feature	Target range
vlan 1026	VLAN	DT-PROGRAMMATIC	Device-tracking	vlan all
vlan 1026	VLAN	LISP-DT-GLEAN-VLAN-MULTI-IP	Device-tracking	vlan all

Flooding Path ARP Request Verification

Edge-1 (10.47.1.12)

After an ARP Request is received from the client in L2 flooding enabled VLAN with flood arp-nd configured, it no longer is handled by ARP snooping. The ARP Request is punted up to the CPU for IPDT learning purposes but not for forwarding.

ARP Snooper does not process the ARP Request, which can be seen with the command **show platform arpsnooping client <MAC address>**

```
<#root>
```

```
Edge-1#
```

```
show platform arpsnooping client 5254.0019.93e9
```

```
PLAT_DAI      : Platform DAI shim
FWDPLANE     : Dataplane forwarding
BRIDGE       : Packet to be bridged
ARPSN        : Arp Snooping
Packet Trace for client MAC 5254.0019.93E9:
```

Timestamp	Sender Mac	Sender IP	Target Mac	Target IP	Opcode

Filtered entries counters:					
ARPSN_FILTER_SVI: 0					

Edge-1 does not create a RMT IPDT entry for the endpoint 10.47.4.3 as evidenced in the output

```
<#root>
```

```
Edge-1#
```

```
show monitor capture 1 buffer display-filter arp brief
```

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

```
1 0.000000 52:54:00:19:93:e9 -> ff:ff:ff:ff:ff:ff ARP 60 Who has 10.47.4.3? Tell 10.47.4.2
```

```
Edge-1#
```

```
show device-tracking database address 10.47.4.3
```

```
Codes: L - Local, S - Static, ND - Neighbor Discovery, ARP - Address Resolution Protocol, DH4 - IPv4 DHCP
Preflevel flags (prlvl):
0001:MAC and LLA match      0002:Orig trunk          0004:Orig access
0008:Orig trusted trunk    0010:Orig trusted access 0020:DHCP assigned
0040:Cga authenticated     0080:Cert authenticated  0100:Statically assigned
```

Network Layer Address	Link Layer Address	Interface	vlan	prlvl	ag
-----------------------	--------------------	-----------	------	-------	----

Now, the ARP Request is VXLAN encapsulated into the broadcast underlay multicast group. Edge-1 has a mroute with Loopback0 as the source, and the group the broadcast underlay group.

<#root>

Edge-1#

show run int lo0

Building configuration...

Current configuration : 135 bytes

!

interface Loopback0

ip address 10.47.1.12 255.255.255.255

no ip redirects

ip pim sparse-mode <-- PIM must be enabled

ip router isis

clns mtu 1400

end

<#root>

Edge-1#

show ip mroute 239.0.17.2

IP Multicast Routing Table

Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,

L - Local, P - Pruned, R - RP-bit set, F - Register flag,

T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,

X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,

U - URD, I - Received Source Specific Host Report,

Z - Multicast Tunnel, z - MDT-data group sender,

Y - Joined MDT-data group, y - Sending to MDT-data group,

G - Received BGP C-Mroute, g - Sent BGP C-Mroute,

N - Received BGP Shared-Tree Prune, n - BGP C-Mroute suppressed,

Q - Received BGP S-A Route, q - Sent BGP S-A Route,

V - RD & Vector, v - Vector, p - PIM Joins on route,

x - VxLAN group, c - PFP-SA cache created entry,

* - determined by Assert, # - iif-starg configured on rpf intf,

e - encap-helper tunnel flag, l - LISP decap ref count contributor

Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join

t - LISP transit group

Timers: Uptime/Expires

Interface state: Interface, Next-Hop or VCD, State/Mode

(* , 239.0.17.2), 5w1d/00:02:05, RP 10.47.1.14, flags: SJC

Incoming interface: GigabitEthernet1/0/2, RPF nbr 10.47.1.4

Outgoing interface list:

L2LISP0.8190, Forward/Sparse-Dense, 01:56:41/00:00:18, flags:

L2LISP0.8192, Forward/Sparse-Dense, 2w2d/00:00:58, flags:

L2LISP0.8188, Forward/Sparse-Dense, 5w1d/00:01:58, flags:

(

10.47.1.12

, 239.0.17.2), 00:02:53/00:00:06, flags: PFT

<-- Lo0 interface of Edge-1

Incoming interface:

Null0

```
, RPF nbr 0.0.0.0,
<-- Incoming interface Null0 is expected
    Outgoing interface list:

GigabitEthernet1/0/2
, Forward/Sparse, 00:04:40/00:02:45, flags:
<-- Outgoing interface Gig1/0/2 faces the fabric underlay
```

In reality, flood arp-nd toggles IPDT/SISF rather than flooding itself. L2 flooding already floods broadcasts but the trick is to disable the LISP AR policy from device-tracking, ownership of ARP is now released and can be flooded just like any other broadcast.

To verify hardware programming for L2 flooding, use the command **show platform software dpidb l2lisp <L2 LISP IID>**

```
<#root>
Edge-1#
show platform software dpidb l2lisp 8190

Instance Id:8190,
dpidx:25
, vlan:1026, Parent Interface:L2LISP0(if_id:23)
<-- dpidx value used in the next command
```

Take the dpidx value from the previous command and use in the command **show platform software fed switch active ifm if-id <dpidx value>**

```
<#root>
Edge-1#
show platform software fed switch active ifm if-id 25

Interface IF_ID      : 0x00000000000000019
Interface Name      : L2LISP0.8190
Interface Block Pointer : 0x7f65ec85ba78
Interface Block State : READY
Interface State     : Enabled
Interface Status    : ADD, UPD
Interface Ref-Cnt   : 2
Interface Type      : L2_LISP
Created Time        : 2023/09/19 17:57:32.046
Last Modified Time  : 2023/10/25 17:59:09.265
Current Time        : 2023/10/25 20:15:44.624
    Is top interface : FALSE
    Asic_num         : 0
```

```
Switch_num      : 0
AAL port Handle : 7a00003a
Parent interface id : 17
Multicast Tunnel IP :
```

239.0.17.2

```
Mcast Tunnel Handle : 0x7f65ed356918
L2 Multicast Tunnel IP : 0.0.0.0
L2 Multicast Vlan Id   : 0
L2 Multicast Tunnel Hd1 : NULL
Vlan Id                : 1026
Instance Id           : 8190
Dest Port              : 4789
SGT                    : Enable
Underlay VRF (V4)     : 0
Underlay VRF (V6)     : 0
Flood Access-tunnel   : Disable
Flood unknown ucast   : Enable

Broadcast              : Enable

Multicast Flood        : Enable
L2 Multicast Flood    : Disable
Host Activity report: Enabled
```

<snip>

You can utilize EPC on Gi1/0/2 in the egress direction, because this ARP Request is forwarded in and out without requiring a CPU Inject, you can trust EPC captures in the egress decision this time.

<#root>

Edge-1#

```
monitor capture 1 start
```

```
Started capture point : 1
```

Edge-1#

```
monitor capture 1 stop
```

```
Capture statistics collected at software:
```

```
Capture duration - 22 seconds
Packets received - 5
Packets dropped - 0
Packets oversized - 0
```

```
Number of Bytes dropped at asic not collected
```

```
Capture buffer will exists till exported or cleared
```

```
Stopped capture point : 1
```

Edge-1#

```
show monitor capture 1 buffer brief
```

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

```
1  0.000000 52:54:00:19:93:e9 -> ff:ff:ff:ff:ff:ff ARP
```

110

Who has 10.47.4.3? Tell 10.47.4.2

<-- Size 110 because VXLAN, UDP, and other headers

You can take a closer look at the VXLAN encapsulated ARP Request

<#root>

Edge-1#

show monitor capture 1 buffer display-filter frame.number==1 detailed

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

Frame 1: 110 bytes on wire (880 bits), 110 bytes captured (880 bits) on interface /tmp/epc_ws/wif_to_ts

Interface id: 0 (/tmp/epc_ws/wif_to_ts_pipe)

Interface name: /tmp/epc_ws/wif_to_ts_pipe

Encapsulation type: Ethernet (1)

Arrival Time: Oct 25, 2023 20:44:36.578645000 UTC

[Time shift for this packet: 0.000000000 seconds]

Epoch Time: 1698266676.578645000 seconds

[Time delta from previous captured frame: 0.000000000 seconds]

[Time delta from previous displayed frame: 0.000000000 seconds]

[Time since reference or first frame: 0.000000000 seconds]

Frame Number: 1

Frame Length: 110 bytes (880 bits)

Capture Length: 110 bytes (880 bits)

[Frame is marked: False]

[Frame is ignored: False]

[Protocols in frame: eth:ethertype:ip:udp:vxlan:eth:ethertype:arp]

Ethernet II, Src: 00:00:00:00:00:00 (

00:00:00:00:00:00

), Dst: 00:00:00:00:00:00 (

00:00:00:00:00:00

)

<-- Ignore the all 0s MAC, not accurate

Destination: 00:00:00:00:00:00 (00:00:00:00:00:00)

Address: 00:00:00:00:00:00 (00:00:00:00:00:00)

.... ..0. = LG bit: Globally unique address (factory default)

.... ..0. = IG bit: Individual address (unicast)

Source: 00:00:00:00:00:00 (00:00:00:00:00:00)

Address: 00:00:00:00:00:00 (00:00:00:00:00:00)

.... ..0. = LG bit: Globally unique address (factory default)

.... ..0. = IG bit: Individual address (unicast)

Type: IPv4 (0x0800)

Internet Protocol Version 4,

Src: 10.47.1.12, Dst: 239.0.17.2 <-- Source is Edge-1 RLOC, Destination is the broadcast underlay group

0100 = Version: 4

.... 0101 = Header Length: 20 bytes (5)

Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)

0000 00.. = Differentiated Services Codepoint: Default (0)

.... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)

Total Length: 96

Identification: 0x8dab (36267)
Flags: 0x4000, Don't fragment
 0... .. = Reserved bit: Not set
 .1... .. = Don't fragment: Set
 ..0... .. = More fragments: Not set
Fragment offset: 0
Time to live: 255
Protocol: UDP (17)
Header checksum: 0xe2a3 [validation disabled]
[Header checksum status: Unverified]
Source: 10.47.1.12
Destination: 239.0.17.2
User Datagram Protocol, Src Port: 65280, Dst Port: 4789
Source Port: 65280
Destination Port: 4789
Length: 76
[Checksum: [missing]]
[Checksum Status: Not present]
[Stream index: 0]
[Timestamps]
 [Time since first frame: 0.000000000 seconds]
 [Time since previous frame: 0.000000000 seconds]

Virtual eXtensible Local Area Network
Flags: 0x8800, GBP Extension, VXLAN Network ID (VNI)
 1... .. = GBP Extension: Defined
 0.. .. = Don't Learn: False
 1... .. = VXLAN Network ID (VNI): True
 0... = Policy Applied: False
 .000 .000 0.00 .000 = Reserved(R): 0x0000
Group Policy ID: 0

VXLAN Network Identifier (VNI): 8190 <-- L2 LISP IID

Reserved: 0
Ethernet II, Src: 52:54:00:19:93:e9 (
52:54:00:19:93:e9
) , Dst: ff:ff:ff:ff:ff:ff (
ff:ff:ff:ff:ff:ff
)

<-- SMAC and DMAC of the ARP Request

Destination: ff:ff:ff:ff:ff:ff (ff:ff:ff:ff:ff:ff)
 Address: ff:ff:ff:ff:ff:ff (ff:ff:ff:ff:ff:ff)
 1. = LG bit: Locally administered address (this is NOT the factory d
 1 = IG bit: Group address (multicast/broadcast)
Source: 52:54:00:19:93:e9 (52:54:00:19:93:e9)
 Address: 52:54:00:19:93:e9 (52:54:00:19:93:e9)
 1. = LG bit: Locally administered address (this is NOT the factory d
 0 = IG bit: Individual address (unicast)
Type: ARP (0x0806)
Trailer: 00000000000000000000000000000000
Address Resolution Protocol (request)
 Hardware type: Ethernet (1)
 Protocol type: IPv4 (0x0800)
 Hardware size: 6
 Protocol size: 4
 Opcode: request (1)
 Sender MAC address: 52:54:00:19:93:e9 (
52:54:00:19:93:e9

```

)
  Sender IP address:
10.47.4.2
  Target MAC address: 00:00:00:00:00:00 (
00:00:00:00:00:00
)
  Target IP address:
10.47.4.3

```

Edge-2 (10.47.1.13)

Edge-2 joins the broadcast underlay group, 239.0.17.2 and has S,G for Edge-1, it receives the VXLAN encapsulated multicast packet on Gig1/0/1 and LISPO.8190 sub-interface is in the outgoing interface list. Earlier versions of code like 17.3 or older use a Tunnel interface instead of a LISPO sub-interface.

```
<#root>
```

```
Edge-2#
```

```
show ip mroute 239.0.17.2
```

```
IP Multicast Routing Table
```

```

Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
      L - Local, P - Pruned, R - RP-bit set, F - Register flag,
      T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
      X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
      U - URD, I - Received Source Specific Host Report,
      Z - Multicast Tunnel, z - MDT-data group sender,
      Y - Joined MDT-data group, y - Sending to MDT-data group,
      G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
      N - Received BGP Shared-Tree Prune, n - BGP C-Mroute suppressed,
      Q - Received BGP S-A Route, q - Sent BGP S-A Route,
      V - RD & Vector, v - Vector, p - PIM Joins on route,
      x - VxLAN group, c - PFP-SA cache created entry,
      * - determined by Assert, # - iif-starg configured on rpf intf,
      e - encap-helper tunnel flag, l - LISP decap ref count contributor

```

```

Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
                        t - LISP transit group

```

```
Timers: Uptime/Expires
```

```
Interface state: Interface, Next-Hop or VCD, State/Mode
```

```

(*, 239.0.17.2), 5w1d/stopped, RP 10.47.1.14, flags: SJC
  Incoming interface: GigabitEthernet1/0/1, RPF nbr 10.47.1.6
  Outgoing interface list:
    L2LISP0.8190, Forward/Sparse-Dense, 02:28:57/00:01:02, flags:
    L2LISP0.8192, Forward/Sparse-Dense, 2w2d/00:00:32, flags:
    L2LISP0.8188, Forward/Sparse-Dense, 5w1d/00:02:54, flags:

```

```
(10.47.1.12, 239.0.17.2), 00:00:03/00:02:56, flags: JT
```

```
  Incoming interface:
```

```
GigabitEthernet1/0/1
```

```
, RPF nbr 10.47.1.6
```

```
<-- Interface that faces the fabric underlay and the RPF interface towards 10.47.1.12
```

Outgoing interface list:

L2LISP0.8188, Forward/Sparse-Dense, 00:00:03/00:02:56, flags:

L2LISP0.8192, Forward/Sparse-Dense, 00:00:03/00:02:56, flags:

L2LISP0.8190, Forward/Sparse-Dense, 00:00:03/00:02:56, flags:

Edge-2 receives the VXLAN encapsulated packet, pop the VXLAN header off and flood the packet into VLAN 1026, which can be seen in an EPC on the incoming interface as well as the interface facing the endpoint.

<#root>

Edge-2#

```
monitor capture 1 interface gig1/0/1 in match any
```

Edge-2#

```
monitor capture 1 int g1/0/3 out
```

Edge-2#

```
monitor capture 1 start
```

Started capture point : 1

Edge-2#

```
monitor capture 1 stop
```

Capture statistics collected at software:

Capture duration - 22 seconds

Packets received - 43

Packets dropped - 0

Packets oversized - 0

Number of Bytes dropped at asic not collected

Capture buffer will exists till exported or cleared

Stopped capture point : 1

Edge-2#

```
show monitor capture 1 buffer display-filter arp
```

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

```
10 6.230153 52:54:00:19:93:e9 -> ff:ff:ff:ff:ff:ff ARP
```

110

```
Who has 10.47.4.3? Tell 10.47.4.2
```

<-- Size 110 is the VXLAN encapsulated ARP Request

```
11 6.404781 52:54:00:19:93:e9 -> ff:ff:ff:ff:ff:ff ARP
```

60

Who has 10.47.4.3? Tell 10.47.4.2

<-- Size 60 is the original ARP Request

Flooding Path ARP Reply Verification

ARP Replies are almost always unicast, unless they are gratuitous ARPs. For unicast ARP Replies, there is no distinction between the workflow for Unicast Path based on LISP/SISF or the Flooding Path based on flood arp-nd, both use the same unicast path which includes SISF/IPDT detection. You can leverage the Unicast Path ARP Reply Verification section for troubleshooting.