LISP Architecture, Protocols, and Product Update

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Session 1.1
Agenda

• LISP Problem Statement
• LISP Overview
• LISP Product Happenings in 2011
• LISP IETF Happenings in 2011
• What’s Next
Today - No ID/Locator Separation

(1) Is this John at the location 'cisco'?
(2) Is this John at location 'home'?
(3) Is this John at 'Starbucks'?

If I have a connection to John does it break because he changed locations?

chambers.cisco.com

198.133.219.25

Application ID

Network ID

Network Location
Future - With ID/Locator Separation

(1) The service binds to an Application Name (DNS)
(2) The Application Name binds to a Endpoint ID (EID)
(3) The EID binds dynamically to a Routing Locator (RLOC)

(1) Users use DNS names (the human “who”)
(2) Applications use EIDs (the network “who”)
(3) Routing uses RLOCs (the network “where”)

<table>
<thead>
<tr>
<th>DNS Name</th>
<th>EID</th>
<th>RLOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>chambers.cisco.com</td>
<td>198.133.219.25</td>
<td>64.100.100.1</td>
</tr>
</tbody>
</table>

Provided by the DNS system
Provided by the LISP routing system
The IP address is overloaded on location and identity.

Why do current IP semantics cause scaling issues?
- Overloaded IP address semantic makes efficient routing impossible
- Today, “addressing follows topology,” which limits route aggregation compactness
- IPv6 does not fix this

Why are route scaling issues bad?
- Routers require expensive memory to hold the Internet Routing Table in forwarding plane
- Your router may have enough memory today; network gear lifetime can be 7 years or more.
- Replacing equipment for the wrong reason (to hold the routing table); gear replacement should be to implement new features and to meet bandwidth requirements

“... routing scalability is the most important problem facing the Internet today and must be solved ...”

Internet Architecture Board (IAB)
October 2006 Workshop (written as RFC 4984)
LISP Overview
How does Location/ID Split help solve this problem?

Today’s Internet Behavior
Loc/ID “overload”

In this model, **everything** goes in the Default Free Zone (DFZ)

LISP Behavior
Loc/ID “split”

In this model, only **RLOCs** go in the DFZ; **EIDs** go in the LISP Mapping System!
What is LISP?

- A new addressing architecture and protocol suite
  - For separating End-point IDs and Locators
- Network-based solution
- No changes to hosts whatsoever
- No addressing changes to site and core devices
- Very few configuration file changes
- Imperative to be incrementally deployable
- Address family agnostic
What is LISP?

- LISP is completely open
  - Started in the IRTF
  - Currently has an IETF working group
  - No known IPR

- 100s of Researchers and Operators Contributed to Design

- Multiple Vendors Interested

- Pilot Network up for nearly 4 years
  - 121 nodes in 25 countries

- Building a LISP-MN Pilot Network
  - Testing server capabilities on Android phones
  - Experimenting new mapping database systems and security mechanisms
IETF LISP WG Status

- 7 Internet Drafts past WG last call
- Currently in AD review
  - draft-ietf-lisp
  - draft-ietf-lisp-alt
  - draft-ietf-lisp-interworking
- Currently IESG last call
  - draft-ietf-lisp-multicast
  - draft-ietf-lisp-ms
  - draft-ietf-lisp-map-versioning
- RFC editor queue (for RFC number assignment)
  - draft-ietf-lisp-lig
ITR – Ingress Tunnel Router
- Receives packets from site-facing interfaces
- Encap to remote LISP sites, or native-fwd to non-LISP sites

ETR – Egress Tunnel Router
- Receives packets from core-facing interfaces
- De-cap, deliver packets to local EIDs at site
LISP Overview
Data-Plane Flow

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LISP Overview
LISP Mapping Resolution - DNS analog

LISP “Level of Indirection” is analogous to a DNS lookup

- DNS resolves **IP addresses** for **URLs**

![DNS URL Resolution Diagram]

- LISP resolves **locators** for queried **identities**

![LISP Mapping Resolution Diagram]
LISP Control Plane Overview
Control Plane Messages

Control Plane **EID Registration**

**Map-Register message**
Sent by ETR to Map-Server to register its associated **EID** prefixes
Specifies the **RLOC(s)** to be used by the Map-Server when forwarding Map-Requests to the ETR

Control Plane “Data-triggered” mapping service

**Map-Request message**
Sent by an ITR when it needs for **EID/RLOC mapping**, to test an **RLOC** for reachability, or to refresh a mapping before TTL expiration

**Map-Reply message**
Sent by an ETR in response to a valid map-request to provide the **EID/RLOC** mapping and site ingress Policy for the requested **EID**
LISP Overview
Mapping Database System

Database Mapping Entry:
10.0.0.0/8 -> (1.1.1.1, 2.2.2.2)

Database Mapping Entry:
11.0.0.0/8 -> (3.3.3.3, 4.4.4.4)

Database Mapping Entry:
12.0.0.0/8 -> (5.5.5.5, 6.6.6.6)

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LISP Control Plane Overview
Map-Registration example

Legend:
EIDs -> Green
Locators -> Red
BGP-over-GRE
Physical link

PI EID-prefix 2.0.0.0/24

PI EID-prefix 3.0.0.0/24

Other 3/8 sites…
LISP Control Plane Overview
Map-Request example

Legend:
- EIDs -> Green
- Locators -> Red
- BGP-over-GRE
- Physical link
LISP Control Plane Overview
Map-Reply example

Legend:
- EIDs -> Green
- Locators -> Red
- BGP-over-GRE
- Physical link

Session 1.1

Mapping Entry

EID-prefix: 3.0.0.0/24
Locator-set:
- 12.0.0.2, priority: 1, weight: 50 (D1)
- 13.0.0.2, priority: 1, weight: 50 (D2)
LISP Overview
Mapping Database Modularity

Legend:
LISP Sites -> green
1st layer access infrastructure -> blue
2nd layer core infrastructure -> red
LISP Team Philosophy

- Cisco will ship 4 LISP-related releases per year
  - We have been doing this since Dec 2009
  - Engineering releases from LISP team
  - Mainline releases from Bus

- **Engineering releases**
  - More features - development support
  - Support level scales less so

- **Mainline releases**
  - Less features - TAC support
  - Support level scales better
Mainline Products

- Shipped summer of 2011
- ISR(s) and ASR 1K
  - IOS 15.1.4M
  - IOS-XE 3.3.0S
- Nexus 7K
  - NX-OS 5.2(1) (mainline delhi)
LISP Engineering-Team Products

- **ISR(s) and ASR 1K**
  - IOS 15.1(4)XB4
  - IOS-XE 2.5.1XC

- **Nexus 7K**
  - NX-OS dino-lisp-r4 (delhi branch)

- **Titanium and UCS c200 bare metal**
  - NX-OS dino-lisp-r4 (delhi branch)

- **Titanium and UCS c200 virtualized**
  - NX-OS dino-lisp-r4 with VMware and KVM
**LISP Shipping Use-Cases**

1. Low OpEx site multi-homing
2. IPv6 coexistence
3. VM-mobility (includes cloud mobility)
4. Multi-tenant VPNs
5. Mapping System support for LISP-MN
LISP Use Cases
Efficient Multi-Homing

Needs:
- Site connectivity to multiple providers
- Low OpEx/CapEx

LISP Solution:
- LISP provides a streamlined solution for handling multi-provider connectivity and policy without BGP complexity

Benefits:
- Multi-homing across different providers
- Simple policy management
- Ingress Traffic Engineering
- Egress Traffic Engineering
LISP Use Cases
IPv6 Migration Support

Needs:

- Rapid IPv6 Deployment
- Minimal Infrastructure disruption

LISP Solution:

- LISP encapsulation is Address Family agnostic
  - IPv6 interconnected over IPv4 core
  - IPv4 interconnected over IPv6 core

Benefits:

- Accelerated IPv6 adoption
- Minimal added configurations
- No core network changes
- Can be used as a transitional or permanent solution
LISP Use Cases
Mobile-Node Mobility

This phone is a LISP site!

EID-prefix: 2610:00d0:xxxx:1/128
Map-Server: 64.1.1.1

1) 2 MNs can roam and stay connected
2) MNs can be servers
3) MNs roam without changing DNS entries
4) MNs can use multiple interfaces
5) MNs can control ingress packet policy
6) Faster hand-offs
7) Low battery use by MS proxy-replying
8) And most importantly, packets have stretch of 1 so latency is best for delay sensitive applications

LISP-MN can scale to 1 billion hand-sets!
LISP Use Cases
VPNs and Segmentation

Needs:

- Highly-scalable VPNs supporting IPv4 and IPv6
- Remove IGP scaling limitations for Branch WAN aggregation

LISP Solution:

- LISP Instance-IDs for Over-the-Top VPNs
- Supports complex topologies including multi-homed branches, partial mesh, etc.
- IPv4/IPv6 co-existence

Benefits:

- No CE-PE coordination required
- LISP Mapping System supports high scalability
- Simplified Management
LISP Use Cases

Separation of Address Spaces

Shared Infrastructure for Scaling, Private VPN sites for Segmentation

Shared Mapping Database System

Shared Core Routing System

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LISP Use Cases
Roaming across Subnets

Mapping Database System

- 10.1.0.0/16 -> A
- 10.1.0.2/32 -> A'
- 10.2.0.0/16 -> A'

RLOC A

RLOC A'

vm2 moves

10.1.0.2

vm1

vm2

vm3

server

server
LISP Use Cases
VM-Mobility

Needs:

- VM-Mobility across subnets
- Move detection, dynamic EID-to-RLOC mappings, traffic redirection

LISP Solution:

- xTR Dynamic EID (VM-Mobility) on access or aggregation switches

Benefits:

- Integrated Mobility
- Direct Data Path (no triangulation)
- Connections maintained across moves
- No routing re-convergence
- Transparent to hosts
- No DNS updates required
- Global Scalability (cloud bursting)
- IPv4/IPv6 Support
- ARP elimination
- Automated move detection
LISP Use Cases

LISP Moves Virtual Machines

RLOC Core Network

10.1.0.0/16 -> (RLOC1, RLOC2)

10.1.1.1 moves

10.2.0.0/16

10.1.1.1/32 -> (RLOC3, RLOC4)
LISP Use Cases

LISP Moves Topologies

10.1.1.0/24 -> (RLOC5, RLOC6)
10.1.2.0/24
10.1.3.0/24

Data Center 1

10.1.0.0/16 -> (RLOC1, RLOC2)

10.2.0.0/16 -> (RLOC3, RLOC4)

10.2.1.0/24
10.2.2.0/24
10.2.3.0/24

Data Center 2

10.2.2.0/23 -> (RLOC5, RLOC6, RLOC7, RLOC8)

10.2.2.0/24
10.2.3.0/24

Cloud Provider

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What’s Next for Products

- **NX-OS 5.2(1) LISP Control-Plane with Platform specific Data-Plane**
  - CRS/1 and CRS/3
  - ASR 9K
- **IOS 15.1 LISP Control-Plane with Platform specific Data-Plane**
  - Cat 6K
- **Cat 3K and Cat4K Future**
- **LISP Mapping Database Services**
  - Nexus 1010 Virtual Appliance (NX-OS in a VM)
What’s Next for LISP Features

• LISP-SEC and LISP-dSEC
• LISP Nat-Traversal Support (NTR)
• More LISP-ODF Features
• New LISP Mapping Databases
  – Researching ISIS-ALT, LISP-DDT and LISP-LDML
• LISP-Multicast
• Additional LCAF Support
  – LISP-TE
  – Geo Coordinates for RLOC addresses
  – PETR rough nonce security check
• New EID Support (i.e. MAC addresses)
  – Layer-2 LISP
Any other Products

- Well yes, not sellable - but public domain
- LISP-MN Implementation
  - Android (Froyo and Gingerbread)
    - Nexus 1 and Nexus S HTC phones
    - Demoed to Google and Vint Cerf
    - Demoed to AT&T & OnStar
    - Working on port to cisco Cius
  - Linux
    - Open source now on github.com (LISPmob)
    - Working on Linksys OpenWRT release
What did we miss?

• Other platforms?
• Other LISP features?
LISP is here now!

- With real implementation experience!
- With real deployment experience!
- With real customer engagement!
- Has been that way for several years
- http://www.lisp\{4,6\}.net
- http://lisp.cisco.com
- lisp@ietf.org
- lisp-support@cisco.com
LISP References

Resources

LISP Information

- IETF LISP WG  http://tools.ietf.org/wg/lisp/
- Cisco LISP Site  http://lisp.cisco.com (v4 and v6)
- Cisco LISP Marketing  http://www.cisco.com/go/lisp

Mailing Lists

- IETF LISP WG  lisp@ietf.org
- LISP Interest (public)  lisp-interest@puck.nether.net
- Cisco LISP Questions  lisp-support@cisco.com
LISP Deployment Experience Executive Panel
Thursday, July 14th, 8:00 am, Mandalay Bay C
Session ID: PNLRST-4000

Want a frank technical discussion with a Cisco Fellow and Cisco CTO? Dino Farinacci, Cisco Fellow will give an introduction to LISP, a next-generation routing architecture, that is in real cisco product's and deployed by a distinguished set of customers. Padmasree Warrior, SVP and CTO, will share with you Cisco’s commitment to LISP and how the technology will change Internet Routing and Roaming. Dino and Padma will be joined by a distinguished group of Internet architects and customers, where they will share their experience deploying LISP. Finally, we will have an open-mic Q&A with Dino, Padma, and the panel members. This intimate, hands-down no nonsense interactive exchange with top industry experts is a must see. This session was a great success at CiscoLive London. There is no telling what will be uncovered during this session.

Hosts:
- Padmasree Warrior, Chief Technology Officer, Cisco
- Dino Farinacci, Cisco Fellow

Panelists:
- John Manville, VP Information Technology, Cisco
- Donn Lee, Senior Network Engineer, Facebook
- Danny McPherson, Chief Security Officer, Verisign
- Parantap Lahiri, Director Network Architecture, Microsoft
- Hwa-Jung Han, Manager, Verizon
- John Feurerherd, Data Center Architect, Wells Fargo

http://www.ustream.tv/recorded/15990101
LISP – A Routing Architecture; Not a Feature

LISP Innovations

LISP enables **IP Number Portability**
- With session survivability
- Never change host IP addresses
  - No renumbering costs
- No DNS “name -> EID” binding change

LISP uses **pull** vs. **push** routing
- OSPF and BGP are **push** models;
  - routing stored in the forwarding plane
- LISP is a **pull** model; Analogous to DNS; massively scalable

LISP is an **over-the-top** technology
- Address Family agnostic
- Incrementally deployable
- No changes in end systems

LISP creates a **Level of Indirection**
- Separates End-Host and Site addresses

LISP deployment **simplicity**
- No host changes
- Minimal CPE changes
- Some new core infrastructure components

LISP enables other **interesting features**
- Simplified multi-homing with Ingress traffic engineering – without the need for BGP
- End-host mobility without renumbering
- Address Family agnostic support

LISP is an **Open Standard**
- No Cisco Intellectual Property Rights
Complete Your Session Evaluation

- Please give us your feedback!!
  Complete the evaluation form you were given when you entered the room
- This is session 1.1

Don’t forget to complete the overall event evaluation form included in your registration kit

YOUR FEEDBACK IS VERY IMPORTANT FOR US!!! THANKS
### IPv4 EID/IPv4 RLOC Example

**IPv4 Inner Header:**
- Host supplies EIDs

**IPv4 Outer Header:**
- Router supplies RLOCs

**LISP Header:**
- UDP

---

**IPv4 EID/IPv4 RLOC Example**

<table>
<thead>
<tr>
<th>Field</th>
<th>IPv4 EID/IPv4 RLOC Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version</td>
<td></td>
</tr>
<tr>
<td>IHL</td>
<td></td>
</tr>
<tr>
<td>Type of Service</td>
<td></td>
</tr>
<tr>
<td>Total Length</td>
<td></td>
</tr>
<tr>
<td>Identification</td>
<td></td>
</tr>
<tr>
<td>Flags</td>
<td></td>
</tr>
<tr>
<td>Fragment Offset</td>
<td></td>
</tr>
<tr>
<td>Time to Live</td>
<td></td>
</tr>
<tr>
<td>Protocol (17)</td>
<td></td>
</tr>
<tr>
<td>Header Checksum</td>
<td></td>
</tr>
<tr>
<td>Source Routing Locator</td>
<td></td>
</tr>
<tr>
<td>Destination Routing Locator</td>
<td></td>
</tr>
<tr>
<td>Source Port (xxxx)</td>
<td></td>
</tr>
<tr>
<td>Dest Port (4341)</td>
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<tr>
<td>UDP Length</td>
<td></td>
</tr>
<tr>
<td>UDP Checksum</td>
<td></td>
</tr>
<tr>
<td>Flags</td>
<td></td>
</tr>
<tr>
<td>Nonce/Map-Version</td>
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</tr>
<tr>
<td>Instance ID/Locator Status Bits</td>
<td></td>
</tr>
<tr>
<td>Version</td>
<td></td>
</tr>
<tr>
<td>IHL</td>
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<tr>
<td>Type of Service</td>
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<td>Source EID</td>
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<tr>
<td>Destination EID</td>
<td></td>
</tr>
</tbody>
</table>
LISP - Data Format Example
All Combinations - IPv4 and IPv6 Supported

IPv4/IPv4

IPv4/IPv6

IPv6/IPv6

IPv6/IPv4