QuickTime™ and a
decompressor
are needed to see this picture.

LISP: An Architectural Solution to Multi-homing, Traffic Engineering, and Internet Route Scaling

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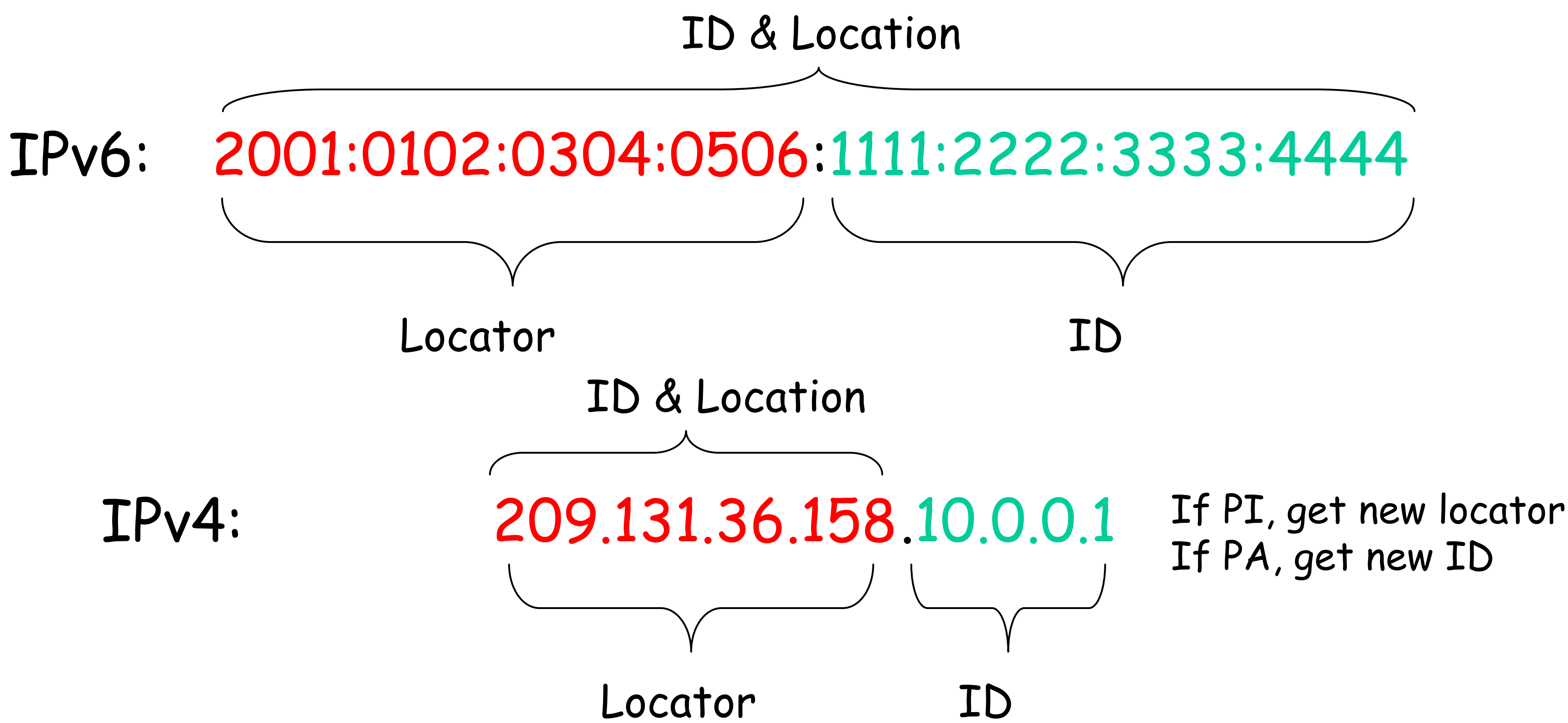
Separating (or adding) an Address

Changing the semantics of the IP address



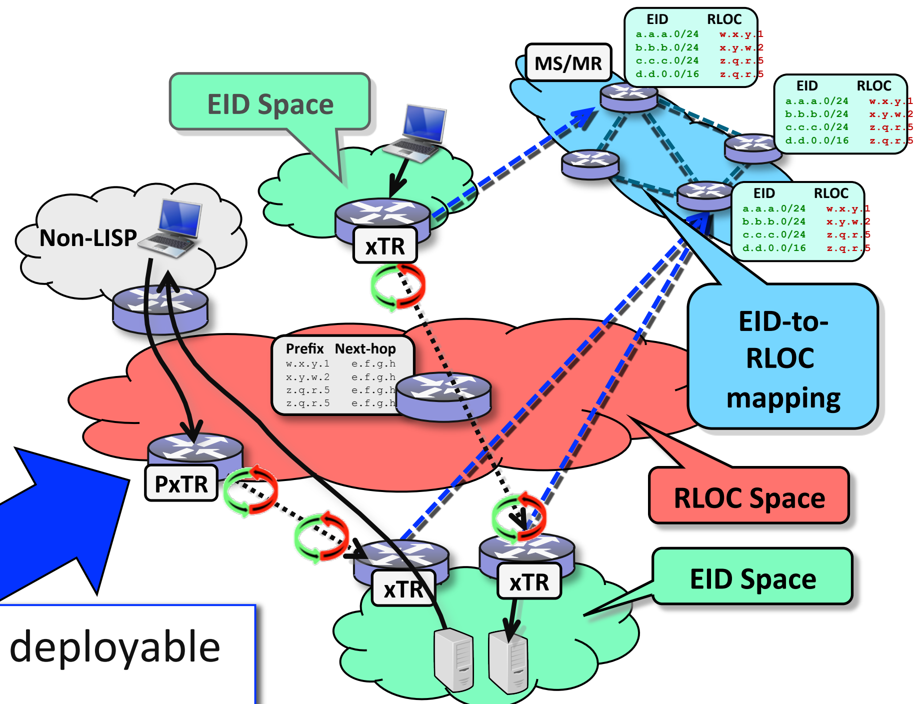
Why the Separation?

- *Level of Indirection* allows us to:
  - Keep either ID or Location fixed while changing the other
  - Create separate namespaces which can have different allocation properties
- By keeping IDs fixed
  - Assign fixed addresses that never change to hosts and routers at a site
- You can change Locators
  - Now the sites can change providers
  - Now the hosts can move

LISP Overview

LISP creates a **Level of indirection** with two namespaces: **EID** and **RLOC**

- **EID (Endpoint Identifier)** is the IP address of a host – just as it is today
- **RLOC (Routing Locator)** is the IP address of the LISP router for the host
- **EID-to-RLOC mapping** is the distributed architecture that maps **EIDs** to **RLOCs**

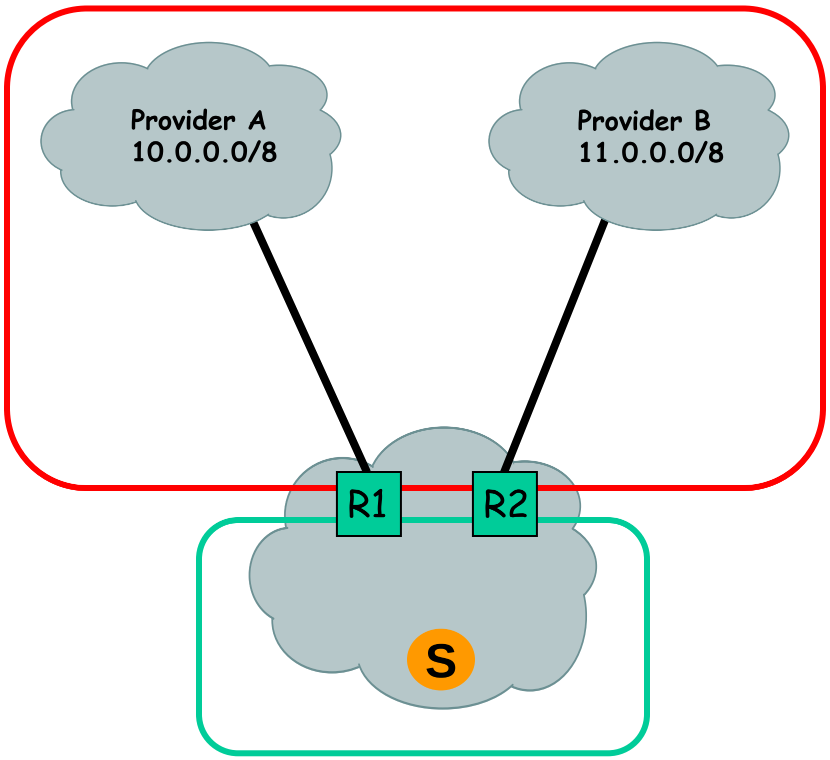


- Network-based solution
- No host changes
- Minimal configuration
- Incrementally deployable
- Support for mobility
- Address Family agnostic

Some Brief Definitions

- IDs or EIDs
  - End-site addresses for hosts and routers at the site
  - They go in DNS records
  - Generally not globally routed on underlying infrastructure
  - New namespace
- RLOCs or Locators
  - Infrastructure addresses for LISP routers and ISP routers
  - Hosts do not know about them
  - They are globally routed and aggregated along the Internet connectivity topology
  - Existing namespace

Multi-Level Addressing



RLOCs used in the core

EIDs are inside of sites

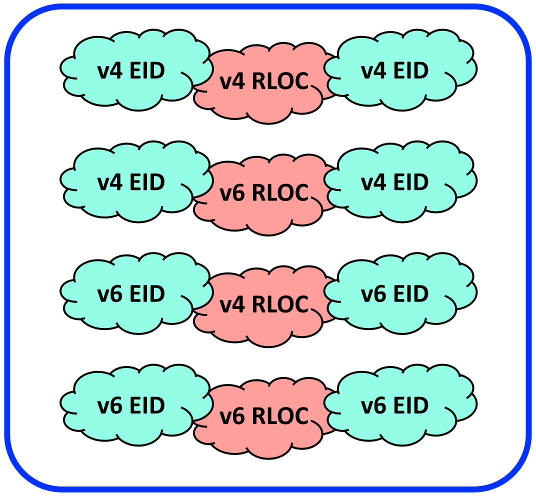
What is LISP?

- Locator/ID Separation Protocol
- Ground rules for LISP
  - Network-based 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

LISP Overview

IP encapsulation scheme

- Decouples host IDENTITY and LOCATION
- Dynamic IDENTITY-to-LOCATION mapping resolution
- Address Family agnostic day-one



Minimal Deployment Impact

- No changes to end systems or core
- Minimal changes to edge devices

Incrementally deployable

- LISP/LISP and non-LISP/LISP considered day-one

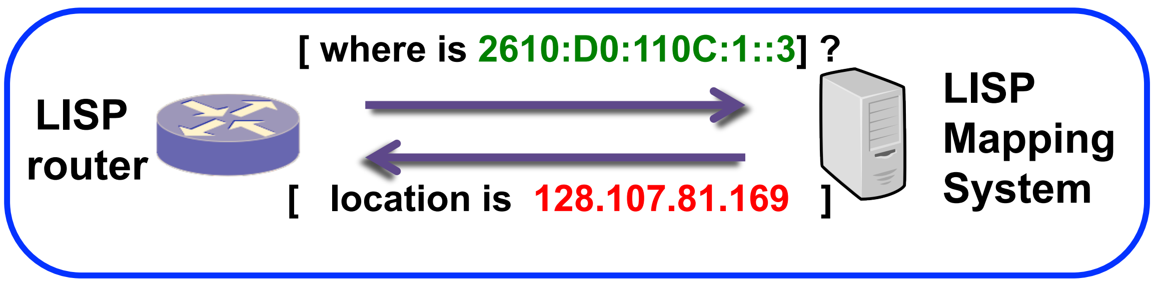
LISP Overview

LISP Map Lookup is analogous to a DNS lookup

- DNS resolves IP addresses for URLs

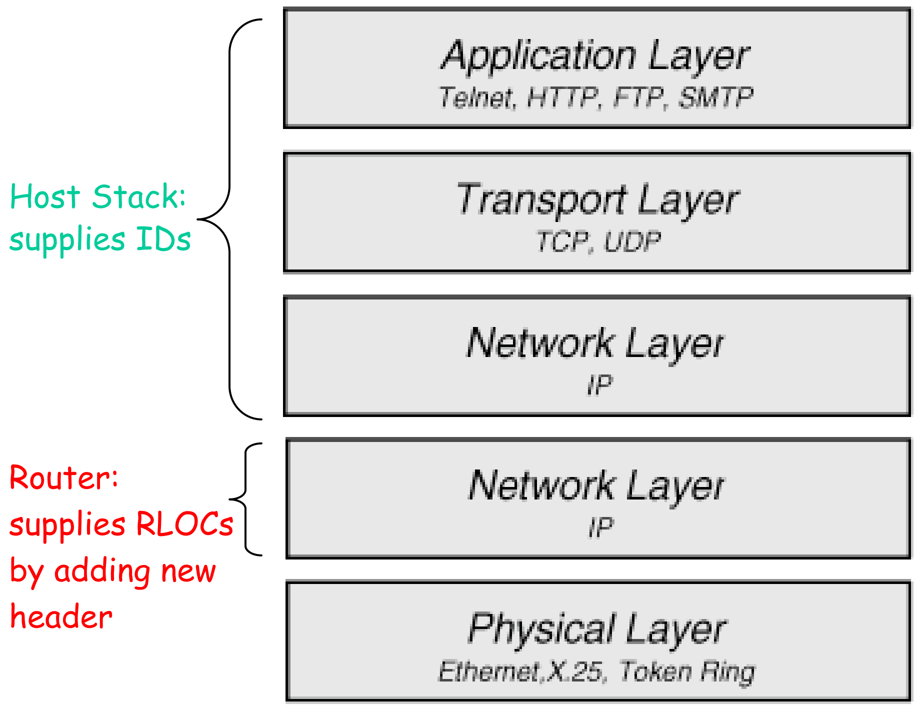
DNS
URL Resolution

- LISP resolves locators for queried identities



LISP
Identity-to-location
Map Resolution

What is LISP?

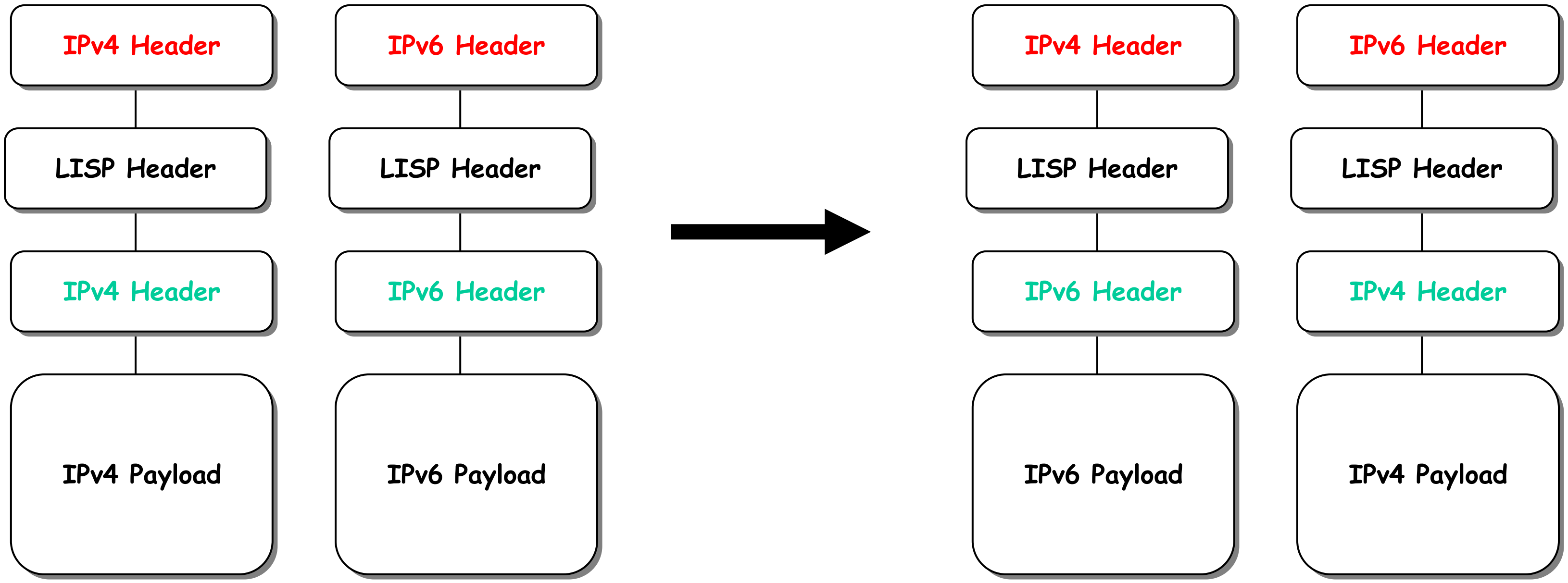


"Jack-Up" or "Map-n-Encap"

draft-farinacci-lisp-11.txt

```
             0                   1                   2                   3
             0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
            +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
          / |Version|  IHL  |Type of Service|          Total Length         |
         /  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
        /   |         Identification        |Flags|      Fragment Offset    |
       /    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     OH     |  Time to Live | Protocol = 17 |         Header Checksum       |
       \    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
        \   |                    Source Routing Locator                     |
         \  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
          \ |                 Destination Routing Locator                   |
            +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
          / |           Source Port         |         Dest Port (4341)      |
       UDP  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
          \ |           UDP length          |        UDP Checksum           |
            +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
          / |                     Locator Reach Bits                       |
      LISP  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
          \ |                             Nonce                             |
            +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
          / |Version|  IHL  |Type of Service|          Total Length         |
         /  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
        /   |         Identification        |Flags|      Fragment Offset    |
       /    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     IH     |  Time to Live |    Protocol   |         Header Checksum       |
       \    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
        \   |                           Source EID                          |
         \  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
          \ |                         Destination EID                       |
            +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

LISP for IPv6 Transition



Legend:

EIDs -> Green

Locators -> Red

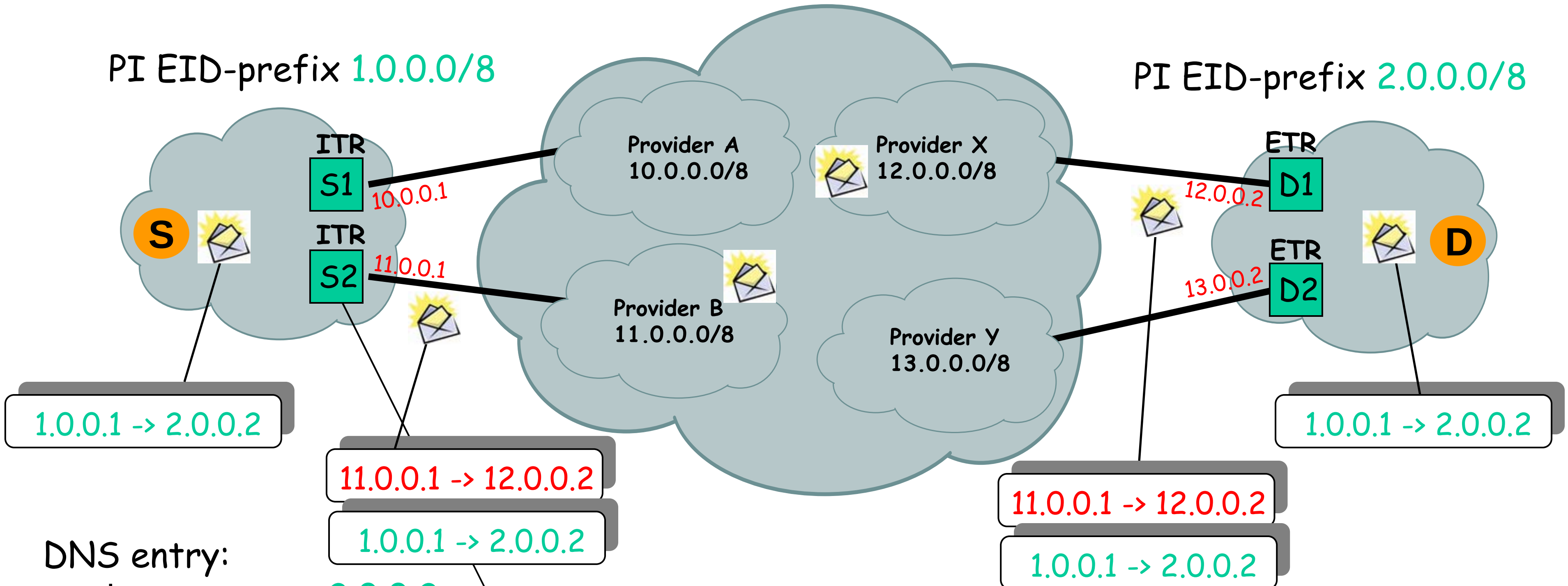
What is LISP?

- Data plane
  - Design for encapsulation and tunnel router placement
  - Design for locator reachability
  - Data-triggered mapping service
- Control plane
  - Design for a scalable mapping service
  - Examples are: CONS, NERD, ALT, EMACS

LISP Network Elements

- Ingress Tunnel Router (ITR)
  - Finds EID to RLOC mapping
  - Encapsulates to Locators at source site
- Egress Tunnel Router (ETR)
  - Owns EID to RLOC mapping
  - Decapsulates at destination site
- xTR
  - Term used when not referring to directionality
  - Basically a LISP router

Unicast Packet Forwarding



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

When the xTR has no Mapping

- Need a scalable EID to Locator mapping lookup mechanism
- Network based solutions
  - Have query/reply latency
  - Can have packet loss characteristics
  - Or, have a full table like BGP does
- How does one design a scalable Mapping Service?

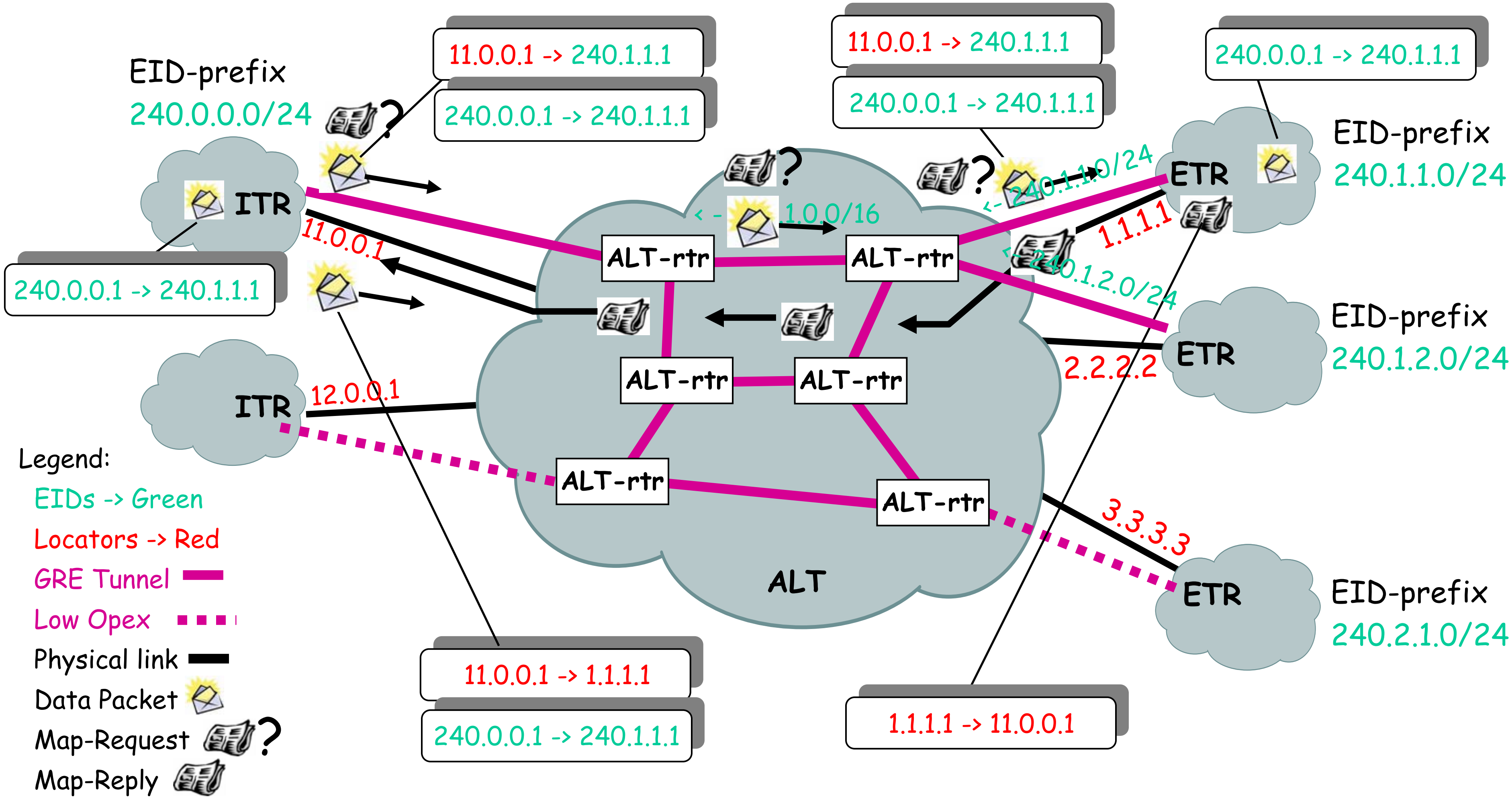
Mapping Database Designs

- You need a "map" before you can "encap"
- We have designed several mapping database protocols
  - CONS, NERD, EMACS, ALT
  - Tradeoff push versus pull benefit/cost
  - Needs to be scalable to 10^{10} entries
- ALT has the most promise
  - We are deploying ALT

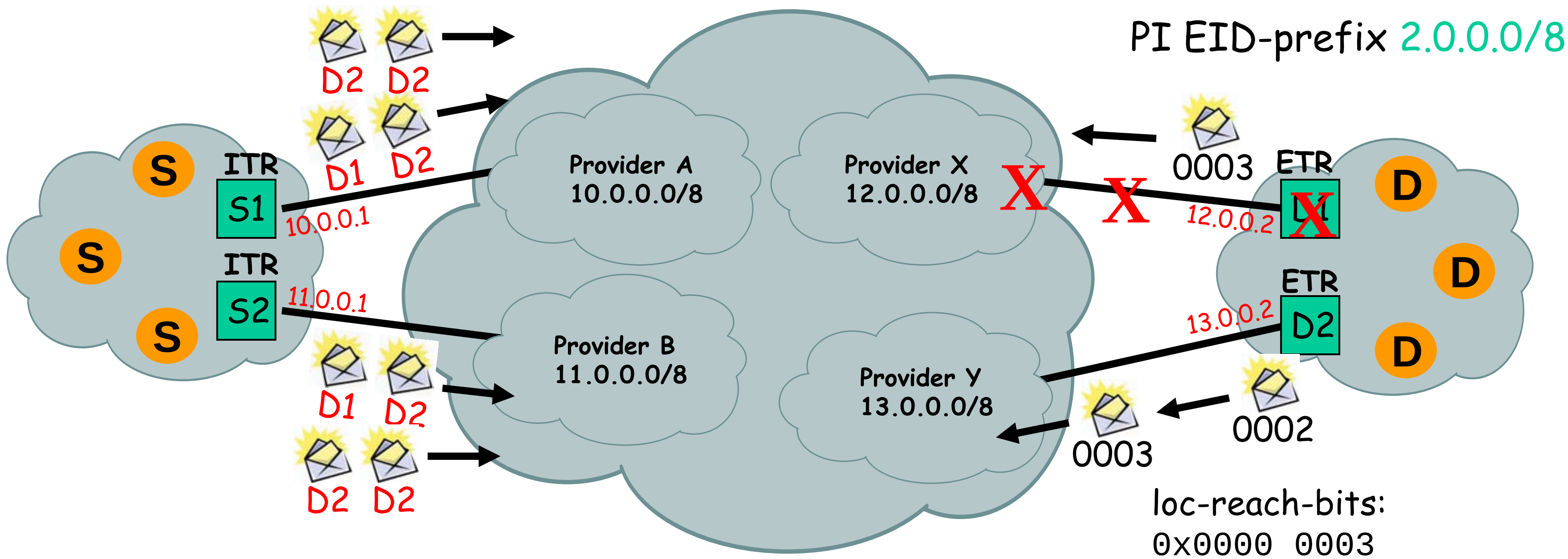
What is LISP+ALT?

- EID namespace is used at the site
- RLOC namespace is used in the Internet core
- Mappings need to be authoritative and reside at site ETRs
- Advertise EID-prefixes in BGP on an alternate topology of GRE tunnels
- ITRs get mappings by routing Map-Requests on ALT topology
- ETRs respond with Map-Replies

How LISP+ALT Works



Locator Reachability



Mapping Entry

EID-prefix: 2.0.0.0/8

Locator-set:

12.0.0.2, priority: 1, weight: 50 (D1) -> ordinal 0

13.0.0.2, priority: 1, weight: 50 (D2) -> ordinal 1

```
 7654 3210
b'xxxx xxxx'
```

Legend:

EIDs -> Green

Locators -> Red

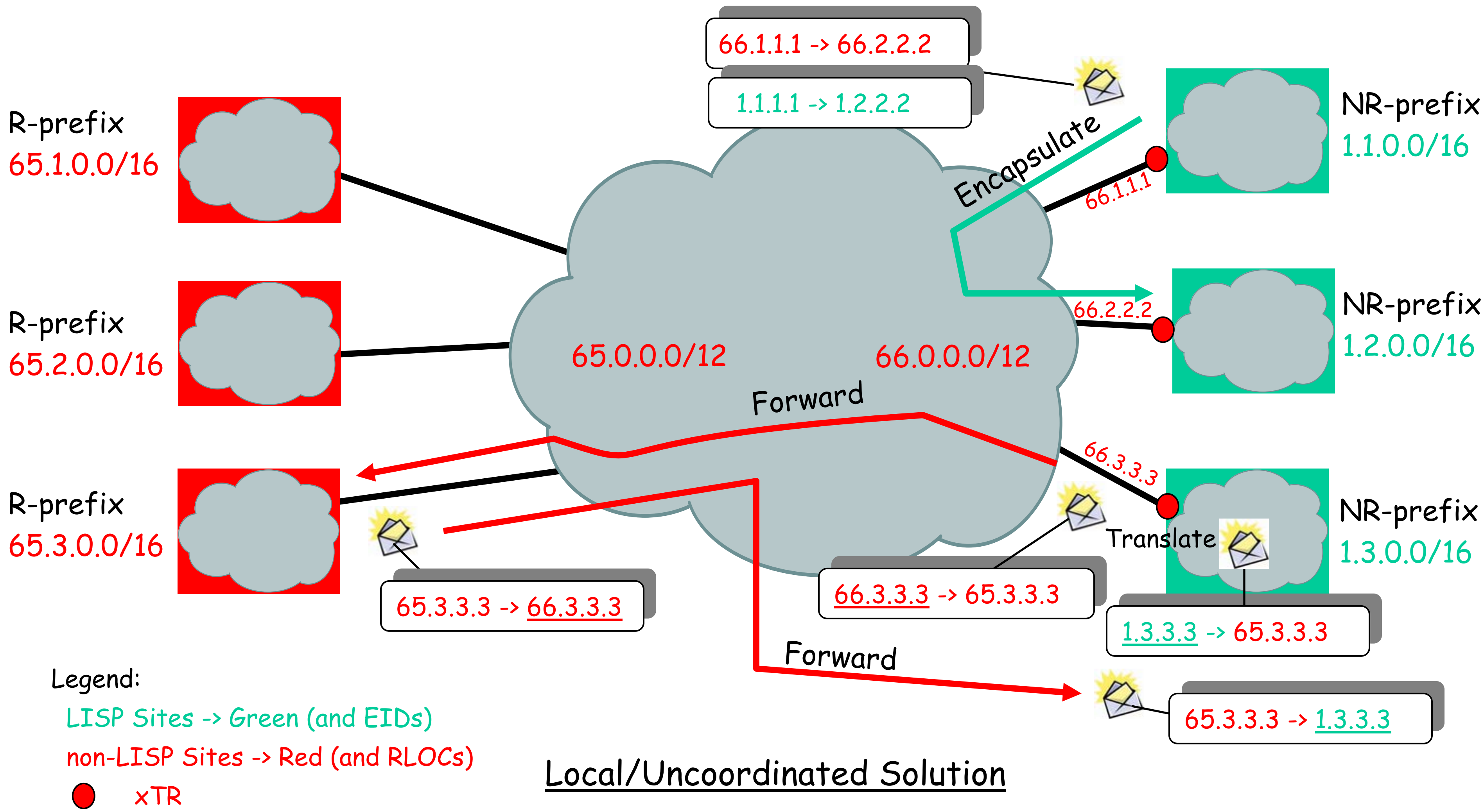
LISP Interworking

- LISP will not be widely deployed day-1
- Need a way for LISP-capable sites to communicate with rest of Internet
- Two basic Techniques
  - LISP Network Address Translators (LISP-NAT)
  - Proxy Tunnel Routers (PTRs)

LISP Interworking

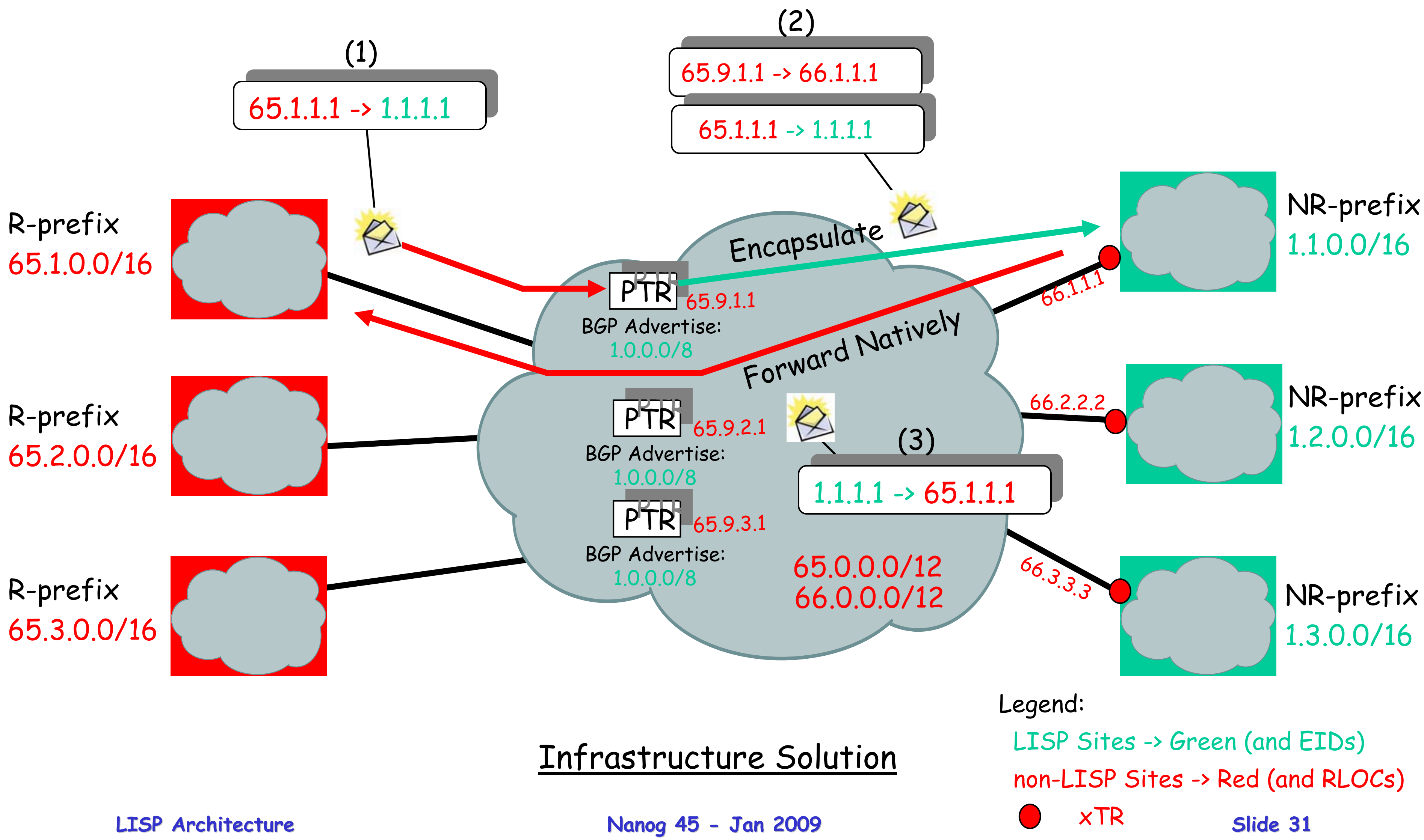
- These combinations must be supported
  - Non-LISP site to non-LISP site
    - Today's Internet
  - LISP site to LISP site
    - Encapsulation over IPv4 makes this work
    - IPv4-over-IPv4 or IPv6-over-IPv4
  - LISP-R site to non-LISP site
    - When LISP site has PI or PA routable addresses
  - LISP-NR site to non-LISP site
    - When LISP site has PI or PA non-routable addresses

Interworking using LISP-NAT



Local/Uncoordinated Solution

Interworking using PTRs



Infrastructure Solution

LISP Use Cases
VM-Mobility

Needs:

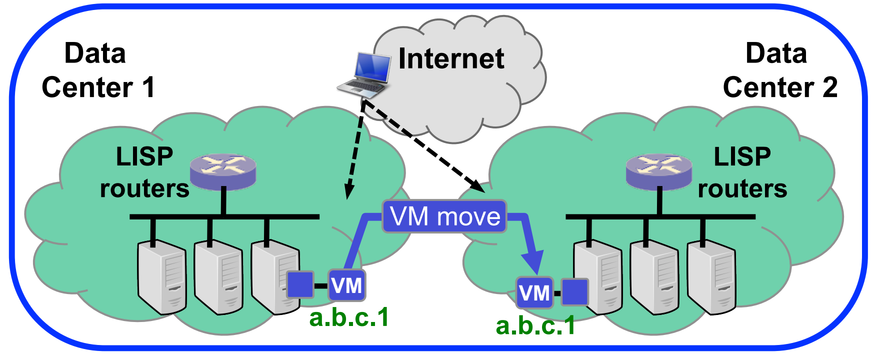
- VM-Mobility across subnets
- Move detection, dynamic EID-to-RLOC mappings, traffic redirection

LISP Solution:

- OTV + LISP to extend subnets
- LISP for VM-moves across subnets

Benefits:

- Integrated Mobility
- Direct Path (no triangulation)
- Connections maintained across moves
- No routing re-convergence
- No DNS updates required
- Global Scalability (cloud bursting)
- IPv4/IPv6 Support
- ARP elimination



Applicability:

- VM OS agnostic
- Services Creation (disaster recovery, cloud burst, etc.)

LISP Use Cases
LISP-MN

Needs:

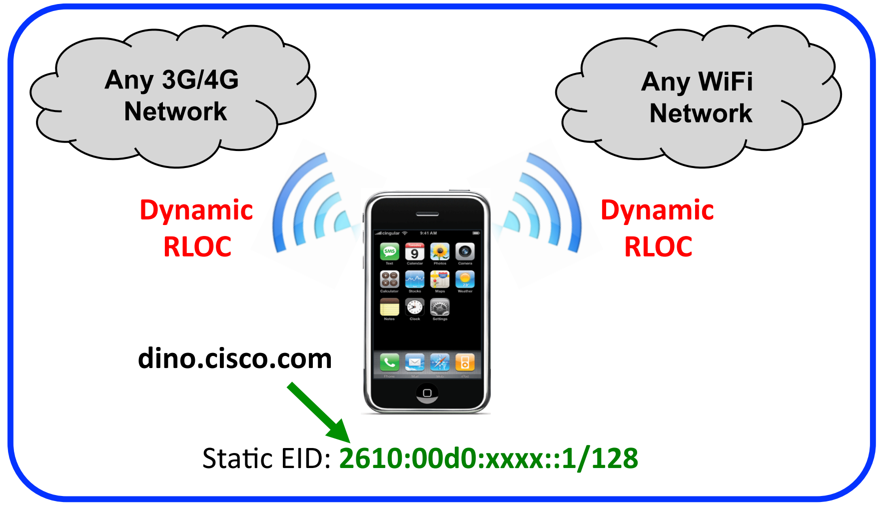
- Mobile devices roaming across any access media without connection reset
- Mobile device keeps the same IP address forever

LISP Solution:

- LISP level or indirection separates endpoints and locators
- Network-based; no host changes, minimal network changes
- Scalable, host-level registration (10^{10})

Benefits:

- MNs can roam and stay connected
- MNs can be servers
- MNs roam without DNS changes
- MNs can use multiple interfaces
- Packets have “stretch-1” reducing latency



Applicability:

- IPv4 and IPv6
- Android and Linux
- Open

Prototype Implementation

- cisco has a LISP prototype implementation
- Supports:

  `draft-farinacci-lisp-11.txt`

  `draft-fuller-lisp-alt-03.txt`

  `draft-lewis-lisp-interworking-02.txt`
- Software switching only
- Supports LISP for both IPv4 and IPv6
  - ITR, ETR, and PTR
  - LISP-NAT for IPv4 only

Internet Drafts

draft-farinacci-lisp-11.txt
draft-farinacci-lisp-multicast-01.txt
draft-fuller-lisp-alt-03.txt
draft-lewis-lisp-interworking-02.txt
draft-meyer-lisp-eid-block-01.txt
draft-meyer-loc-id-implications-01.txt

draft-mathy-lisp-dht-00.txt
draft-iannone-openlisp-implementation-02.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

References

- Public mailing list:

  lisp@ietf.org

- More info at:

  http://www.lisp4.net

  http://www.lisp6.net