Cisco IOS LISP Application Note Series: Lab Testing Guide

Version 3.0 (28 April 2011)

Background

The LISP Application Note Series provides targeted information that focuses on the integration and configuration of relevant Cisco IOS features in conjunction with the deployment of LISP.

LISP (Locator/ID Separation Protocol) is not a feature, but rather is a next-generation routing architecture which implements a new semantic for IP addressing that creates two namespaces: Endpoint Identifiers (EIDs), which are assigned to end-hosts, and Routing Locators (RLOCs), which are assigned to devices (primarily routers) that make up the global routing system. Creating separate namespaces for EIDs and RLOCs creates a *level of indirection* that yields many advantages over a single namespace (i.e. the current IP address concept) including: improved scalability of the routing system through greater aggregation of RLOCs, improved multi-homing efficiency, ingress traffic engineering, and the ability to move EIDs without breaking sessions (mobility). LISP also was designed at the outset to be Address Family agnostic, and thus handles multiple AF's seamlessly making its use ideal in IPv6 transition solutions.

This and other LISP Application Notes in this series assume a working knowledge of LISP and are not intended to provide basic information on its use-cases, or guidelines on configuration and deployment. These details can be found in the *Cisco LISP Command Reference Guide*, *Cisco LISP Configuration Guide*, and other information available at **http:// lisp.cisco.com**.

Application Note Organization

Like all Application Notes in the LISP series, this application note is organized into three main sections.

1. Concept Overview – This section provides a brief description of the feature or technology being addressed in this Application Note in the context of a LISP implementation.
2. Concept Details – This section provides a detailed description of the feature or technology and its interaction with LISP, and a description of its (typical) usage in deployment.
3. Concept Examples – This section provides detailed testing of the feature or technology. This provides verification of the detailed descriptions, and also allows network administrators to set up a similar LISP environment and repeat the feature test.

Comments and corrections are welcome. Please direct all queries to: **lisp-support@cisco.com**.

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Concept Overview: Cisco IOS LISP Lab Testing Overview

LISP is a routing architecture and protocol that implements a new semantic for IP addressing. In the current Internet routing and addressing architecture, the IP address is used as a single namespace that simultaneously expresses two functions about a device: its identity and how it is attached to the network. One very visible and detrimental result of this single namespace is manifested in the rapid growth of the Internet's DFZ (default-free zone) as a consequence of multi-homing, traffic engineering (TE), non-aggregatable address allocations, and business events such as mergers and acquisitions.

LISP changes current IP address semantics by creating two new namespaces: Endpoint Identifiers (EIDs), assigned to end-hosts, and Routing Locators (RLOCs), assigned to devices (primarily routers) that make up the global routing system. Performing this separation offers several advantages, including:

- Improved routing system scalability with topologically-aggregated RLOCs
- Provider-independence for devices numbered out of the EID space
- Low-OPEX multi-homing of end-sites with improved traffic engineering
- IPv6 transition functionality, and
- Improved endpoint mobility capabilities

LISP is a simple, incremental, network-based implementation that is deployed primarily in network edge devices. It requires no changes to host stacks, DNS, or local network infrastructure, and little to no major changes to existing network infrastructures.

Cisco has been leading the development of LISP through leadership in IETF LISP Working Groups, and through the development of LISP code and the deployment and operation of a public LISP network. A summary of these and other efforts is can be found at **http:// www.lisp4.net** or **http://www.lisp6.net.**

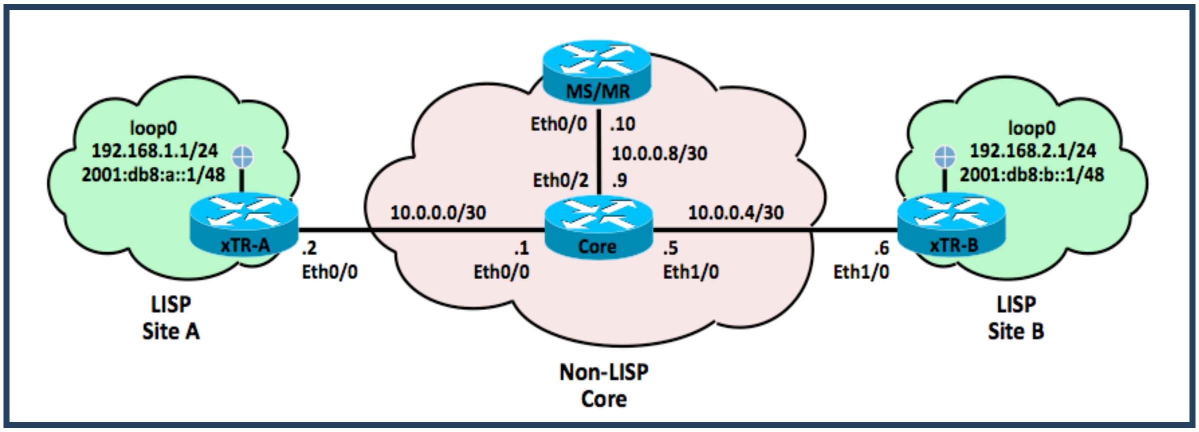
This *Cisco LISP Lab Testing Application Note* is intended to provide guidelines for deploying a minimal LISP configuration in a lab setting to gain experience with this new routing architecture. It does not cover all configurations, conditions, or LISP use cases. Additional information and details can be found in the *Cisco LISP Command Reference Guide*, *Cisco LISP Configuration Guide*, and other information available on the Cisco LISP site: **http:// lisp.cisco.com** (Reference [1]).

Concept Details: Cisco IOS LISP Lab Testing Details

Cisco LISP can be deployed and tested in a very basic lab configuration. The suggested topology for testing LISP in a lab environment is illustrated in Figure 1. All further configuration and diagnostic examples provided in this Application note are based on this topology and indicated IP addresses. Note in Figure 1 that a total of four routers are used, including three Cisco LISP-capable routers, one at each LISP-site function as Ingress Tunnel Routers/Egress Tunnel Routers (xTRs), and one functioning as a Map-Server/Map-Resolver (MS/MR). A fourth Cisco router functions as the non-LISP (Internet) core.

Note in Figure 1 that both LISP Sites have been configured with IPv4 and IPv6 EID addresses, but that the non-LISP core is only configured with IPv4 RLOC addressing. This lab will demonstrate the capability of LISP to carry both IPv4 and IPv6 EIDs over an IPv4 core. This capability of LISP can greatly simplify IPv6 transition initiatives for customers.

Figure 1. Cisco LISP Example Lab Test Network Topology.



Note in Figure 1 that both LISP Sites have been configured with IPv4 and IPv6 EID addresses, but that the non-LISP core is only configured with IPv4 RLOC addressing. This lab will demonstrate the capability of LISP to carry both IPv4 and IPv6 EIDs over an IPv4 core. This capability of LISP can greatly simplify IPv6 transition initiatives for customers.

Prerequisites

In order to set up the lab topology shown in Figure 1, the Cisco routers used must meet the following hardware and Cisco Software prerequisites.

- For ITR, ETR, PITR, PETR, MS, and MR functionality, Cisco ISR (1800, 2800, 3800), ISR-G2 (1900, 2900, 3900), or 7200 family router running Cisco IOS Version 15.1(4)XB4 software or Cisco IOS Version 15.1(4)M software.
- For ITR, ETR, PITR, PETR, MS, and MR functionality, Cisco ASR1K running Cisco IOS-XE Version 3.3.0S software.

Since only basic features are illustrated in this Lab Guide, previous releases will also work. The releases shown above are the latest available at the time this document was written.

Note: NX-OS configurations are also provided here for completeness. Although the CLI is different, the functionality is the same. See the LISP Configuration Guide and the NX-OS Command Reference Guide for more details. The NX-OS configurations shown are based on Cisco NX-OS Version 5.0(3.lisp-80) software. Previous releases will also work

See the Release Notes posted on http://lisp.cisco.com for the current list of supported hardware and software Cisco Software prerequisites.

Concept Examples: Cisco IOS LISP Lab Testing Configuration and Verification

Initial Router Configuration

In preparation for Cisco LISP lab testing, install the routers in the topology shown in Figure 1, and then configure each router (xTR-A, xTR-B, Core, and MS-MR respectively) in order to provide basic connectivity in the *Routing Locator* (RLOC) namespace between the four devices. These initial configurations are summarized in Table 1 below.

Table 1. Initial (non-LISP) configurations for lab routers.

<table>
<tr><th>Cisco IOS, IOS-XE Configuration</th><th>Cisco NX-OS Configuration</th></tr>
<tr><td><u>xTR-A Base Configuration</u><pre>!
hostname xTR-A
!
ip cef
ipv6 unicast-routing
ipv6 cef
!
interface Loopback0
 ip address 192.168.1.1 255.255.255.0
 ipv6 address 2001:DB8:A::1/48
!
interface Ethernet0/0
 description To Core
 ip address 10.0.0.2 255.255.255.252
!
ip route 0.0.0.0 0.0.0.0 10.0.0.1
ipv6 route ::/0 Null0
!</pre></td><td><u>xTR-A Base Configuration</u><pre>!
hostname xTR-A
!
interface Loopback0
 ip address 192.168.1.1 255.255.255.0
 ipv6 address 2001:DB8:A::1/48
!
interface Ethernet0/0
 description To Core
 ip address 10.0.0.2 255.255.255.252
!
ip route 0.0.0.0 0.0.0.0 10.0.0.1
ipv6 route ::/0 Null0
!</pre></td></tr>
<tr><td><u>xTR-B Base Configuration</u><pre>!
hostname xTR-B
!
ip cef
ipv6 unicast-routing
ipv6 cef
!
interface Loopback0
 ip address 192.168.2.1 255.255.255.0
 ipv6 address 2001:DB8:B::1/48
!
interface Ethernet0/0
 description To Core
 ip address 10.0.0.6 255.255.255.252
!
ip route 0.0.0.0 0.0.0.0 10.0.0.5
ipv6 route ::/0 Null0
!</pre></td><td><u>xTR-B Base Configuration</u><pre>!
hostname xTR-B
!
interface Loopback0
 ip address 192.168.2.1 255.255.255.0
 ipv6 address 2001:DB8:B::1/48
!
interface Ethernet0/0
 description To Core
 ip address 10.0.0.6 255.255.255.252
!
ip route 0.0.0.0 0.0.0.0 10.0.0.5
ipv6 route ::/0 Null0
!</pre></td></tr>
<tr><td><u>Core Base Configuration</u><pre>!
hostname Core
!
ip cef
ipv6 unicast-routing
ipv6 cef
!
interface Ethernet0/0
 description To xTR-A
 ip address 10.0.0.1 255.255.255.252
!
interface Ethernet0/1
 description To xTR-B
 ip address 10.0.0.5 255.255.255.252
!
interface Ethernet0/2
 description To MS-MR
 ip address 10.0.0.9 255.255.255.252
!</pre></td><td><u>Core Base Configuration</u><pre>!
hostname Core
!
interface Ethernet0/0
 description To xTR-A
 ip address 10.0.0.1 255.255.255.252
!
interface Ethernet0/1
 description To xTR-B
 ip address 10.0.0.5 255.255.255.252
!
interface Ethernet0/2
 description To MS-MR
 ip address 10.0.0.9 255.255.255.252
!</pre></td></tr>
<tr><td><u>MS-MR Base Configuration</u><pre>!
hostname MS-MR
!
ip cef
ipv6 unicast-routing</pre></td><td><u>MS-MR Base Configuration</u><pre>!
hostname MS-MR
!
interface Ethernet0/0
 description To Core</pre></td></tr>
</table>

```
ipv6 cef
!
interface Ethernet0/0
 description To Core
 ip address 10.0.0.10 255.255.255.252!
!
ip route 0.0.0.0 0.0.0.0 10.0.0.9
!
```

```
 ip address 10.0.0.10 255.255.255.252!
!
ip route 0.0.0.0 0.0.0.0 10.0.0.9
!
```

At this point, you should be able to demonstrate basic connectivity within the RLOC namespace. For example, try pinging **xTRB** (10.0.0.6) and the **MS-MR** (10.0.0.10):

```
xTR-A# ping 10.0.0.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.6, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/4/16 ms
xTR-A# ping 10.10.10.10

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.10.10.10, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/6/24 ms
xTR-A#
```

However, you should not yet be able to establish connectivity between EID namespaces. For example:

```
xTR-A# ping 192.168.2.1 source 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.1
.....
Success rate is 0 percent (0/5)
xTR-A#
```

The router **Core** has no information about the EID namespace, and LISP is not yet configured.

Cisco LISP Configuration

In this lab, only the routers xTR-A and xTR-B (which represent the end-customer edge routers), and the MS-MR router (which provides LISP Mapping Services support) require LISP configurations. No other LISP configurations are required to demonstrate LISP.

The following instructions describe how to configure Cisco LISP from the command-line interface (CLI). Since this lab demonstrates the capability of LISP to carry both IPv4 and IPv6 EIDs over an IPv4 core, LISP configurations are shown to support both Address Families. (For a listing of all Cisco LISP-related commands, refer to the *Cisco IOS LISP Command Reference Guide* or *Cisco NX-OS LISP Command Reference Guide* located at http://lisp.cisco.com.

Step 1. Enable LISP xTR functionality for both IPv4 and IPv6 address families on xTR-A and xTR-B

Cisco IOS, IOS-XE Configuration

```
xTR-A(config)# router lisp
xTR-A(config-router-lisp)# ipv4 itr
xTR-A(config-router-lisp)# ipv4 etr
xTR-A(config-router-lisp)# ipv6 itr
xTR-A(config-router-lisp)# ipv6 etr
```

Cisco NX-OS Configuration

```
xTR-A(config)# feature lisp
xTR-A(config)# ip lisp itr-etr
xTR-A(config)# ipv6 lisp itr-etr
```

and
`xTR-B(config)# router lisp`
`xTR-B(config-router-lisp)# ipv4 itr`
`xTR-B(config-router-lisp)# ipv4 etr`
`xTR-B(config-router-lisp)# ipv6 itr`
`xTR-B(config-router-lisp)# ipv6 etr`
	and
	`xTR-B(config)# feature lisp`
	`xTR-B(config)# ip lisp itr-etr`
	`xTR-B(config)# ipv6 lisp itr-etr`

This enables the LISP processes and creates the mapping structures that LISP uses for cache management and forwarding.

Step 2. Configure the LISP database mapping between the EID namespace and RLOC namespace for both IPv4 and IPv6 address families on xTR-A and xTR-B

Cisco IOS, IOS-XE Configuration	Cisco NX-OS Configuration

`xTR-A(config-router-lisp)# database-mapping 192.168.1.0/24 10.0.0.2 priority 1 weight 100`
`xTR-A(config-router-lisp)# database-mapping 2001:db8:a::/48 10.0.0.2 priority 1 weight 100`
and
`xTR-B(config-router-lisp)# database-mapping 192.168.2.0/24 10.0.0.6 priority 1 weight 100`
`xTR-B(config-router-lisp)# database-mapping 2001:db8:b::/48 10.0.0.6 priority 1 weight 100`
	`xTR-A(config)# ip lisp database-mapping 192.168.1.0/24 10.0.0.2 priority 1 weight 100`
	`xTR-A(config)# ipv6 lisp database-mapping 2001:db8:a::/48 10.0.0.2 priority 1 weight 100`
	and
	`xTR-B(config)# ip lisp database-mapping 192.168.2.0/24 10.0.0.6 priority 1 weight 100`
	`xTR-B(config)# ipv6 lisp database-mapping 2001:db8:b::/48 10.0.0.6 priority 1 weight 100`

This defines the LISP mapping between the EID prefixes for which each xTR is authoritative and the associated RLOC. Note that in this case, each xTR is authoritative for both one IPv4 and one IPv6 EID prefix, and each only has a single IPv4 locator.

Step 3. Configure xTR-A and xTR-B to point to the Map-Resolver and to register with the Map-Server

Cisco IOS, IOS-XE Configuration	Cisco NX-OS Configuration

`xTR-A(config-router-lisp)# ipv4 itr map-resolver 10.0.0.10`
`xTR-A(config-router-lisp)# ipv6 itr map-resolver 10.0.0.10`
`xTR-A(config-router-lisp)# ipv4 etr map-server 10.0.0.10 key site-a-s3cr3t`
`xTR-A(config-router-lisp)# ipv6 etr map-server 10.0.0.10 key site-a-s3cr3t`
and
`xTR-B(config-router-lisp)# ipv4 itr map-resolver 10.0.0.10`
`xTR-B(config-router-lisp)# ipv6 itr map-resolver 10.0.0.10`
`xTR-B(config-router-lisp)# ipv4 etr map-server 10.0.0.10 key site-b-s3cr3t`
`xTR-B(config-router-lisp)# ipv6 etr map-server 10.0.0.10 key site-b-s3cr3t`
	`xTR-A(config)# ip lisp itr map-resolver 10.0.0.10`
	`xTR-A(config)# ipv6 lisp itr map-resolver 10.0.0.10`
	`xTR-A(config)# ip lisp etr map-server 10.0.0.10 key site-a-s3cr3t`
	`xTR-A(config)# ipv6 lisp etr map-server 10.0.0.10 key site-a-s3cr3t`
	and
	`xTR-B(config)# ip lisp itr map-resolver 10.0.0.10`
	`xTR-B(config)# ipv6 lisp itr map-resolver 10.0.0.10`
	`xTR-B(config)# ip lisp etr map-server 10.0.0.10 key site-b-s3cr3t`
	`xTR-B(config)# ipv6 lisp etr map-server 10.0.0.10 key site-b-s3cr3t`

This configures each xTR to point to the Map-Resolver for EID-to-RLOC mapping resolution. When either site wants to communicate with the EID namespace of the other site, it will obtain the necessary map-cache data by querying the configured Map-Resolver. This also configures each xTR to register with the indicated Map-Server using the specified key.

Step 4. Configure the Map-Server/Map-Resolver

Cisco IOS, IOS-XE Configuration

```
MS-MR(config)# router lisp
MS-MR(config-router-lisp)# site Site-A
MS-MR(config-router-lisp-site)#
description LISP Site A
MS-MR(config-router-lisp-site)# eid-prefix
192.168.1.0/24
MS-MR(config-router-lisp-site)# eid-prefix
2001:DB8:A::/48
MS-MR(config-router-lisp-site)#
authentication-key site-a-s3cr3t
MS-MR(config-router-lisp-site)# exit
MS-MR(config-router-lisp)# site Site-B
MS-MR(config-router-lisp-site)#
description LISP Site B
MS-MR(config-router-lisp-site)# eid-prefix
192.168.2.0/24
MS-MR(config-router-lisp-site)# eid-prefix
2001:DB8:B::/48
MS-MR(config-router-lisp-site)#
authentication-key site-b-s3cr3t
MS-MR(config-router-lisp-site)# exit
MS-MR(config-router-lisp)# ipv4 map-
resolver
MS-MR(config-router-lisp)# ipv4 map-server
MS-MR(config-router-lisp)# ipv6 map-
resolver
MS-MR(config-router-lisp)# ipv6 map-server
MS-MR(config-router-lisp)# exit
MS-MR(config)#
```

Cisco NX-OS Configuration

```
MS-MR(config)# vrf context lisp
MS-MR(config-vrf)# exit
MS-MR(config)# feature lisp
MS-MR(config)# ip lisp map-resolver
MS-MR(config)# ip lisp map-server
MS-MR(config)# ip lisp alt-vrf lisp
MS-MR(config)# ipv6 lisp map-resolver
MS-MR(config)# ipv6 lisp map-server
MS-MR(config)# ipv6 lisp alt-vrf lisp
MS-MR(config)# lisp site Site-A
MS-MR(config-lisp-site)# description LISP
Site A
MS-MR(config-lisp-site)# eid-prefix
192.168.1.0/24
MS-MR(config-lisp-site)# eid-prefix
2001:DB8:A::/48
MS-MR(config-lisp-site)# authentication-
key site-a-s3cr3t
MS-MR(config-lisp-site)# exit
MS-MR(config)# lisp site Site-B
MS-MR(config-lisp-site)# description LISP
Site B
MS-MR(config-lisp-site)# eid-prefix
192.168.2.0/24
MS-MR(config-lisp-site)# eid-prefix
2001:DB8:B::/48
MS-MR(config-lisp-site)# authentication-
key site-b-s3cr3t
MS-MR(config-lisp-site)# exit
MS-MR(config)#
```

In this lab demonstration, a single device is being used to function as both a Map-Server and a Map-Resolver. This is often the case in operation as well.

This completes the Cisco LISP lab test configuration. The above commands are summarized in Table 2 below. You can now communicate between IPv4 EID prefixes and between IPv6 EID prefixes using LISP.

Table 2. LISP configurations for lab routers.

Cisco IOS, IOS-XE Configuration

xTR-A LISP Configuration

```
!
router lisp
 database-mapping 192.168.1.0/24 10.0.0.2
priority 1 weight 1
 database-mapping 2001:DB8:A::/48 10.0.0.2
priority 1 weight 1
 ipv4 itr map-resolver 10.0.0.10
 ipv4 itr
 ipv4 etr map-server 10.0.0.10 key site-a-
s3cr3t
 ipv4 etr
 ipv6 itr map-resolver 10.0.0.10
```

Cisco NX-OS Configuration

xTR-A LISP Configuration

```
!
feature lisp
!
ip lisp database-mapping 192.168.1.0/24
10.0.0.2 priority 1 weight 1
ip lisp itr map-resolver 10.0.0.10
ip lisp itr-etr
ip lisp etr map-server 10.0.0.10 key site-
a-s3cr3t
ipv6 lisp database-mapping 2001:DB8:A::/48
10.0.0.2 priority 1 weight 1
ipv6 lisp itr map-resolver 10.0.0.10
```

```
 ipv6 itr
 ipv6 etr map-server 10.0.0.10 key site-a-
s3cr3t
 ipv6 etr
 exit
!
```

```
ipv6 lisp itr-etr
ipv6 lisp etr map-server 10.0.0.10 key
site-a-s3cr3t
!
```

xTR-B LISP Configuration

```
!
router lisp
 database-mapping 192.168.2.0/24 10.0.0.6
priority 1 weight 1
 database-mapping 2001:DB8:B::/48 10.0.0.6
priority 1 weight 1
 ipv4 itr map-resolver 10.0.0.10
 ipv4 itr
 ipv4 etr map-server 10.0.0.10 key site-b-
s3cr3t
 ipv4 etr
 ipv6 itr map-resolver 10.0.0.10
 ipv6 itr
 ipv6 etr map-server 10.0.0.10 key site-b-
s3cr3t
 ipv6 etr
 exit
!
```

xTR-B LISP Configuration

```
!
feature lisp
!
ip lisp database-mapping 192.168.2.0/24
10.0.0.6 priority 1 weight 1
ip lisp itr map-resolver 10.0.0.10
ip lisp itr-etr
ip lisp etr map-server 10.0.0.10 key site-
b-s3cr3t
ipv6 lisp database-mapping 2001:DB8:B::/48
10.0.0.6 priority 1 weight 1
ipv6 lisp itr map-resolver 10.0.0.10
ipv6 lisp itr-etr
ipv6 lisp etr map-server 10.0.0.10 key
site-b-s3cr3t
!
```

MS-MR LISP Configuration

```
!
router lisp
 site Site-A
  description LISP Site A
  authentication-key site-a-s3cr3t
  eid-prefix 192.168.1.0/24
  eid-prefix 2001:DB8:A::/48
  exit
 !
 site Site-B
  description LISP Site B
  authentication-key site-b-s3cr3t
  eid-prefix 192.168.2.0/24
  eid-prefix 2001:DB8:B::/48
  exit
 !
 ipv4 map-server
 ipv4 map-resolver
 ipv4 alt-vrf lisp
 ipv6 map-server
 ipv6 map-resolver
 ipv6 alt-vrf lisp
 exit
!
```

MS-MR LISP Configuration

```
!
vrf context lisp
feature lisp
!
lisp site Site-A
 description LISP Site A
 authentication-key site-a-s3cr3t
 eid-prefix 192.168.1.0/24
 eid-prefix 2001:DB8:A::/48
lisp site Site-B
 description LISP Site B
 authentication-key site-b-s3cr3t
 eid-prefix 192.168.2.0/24
 eid-prefix 2001:DB8:B::/48
!
ip lisp map-server
ip lisp map-resolver
ip lisp alt-vrf lisp
ipv6 lisp map-server
ipv6 lisp map-resolver
ipv6 lisp alt-vrf lisp
!
```

Cisco LISP Examination

You can now demonstrate basic connectivity between IPv4 EID prefixes at Site-A and Site-B, as well as between IPv6 EID prefixes using LISP. In order to investigate LISP, review the following results:

1. Observe the routing tables on the routers.

On xTR-A:

```
xTR-A# show ip route
---<skip>---
S*    0.0.0.0/0 [1/0] via 10.0.0.1
      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.0.0.0/30 is directly connected, Ethernet0/0
L        10.0.0.2/32 is directly connected, Ethernet0/0
      192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
```

```
C        192.168.1.0/24 is directly connected, Loopback0
L        192.168.1.1/32 is directly connected, Loopback0
xTR-A#
```

On xTR-B:

```
xTR-B# show ip route
---<skip>---
S*    0.0.0.0/0 [1/0] via 10.0.0.5
      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.0.0.4/30 is directly connected, Ethernet0/1
L        10.0.0.6/32 is directly connected, Ethernet0/1
      192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C        192.168.2.0/24 is directly connected, Loopback0
L        192.168.2.1/32 is directly connected, Loopback0
xTR-B#
```

On Core:

```
Core# show ip route
---<skip>---
10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C        10.0.0.0/30 is directly connected, Ethernet0/0
L        10.0.0.1/32 is directly connected, Ethernet0/0
C        10.0.0.4/30 is directly connected, Ethernet0/1
L        10.0.0.5/32 is directly connected, Ethernet0/1
C        10.0.0.8/30 is directly connected, Ethernet0/2
L        10.0.0.9/32 is directly connected, Ethernet0/2
Core#
```

And, on MS-MR:

```
MS-MR# show ip route
---<skip>---
S*    0.0.0.0/0 [1/0] via 10.0.0.9
      10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        10.0.0.8/30 is directly connected, Ethernet0/0
L        10.0.0.10/32 is directly connected, Ethernet0/0
MS-MR#
```

As you can see, each router has reachability information only for the RLOC prefixes. (The EID prefixes shown in xTR-A and xTR-B are connected interfaces).

2. Observe the LISP output and status on the MS-MR

```
MS-MR# show lisp site detail
LISP Site Registration Information

Site name: Site-A
Description: LISP Site A
Allowed configured locators: any
Allowed EID-prefixes:
  EID-prefix: 192.168.1.0/24
    First registered:     00:31:17
    Routing table tag:    0x0
    Origin:               Configuration
    Registration errors:
      Authentication failures:   0
      Allowed locators mismatch: 0
    ETR 10.0.0.2, last registered 00:00:41, no proxy-reply, no map-notify
                  TTL 1d00h
      Locator   Local  State      Pri/Wgt
      10.0.0.2  yes    up           1/1
  EID-prefix: 2001:DB8:A::/48
    First registered:     00:31:17
    Routing table tag:    0x0
    Origin:               Configuration
    Registration errors:
      Authentication failures:   0
```

```
      Allowed locators mismatch: 0
    ETR 10.0.0.2, last registered 00:00:40, no proxy-reply, no map-notify
                  TTL 1d00h
      Locator   Local  State      Pri/Wgt
      10.0.0.2  yes    up           1/1
Site name: Site-B
Description: LISP Site B
Allowed configured locators: any
Allowed EID-prefixes:
  EID-prefix: 192.168.2.0/24
    First registered:     00:31:44
    Routing table tag:    0x0
    Origin:               Configuration
    Registration errors:
      Authentication failures:   0
      Allowed locators mismatch: 0
    ETR 10.0.0.6, last registered 00:00:13, no proxy-reply, no map-notify
                  TTL 1d00h
      Locator   Local  State      Pri/Wgt
      10.0.0.6  yes    up           1/1
  EID-prefix: 2001:DB8:B::/48
    First registered:     00:30:45
    Routing table tag:    0x0
    Origin:               Configuration
    Registration errors:
      Authentication failures:   0
      Allowed locators mismatch: 0
    ETR 10.0.0.6, last registered 00:00:09, no proxy-reply, no map-notify
                  TTL 1d00h
      Locator   Local  State      Pri/Wgt
      10.0.0.6  yes    up           1/1
MS-MR#
```

4. Observe the initial Map-Cache status on xTR-A and xTR-B

```
xTR-A# show ip lisp map-cache
LISP IPv4 Mapping Cache, 1 entries

0.0.0.0/0, uptime: 00:01:57, expires: never, via static
  Negative cache entry, action: send-map-request
xTR-A# show ipv6 lisp map-cache
LISP IPv6 Mapping Cache, 1 entries

::/0, uptime: 00:01:56, expires: never, via static
  Negative cache entry, action: send-map-request
xTR-A#
```

and

```
xTR-B# show ip lisp map-cache
LISP IPv4 Mapping Cache, 1 entries

0.0.0.0/0, uptime: 00:03:10, expires: never, via static
  Negative cache entry, action: send-map-request
xTR-B# show ipv6 lisp map-cache
LISP IPv6 Mapping Cache, 1 entries

::/0, uptime: 00:03:09, expires: never, via static
  Negative cache entry, action: send-map-request
xTR-B#
```

As you can see, initially neither xTR has mapping data for other IPv4 or IPv6 EID namespace. (The entry shown is the default entry that causes map-requests to be sent for all map- cache misses).

5. Test IPv4 and IPv6 EID namespace reachability, and then re-verify the LISP map-cache status.

```
xTR-A# ping 192.168.2.1 source 192.168.1.1 repeat 100
```

```
Type escape sequence to abort.
Sending 100, 100-byte ICMP Echos to 192.168.2.1, timeout is 2 seconds:
Packet sent with a source address of 192.168.1.1
..!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Success rate is 98 percent (98/100), round-trip min/avg/max = 1/1/4 ms
xTR-A#
xTR-A# ping 2001:db8:b::1 source 2001:db8:a::1 repeat 100

Type escape sequence to abort.
Sending 100, 100-byte ICMP Echos to 2001:DB8:B::1, timeout is 2 seconds:
Packet sent with a source address of 2001:DB8:A::1
..!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Success rate is 98 percent (98/100), round-trip min/avg/max = 0/1/4 ms
xTR-A#
```

As you can see, the first two packets are dropped while the xTR builds its map-cache. All subsequent packets succeed, as will all packets in the future since the map-cache now exists – as shown next.

```
xTR-A# show ip lisp map-cache
LISP IPv4 Mapping Cache for EID-table default (IID 0), 2 entries

0.0.0.0/0, uptime: 00:08:31, expires: never, via static send map-request
  Negative cache entry, action: send-map-request
192.168.2.0/24, uptime: 00:08:28, expires: 23:59:09, via map-reply, complete
  Locator  Uptime    State      Pri/Wgt
  10.0.0.6 00:08:28  up           1/1

xTR-A# show ipv6 lisp map-cache
LISP IPv6 Mapping Cache for EID-table default (IID 0), 2 entries

::/0, uptime: 00:36:16, expires: never, via static send map-request
  Negative cache entry, action: send-map-request
2001:DB8:B::/48, uptime: 00:36:15, expires: 23:59:38, via map-reply, complete
  Locator  Uptime    State      Pri/Wgt
  10.0.0.6 00:36:15  up           1/1
xTR-A#
```

and

```
xTR-B# show ip lisp map-cache
LISP IPv4 Mapping Cache for EID-table default (IID 0), 2 entries

0.0.0.0/0, uptime: 00:09:29, expires: never, via static
  Negative cache entry, action: send-map-request
192.168.1.0/24, uptime: 00:04:38, expires: 23:55:19, via map-reply, complete
  Locator  Uptime    State      Pri/Wgt
  10.0.0.2 00:04:38  up           1/1
xTR-B# show ipv6 lisp map-cache
LISP IPv6 Mapping Cache for EID-table default (IID 0), 2 entries

::/0, uptime: 00:09:28, expires: never, via static
  Negative cache entry, action: send-map-request
2001:DB8:A::/48, uptime: 00:03:27, expires: 23:56:30, via map-reply, complete
  Locator  Uptime    State      Pri/Wgt
  10.0.0.2 00:03:27  up           1/1
xTR-B#
```

6. Investigate lig usage and LISP debugging on the xTR and MS-MR

```
xTR-A# clear ip lisp map-cache
xTR-A# clear ipv6 lisp map-cache
xTR-A# show ip lisp map-cache
LISP IPv4 Mapping Cache for EID-table default (IID 0), 1 entries

0.0.0.0/0, uptime: 00:00:03, expires: never, via static
  Negative cache entry, action: send-map-request
xTR-A# show ipv6 lisp map-cache
LISP IPv6 Mapping Cache for EID-table default (IID 0), 1 entries
```

```
::/0, uptime: 00:00:03, expires: never, via static
  Negative cache entry, action: send-map-request
xTR-A#
```

Then, turn on lisp debugging on xTR-A and MS-MR

```
xTR-A# debug lisp control-plane lig
LISP control plane Internet Groper debugging is on
```

and

```
MS-MR# debug lisp control-plane all
```

Now, on xTR-A, `lig` for the EID at Site-B

```
xTR-A# lig 192.168.2.1
Mapping information for EID 192.168.2.1 from 10.0.0.6 with RTT 72 msecs
192.168.2.0/24, uptime: 00:00:00, expires: 23:59:52, via map-reply, complete
  Locator    Uptime     State      Pri/Wgt
  10.0.0.6   00:00:00   up           1/1
xTR-A#
*Apr 29 15:39:07.139: LISP: LIG request for IPv4, EIDs 192.168.2.1, count 3.
*Apr 29 15:39:07.187: LISP: Send map request type remote EID prefix
*Apr 29 15:39:07.187: LISP: Send map request for EID prefix IID 0 192.168.2.1/32
*Apr 29 15:39:07.187: LISP: LIG 192.168.2.1 Overriding map request parameters.
*Apr 29 15:39:07.191: LISP: Processing received Map-Reply message from 10.0.0.6 to
10.0.0.2
*Apr 29 15:39:07.191: LISP: Received map reply nonce 0xCE071D2D-0x42543550, records 1
*Apr 29 15:39:07.191: LISP: Processing Map-Reply mapping record for IID 0 192.168.2.0/24,
ttl 1440, state complete, authoritative, 1 locator 10.0.0.6 pri/wei=1/1 LpR
*Apr 29 15:39:07.191: LISP: Processing mapping information for EID prefix IID 0
192.168.2.0/24
*Apr 29 15:39:07.191: LISP: LIG 192.168.2.1 Moving info block from mapping entry
192.168.2.1/32 to 192.168.2.0/24.
*Apr 29 15:39:07.639: LISP: LIG 192.168.2.1 Checking for mapping updates.
*Apr 29 15:39:07.639: LISP: LIG 192.168.2.1 Displaying info.
xTR-A#
```

and

```
MS-MR#
*Apr 29 15:39:07.107: LISP: Processing received Encap-Control message from 10.0.0.2 to
10.0.0.10
*Apr 29 15:39:07.107: LISP: Processing received Map-Request message from 192.168.1.1 to
192.168.2.1
*Apr 29 15:39:07.107: LISP: Received map request, source_eid UNSPEC, ITR-RLOCs: 10.0.0.2,
records 1, nonce 0xCE071D2D-0x42543550
MS-MR#
```

Now review the lisp map-cache on xTR-A again.

```
xTR-A# show ip lisp map-cache
LISP IPv4 Mapping Cache for EID-table default (IID 0), 2 entries

0.0.0.0/0, uptime: 00:07:20, expires: never, via static
  Negative cache entry, action: send-map-request
192.168.2.0/24, uptime: 00:02:28, expires: 23:58:03, via map-reply, complete
  Locator    Uptime     State      Pri/Wgt
  10.0.0.6   00:02:28   up           1/1
xTR-A#
```

The LISP management tool "LISP Internet Groper" (**lig**), which is analogous to the DNS-related **dig**, is used to query for the indicated destination (hostname or EID) as a test of the LISP control plane. The **clear ip lisp map-cache** command is first used to clear the lisp map-cache. This is verified by showing the lisp map-cache. To demonstrate the use of LISP debugging, the **debug lisp control-plane lig** command is issued to turn on lig debugging. Next, the **lig** command is applied for the EID 192.168.2.1. This generates lig debug activity – a map-request is generated, a map-reply is received and processed. Finally, the lisp map-cache is checked again, verifying that the information returned via **lig** has been cached. Note also that the MS-MR received the Encapsulated Control Message (Map-Request), processed the Map-Request, and forwarded it to the ETR at Site-B (xTR-B) – who replied to the Map-Request with a Map-Reply directly back to xTR-A.

IPv6 Considerations

The mixed address family capabilities of LISP allow for both IPv4 and IPv6 packets to be used as EIDs and as RLOCs. Thus, LISP encapsulations can contain any of the following combinations: IPv4-to-IPv4-over-IPv4, IPv4-to-IPv4-over-IPv6, IPv6-to-IPv6-over-IPv4, and IPv6-to-IPv6-over-IPv6.

Both LISP sites shown in Figure 1 have IPv6 EIDs (2001:db8:a::/48 and 2001:db8:b::/48), and IPv4 EIDs (192.168.1.0/24 and 192.168.2.0/24). Both IPv4 and IPv6 EIDs were used in the example tests above. Note also that the RLOCs for both sites and core network are IPv4-only. Using LISP, it is simple to connect these two IPv6 islands over the IPv4 infrastructure.

Conclusions

This application note described a very basic lab test to demonstrate the deployment, configuration, and verification of LISP. The basic topology and LISP commands presented in this application note are meant to provide a simply environment in which to begin investigating LISP. In this lab environment, the routers xTR-A and xTR-B (which represent end-customer edge routers), and the router MS-MR (functioning as a Map-Server/Map-Resolver) were tested. No other LISP infrastructure components (such as Proxy-ITR/Proxy-ETR) were deployed or tested. Even so, many LISP features and functionality were successfully demonstrated.

LISP Resources

1. LISP Documentation, including the LISP Command Reference Guide, LISP Configuration Guide, and LISP Lab Test Guide can be found here: http://lisp.cisco.com.
2. Cisco Marketing Information about LISP can be found here: http://www.cisco.com/go/lisp
3. LISP Beta Network information can be found here: http://www.lisp4.net and http://www.lisp6.net

Comments and corrections are welcome. Please direct all queries to: **lisp-support@cisco.com**.

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