LISP: Practice and Experience

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Agenda

- LISP in a Nutshell
- Currently Deployed Network
- Deployment Model
- Numbers and Names
- Configuring LISP
- Futures
- A Few Open Questions
- Active Internet Drafts
- Q/A

LISP in a Nutshell

- Locator/ID Separation Protocol
  - Endpoint Identifiers (EIDs) to number hosts
  - Topological Routing Locators (RLOCs) for routing
  - Network-based map-and-encap solution
  - No changes to hosts whatsoever
  - No new addressing changes to site devices
  - Very few configuration file changes
  - Imperative to be incrementally deployable
  - Address family agnostic

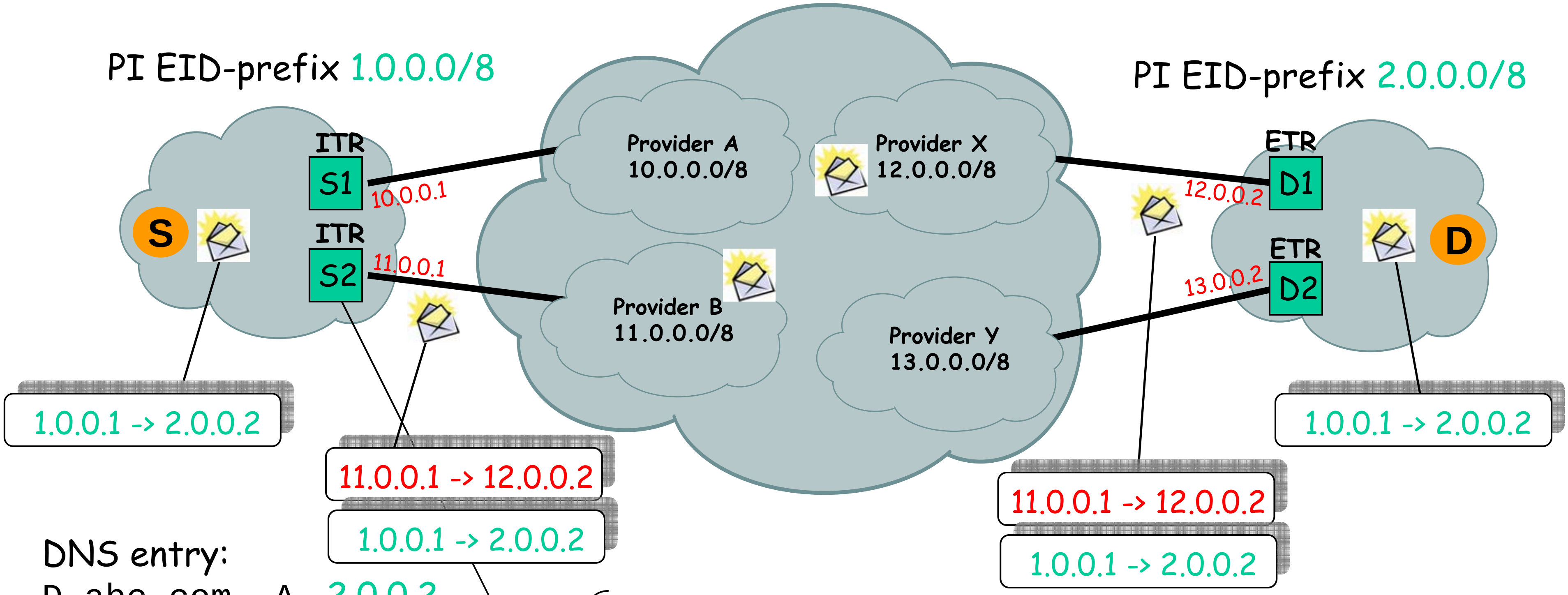
- For more, see tutorials at http://www.lisp4.net

New Network Elements

- Ingress Tunnel Router (ITR)
  - Finds EID to RLOC mapping
    - This is the map part of map-and-encap
  - Encapsulates to Locators at source site
    - This is the encap part of map-and-encap

- Egress Tunnel Router (ETR)
  - Authoritative for its EID to RLOC mapping
  - Decapsulates at destination site

How the LISP Data Plane Works



DNS entry:

`D.abc.com   A   2.0.0.2`

Mapping Entry

EID-prefix: 2.0.0.0/8

Locator-set:

12.0.0.2, priority: 1, weight: 50 (D1)

13.0.0.2, priority: 1, weight: 50 (D2)

Policy controlled by destination site

Legend:

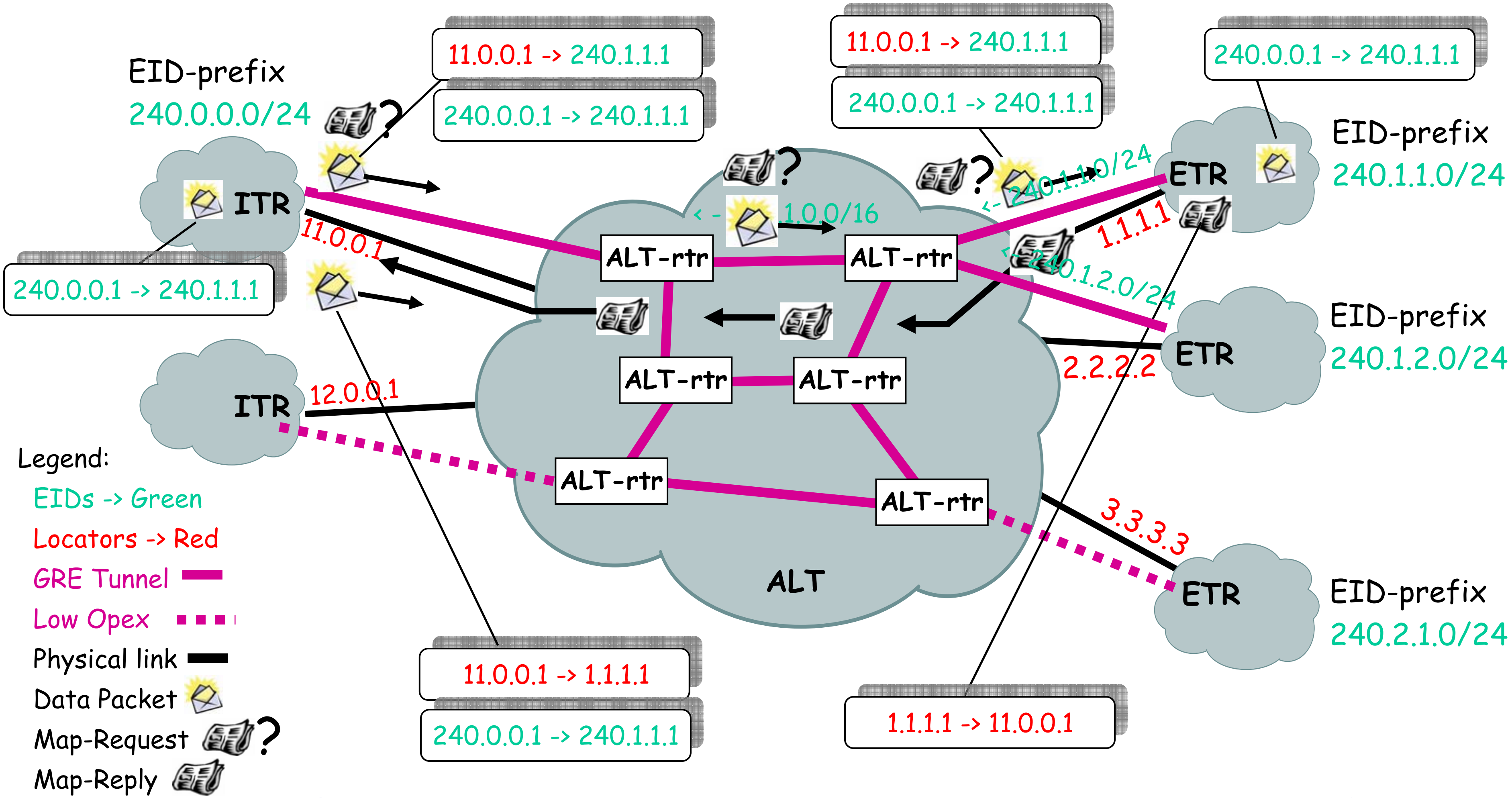
EIDs -> Green

Locators -> Red

Finding an ETR: LISP+ALT

- Hybrid push/pull approach
  - ALT pushes aggregates, LISP pulls specifics
- Hierarchical EID prefix assignment
- Aggregation of EID prefixes
- GRE-based overlay network
- BGP used to advertise EIDs on overlay
- Option for data-triggered Map-Replies

How the ALT Works



EID-prefix
240.0.0.0/24

11.0.0.1 -> 240.1.1.1
240.0.0.1 -> 240.1.1.1

11.0.0.1 -> 240.1.1.1
240.0.0.1 -> 240.1.1.1

240.0.0.1 -> 240.1.1.1

EID-prefix
240.1.1.0/24

240.0.0.1 -> 240.1.1.1

ITR
11.0.0.1

< - 1.0.0/16

<- - 240.1.1.0/24

ETR
1.1.1.1

<- 240.1.2.0/24

ALT-rtr
ALT-rtr
ALT-rtr
ALT-rtr
ALT-rtr
ALT-rtr

EID-prefix
240.1.2.0/24

ETR
2.2.2.2

ITR
12.0.0.1

3.3.3.3
ETR

EID-prefix
240.2.1.0/24

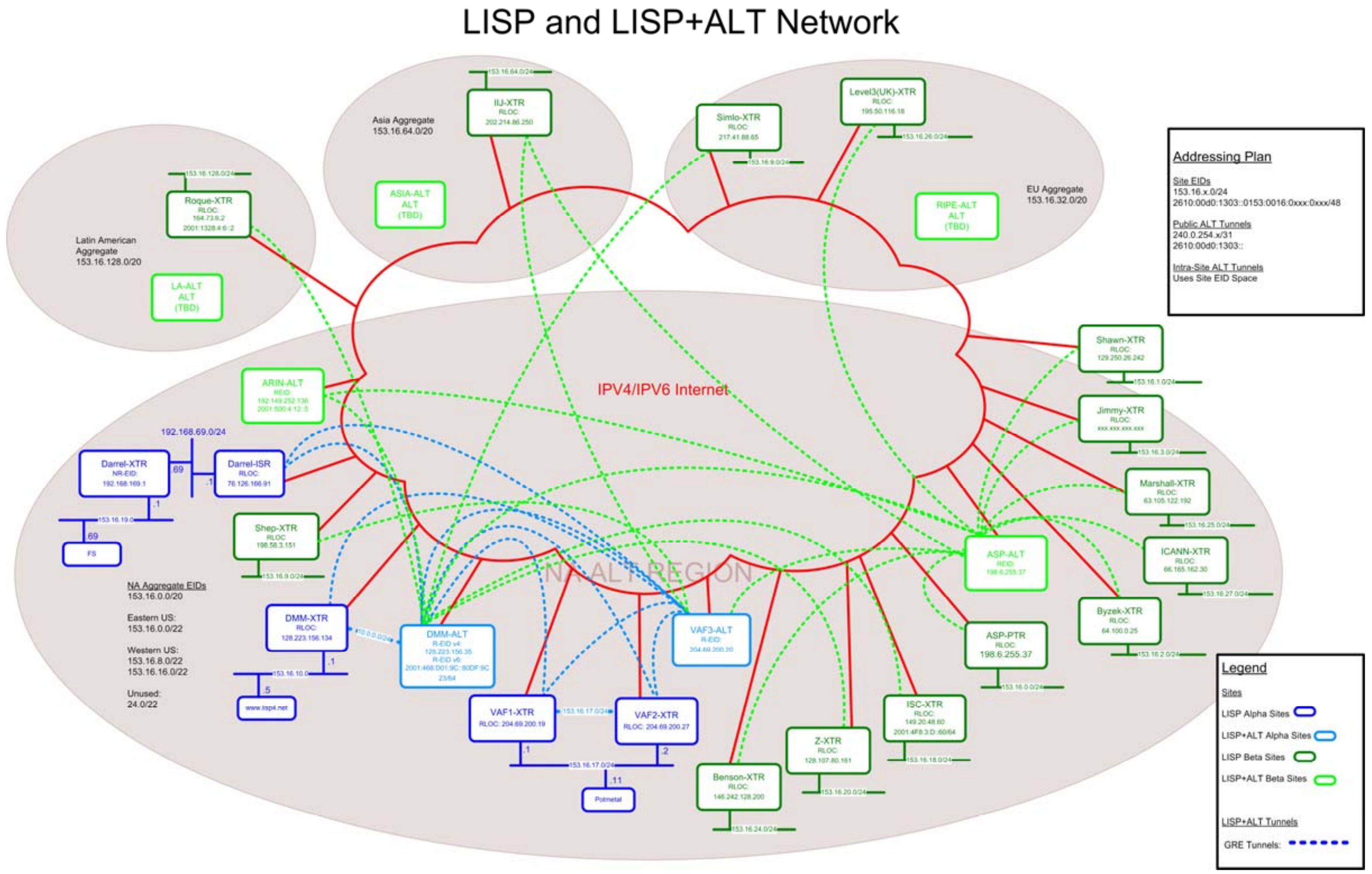
ALT

11.0.0.1 -> 1.1.1.1
240.0.0.1 -> 240.1.1.1

1.1.1.1 -> 11.0.0.1

Legend:
- EIDs -> Green
- Locators -> Red
- GRE Tunnel ▬
- Low Opex ▪▪▪
- Physical link ▬
- Data Packet ✉
- Map-Request 📰?
- Map-Reply 📰

What the Network Looks Like


LISP and LISP+ALT Network
Latin American Aggregate 153.16.128.0/20
153.16.128.0/24
Roque-XTR RLOC: 164.73.6.2 2001:1328:4:6::2
LA-ALT ALT (TBD)
Asia Aggregate 153.16.64.0/20
153.16.64.0/24
IIJ-XTR RLOC: 202.214.86.250
ASIA-ALT ALT (TBD)
Simlo-XTR RLOC: 217.41.88.65
153.16.9.0/24
Level3(UK)-XTR RLOC: 195.50.116.18
153.16.26.0/24
RIPE-ALT ALT (TBD)
EU Aggregate 153.16.32.0/20
Addressing Plan
Site EIDs
153.16.x.0/24
2610:00d0:1303::0153:0016:0xxx:0xxx/48
Public ALT Tunnels
240.0.254.x/31
2610:00d0:1303::
Intra-Site ALT Tunnels
Uses Site EID Space
IPV4/IPV6 Internet
NA ALT REGION
ARIN-ALT REID: 192.149.252.136 2001:500:4:12::5
192.168.69.0/24
Darrel-XTR NR-EID: 192.168.169.1
.69
.1
Darrel-ISR RLOC: 76.126.166.91
.1
153.16.19.0
.69
FS
Shep-XTR RLOC: 198.58.3.151
153.16.9.0/24
NA Aggregate EIDs
153.16.0.0/20
Eastern US:
153.16.0.0/22
Western US:
153.16.8.0/22
153.16.16.0/22
Unused:
24.0/22
DMM-XTR RLOC: 128.223.156.134
10.0.0.0/24
.1
153.16.10.0
.5
www.lisp4.net
DMM-ALT R-EID v4: 128.223.156.35 R-EID v6: 2001:468:D01:9C::80DF:9C 23/64
VAF1-XTR RLOC: 204.69.200.19
153.16.17.0/24
VAF2-XTR RLOC: 204.69.200.27
.1
.2
153.16.17.0/24
.11
Potmetal
VAF3-ALT R-EID: 204.69.200.20
Benson-XTR RLOC: 146.242.128.200
153.16.24.0/24
Z-XTR RLOC: 128.107.80.161
153.16.20.0/24
ISC-XTR RLOC: 149.20.48.60 2001:4F8:3:D::60/64
153.16.18.0/24
ASP-ALT REID: 198.6.255.37
ASP-PTR RLOC: 198.6.255.37
153.16.0.0/24
Shawn-XTR RLOC: 129.250.26.242
153.16.1.0/24
Jimmy-XTR RLOC: xxx.xxx.xxx.xxx
153.16.3.0/24
Marshall-XTR RLOC: 63.105.122.192
153.16.25.0/24
ICANN-XTR RLOC: 66.165.162.30
153.16.27.0/24
Byzek-XTR RLOC: 64.100.0.25
153.16.2.0/24
Legend
Sites
LISP Alpha Sites
LISP+ALT Alpha Sites
LISP Beta Sites
LISP+ALT Beta Sites
LISP+ALT Tunnels
GRE Tunnels:

Deployment Model

- Currently deployed LISP network elements are 1RU PCs ("titanium") running a LISP-capable version of NXOS
  - There are also IOS and Open Source implementations underway

- Endpoint Identifier (EID) Assignment Strategy
  - The basic idea : Geographic (probably)
  - With "ALT-Aggregators" strategically placed within a geography

- GRE tunnel topology
  - Partially meshed ALT-Aggregators, with sites arranged in a star around one or more ALT-Aggregators
  - ALT-Aggregators are typically "ALT-only"
  - Note the *ALT doesn't require GRE*

Deployment Model: Interworking

- LISP Translation
  - "LISP NAT"

- Proxy Tunnel Router (PTR)
  - Advertises coarsely aggregated EID-prefix(es) into the DFZ to attract traffic for those prefixes
  - Behaves like an ITR for that traffic

Deployment Model: Interworking

- You can also respond to a Map-Request for a v6 EID with a v4 locator (and vice versa)
- We call this “mixed locators”
- This allows you to, for example, connect sites deploying IPv6 EIDs over IPv4 locators without an intervening native IPv6 capable network
- More on Interworking in a minute

Network Numbers

- EID Prefixes
  - 153.16/16, geographically subdivided
    - i.e. 153.16.32.0/20 is EU
  - 2610:00d0::/32, sites get 2610:D0:xyzz:/48
    - x is continent, y is region, zz is site
  - Note that both of these are advertised into the DFZ for interworking (PTR) purposes

- GRE tunnels numbered out of 240/4

- ALT uses 4-byte ASNs (32768.x for now)

Network Names

- lisp4.net
  - IPv4 EIDs
  - Exception:
    - www.translate.lisp4.net
    - IPv4 RLOC LISP-translated to an EID
    - More on LISP translation in a moment
- lisp6.net
  - IPv6 EIDs

ITR Configuration

- Enable ITR Functionality
  - **`ip lisp itr`**
  - **`ipv6 lisp itr`**

- Use the ALT to resolve mappings
  - **`ip lisp alt-vrf lisp`**

- Map-Requests vs. Data-Probes
  - **`ip lisp itr send-data-probe`**
    - **Don’t use data-probes**

ETR Configuration

- Enable ETR Functionality
  - **`ip lisp etr`**
  - **`ipv6 lisp etr`**

- Configure an EID-to-RLOC database entry
  - **`ip lisp database-mapping <EID-Prefix> <RLOC> priority <p> weight <w>`**
  - Priority tells the ETR which mappings to use first
  - Weight is a percentage of traffic (covered by EID-Prefix) that should be sent to RLOC
  - Weight can be used to implement **active-active BGP-free multihoming** (among other things)

ETR Configuration

- An ETR will typically advertise its EID-prefix into the ALT
  - Attracts Map-Requests to the authoritative ETR

- If you want "Mixed Locators"
  - ipv6 lisp database-mapping 2610:00d0:1200::/48 128.223.156.134 priority 1 weight 100
  - ipv6 lisp database-mapping 2610:00d0:1200::/48 2001:468:D01:9C:80DF:9C86 priority 2 weight 100

- And if you want the Map-Reply to come back over IPv4
  - ipv6 lisp etr send-ip-map-reply

Advertising an EID-Prefix into the ALT (pretty standard stuff)

```
…
vrf context lisp
  ip   route 153.16.10.0/24    null0 tag 1
  ipv6 route 2610:D0:1200::/48 null0 tag 1
…
router bgp 32768.1
  vrf lisp
    address-family ipv4 unicast
      redistribute static route-map static-to-bgp
     address-family ipv6 unicast
      redistribute static route-map static-to-bgp
  vrf lisp
    neighbor FC00:FFFF:FFFF:FFFF::10:0:0:2 remote-as 32768.613
    address-family ipv6 unicast
    route-map my-eid-prefixes out
  vrf lisp
    neighbor 240.0.254.135 remote-as 32768.100
    address-family ipv4 unicast
    route-map my-eid-prefixes out
```

'Low OPEX' xTR

On the Low OPEX xTR (note: BGP-free):

```
…
vrf context lisp
  ip   route 153.16.0.0/16  240.0.254.140
  ipv6 route 2610:00d0::/32 2610:00d0:1fff::0240:0000:0254:0140/127
```

On the upstream ALT-Aggregator:

```
…
vrf context lisp
  ip route   153.16.19.0/24      Tunnel3 tag 613
  ipv6 route 2610:00d0:1303::/48 Tunnel3 tag 613
```

This is equivalent to static routing a customer

Interworking - LISP Translate

- Essentially "LISP-NAT"
- A router which is upstream from translating ETR advertises the "outside prefix" (usually part of a larger aggregate) into the DFZ, and points the prefix at the ETR doing the translation; standard NAT configuration

- ETR configuration for the translate case:
  - `ip lisp etr`
  - `ip lisp database-mapping 153.16.10.0/24 128.223.156.134 priority 1 weight 100`
  - `ip lisp translate inside 153.16.10.5 outside 128.223.157.65`

- Note that the the "inside" EID (153.16.10.5 in this case) must be covered by the EID prefix in the database-mapping command (153.16.10.0/24 in this case)
- Try http://www.translate.lisp4.net

Interworking - LISP PTR

- The PTR advertises the aggregated EID prefix (e.g., 153.16/16 and/or 2610:D0:/32) into the DFZ
  - This attracts traffic addressed to an EID which originates on the Internet to the PTR

- Upon receiving the traffic (addressed to an EID), the PTR functions as an ITR
  - i.e., it queries the ALT to get the EID-to-RLOC mapping and
  - LISP-encapsulates packets to the destination ETR's RLOC

- Note that the PTR doesn't have mapping state since its not really a LISP site

IPv6 LISP PTR Config

```
!
! Use the LISP VRF for the ALT
!
ipv6 lisp alt-vrf lisp
!
! Enable the PTR
!
ipv6 lisp proxy-itr 2001:0468:0d01:009C::80df:9c23
```

That's really it.

Try http://www.lisp4.net or http://www.lisp6.net

Futures

- Continue to develop LISP software base
  - NXOS, IOS, OpenLISP,...
  - Recent packet format changes
    - Piggyback mappings on map-requests
    - **`draft-farinacci-lisp-09.txt`**
- Continue to build out the network
  - New sites: L3 (London), ARIN, UY
  - Several boxes "in-flight"
    - Let us know if you are interested...
- Simplify ALT configuration and operation

Open Questions

- Who runs the mapping system, and what is the business model?
- Complexity of the mapping system?
- Negative Map-Replies?
- Using LISP for IPv4 Address Conservation
- Effects of the mapping system on applications
  - first packet loss/lookup latency
- Scalability of the ALT
- PMTU effects
- "Stretch" effects
- Caching behavior in xTRs
- ...

LISP Internet Drafts

draft-farinacci-lisp-09.txt
draft-fuller-lisp-alt-02.txt
draft-lewis-lisp-interworking-01.txt
draft-farinacci-lisp-multicast-00.txt
draft-meyer-lisp-eid-block-01.txt

draft-mathy-lisp-dht-00.txt
draft-iannone-openlisp-implementation-01.txt
draft-brim-lisp-analysis-00.txt

draft-meyer-lisp-cons-04.txt
draft-lear-lisp-nerd-04.txt
draft-curran-lisp-emacs-00.txt

Questions/Comments?

Contact us: lisp-interest@lists.civil-tongue.net
Information: http://www.lisp4.net
http://www.lisp6.net
OpenLISP: http://inl.info.ucl.ac.be/softwares/openlisp

Thanks!

(IP (UDP (LISP (IP (UDP (LISP (✉))))))