LISP - Locator/ID Separation Protocol

Luigi Iannone

Road Map

- Historical Notes
- LISP Data Plane
  - RFC 6830
- LISP Control Plane
  - RFC 6833; RFC 6836; RFC 6837; draft-ietf-lisp-ddt-01.txt
- LISP-Interworking
  - RFC 6832
- The Big Picture

Historical Notes

"Addressing can follow topology

or

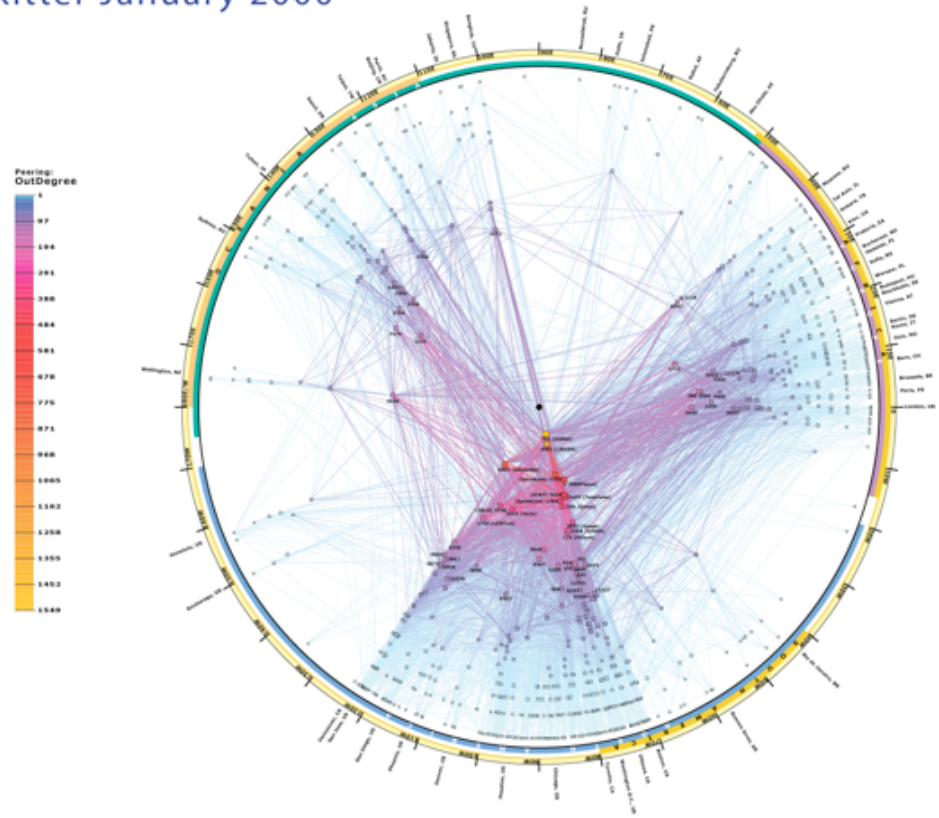
topology can follow addressing. Choose one."

Rekhter's Law

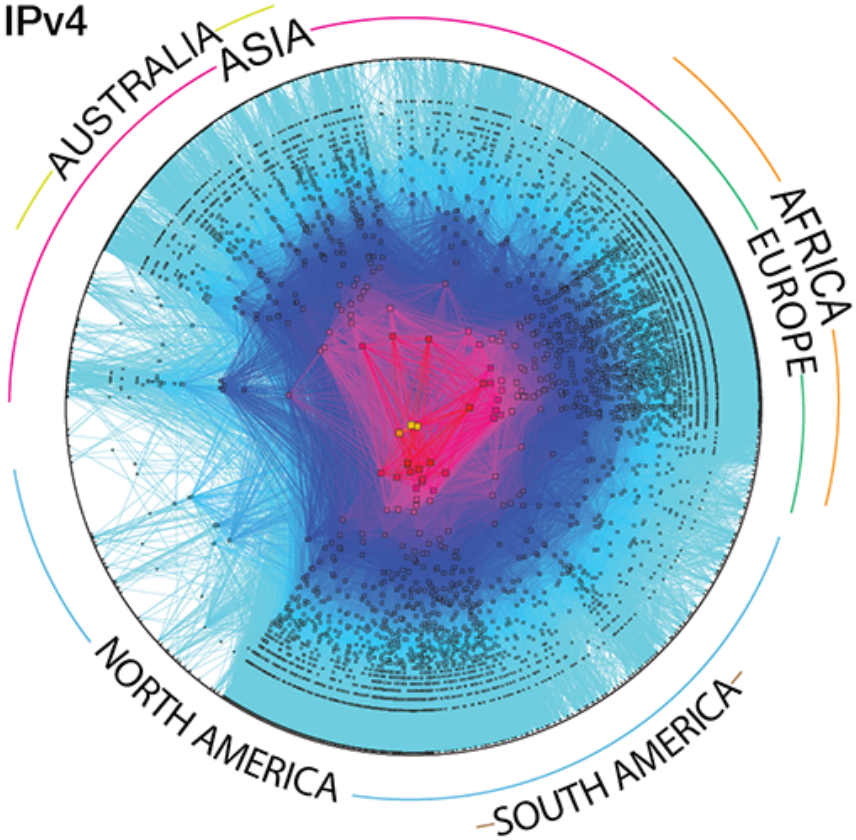
Does the Internet Really Scale?

CAIDA's IPv4 AS Core
AS-level INTERNET GRAPH

Skitter January 2000

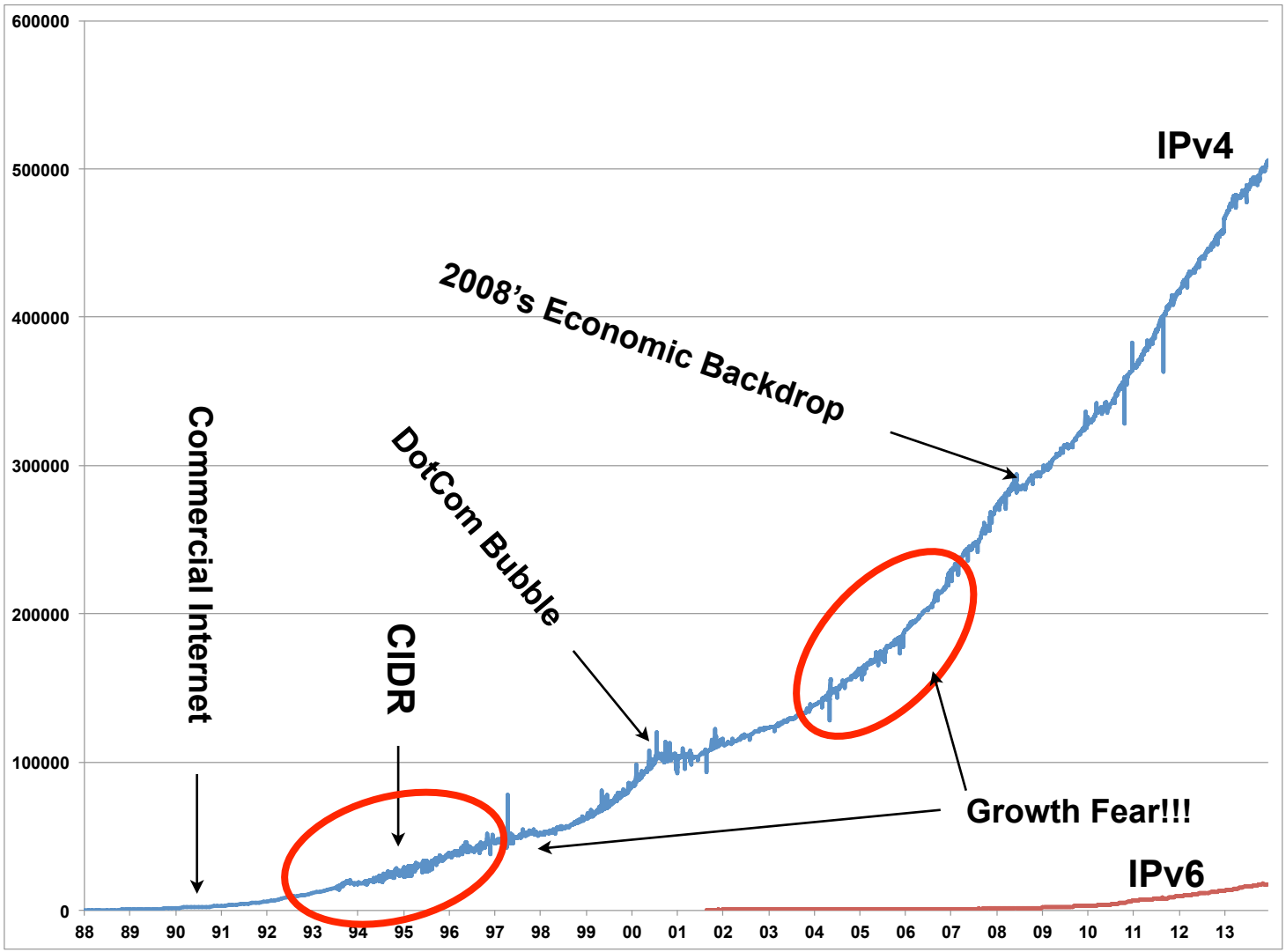


2000

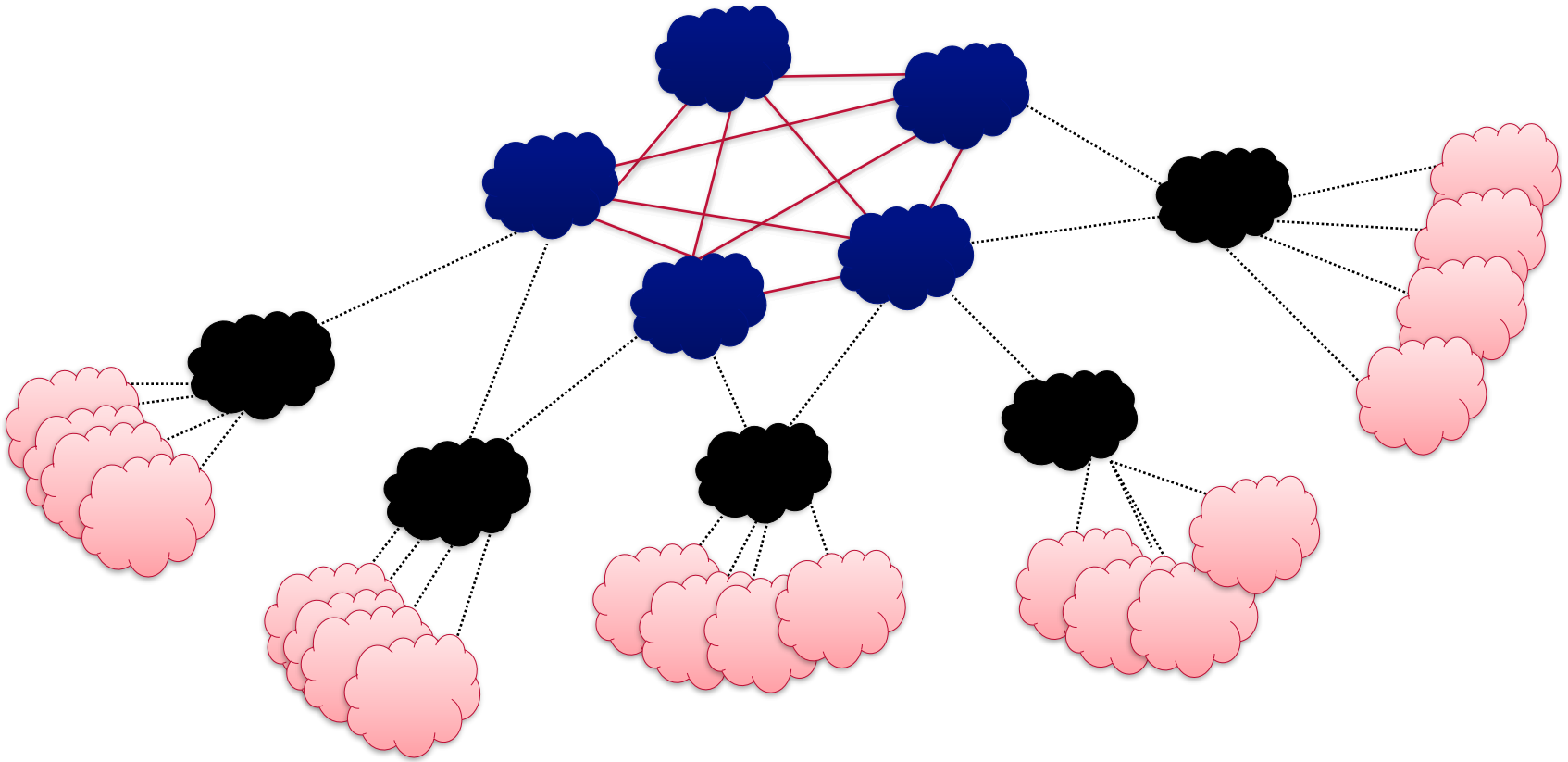


2014

Is it the Internet growth sustainable???



The Proactive Routing Architecture: Do you speak BGP?



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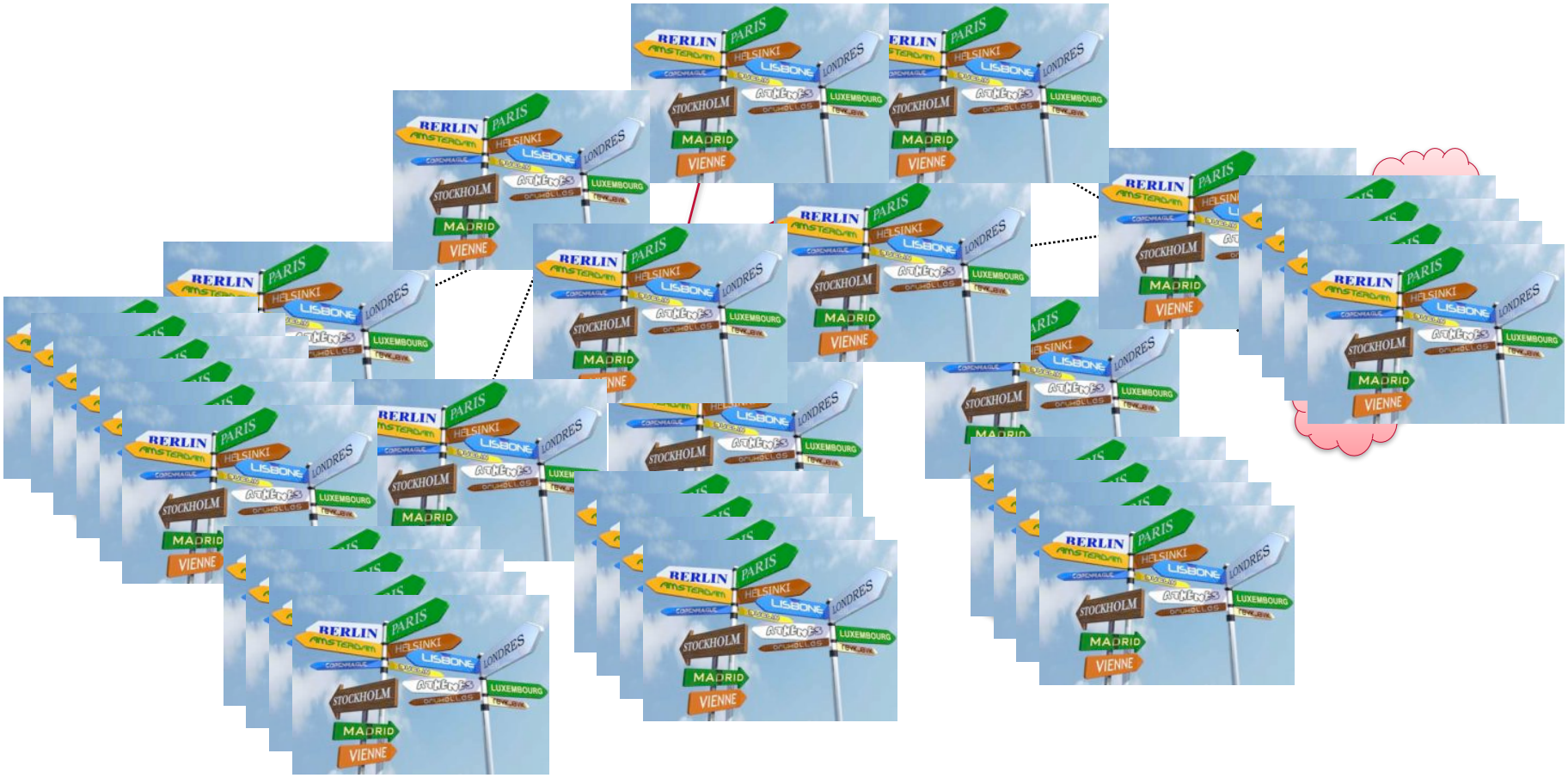

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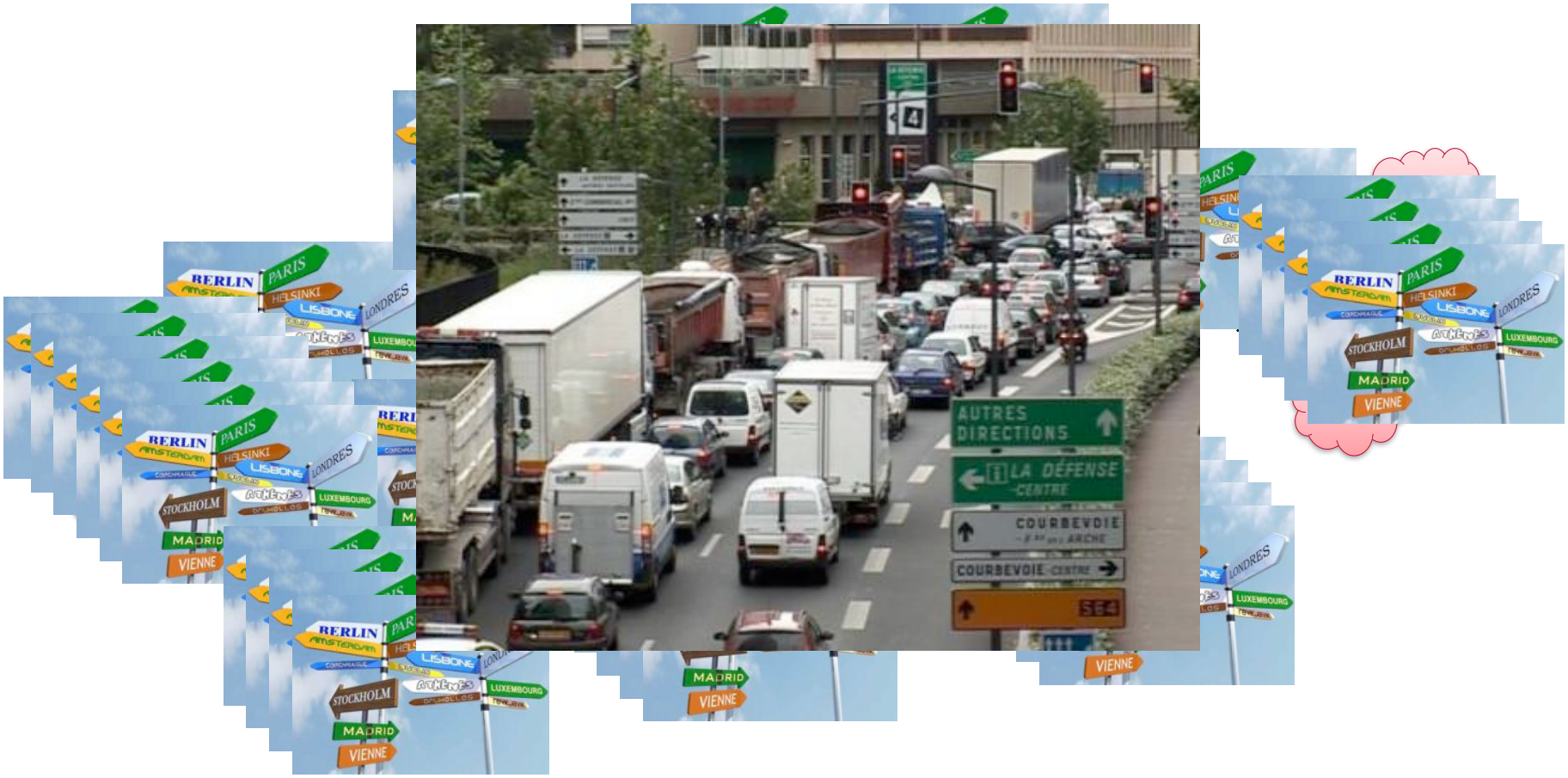

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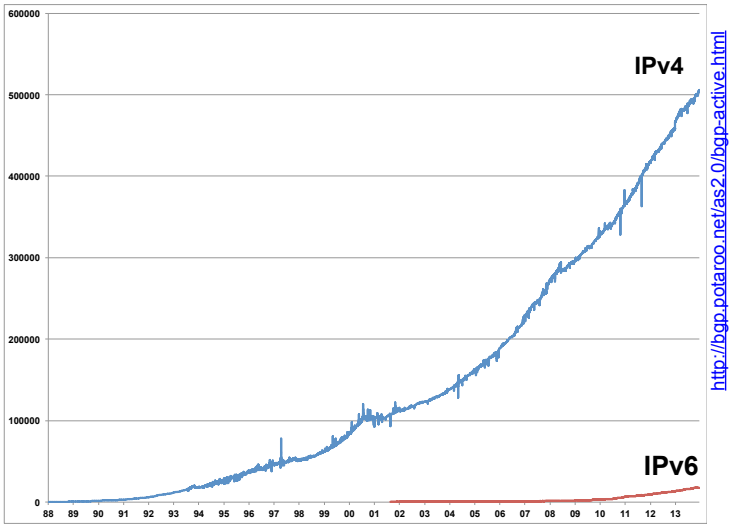
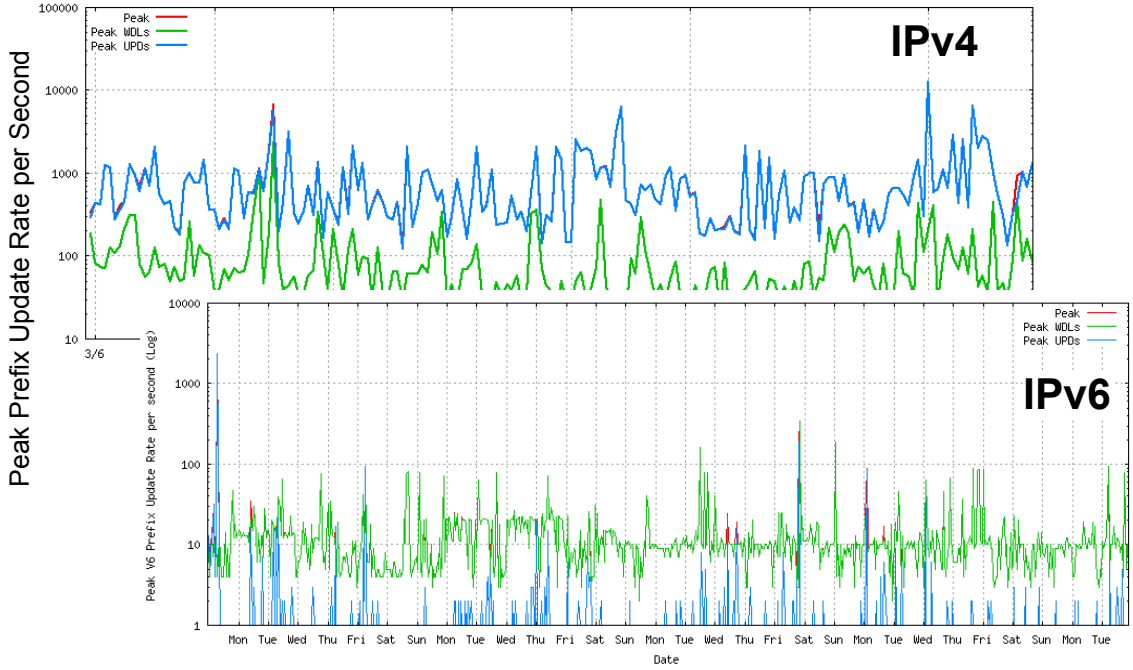
Root of the BGP's FIB inflation problem

No... it is not just natural Internet growth



http://bgp.potaroo.net/as2.0/bgp-active.html



BGP Forwarding Information Base (FIB) and Churn Explosion:

- PI (Provider Independent) prefix assignment
  - Multi-homing
  - Traffic-Engineering
  - Security
    - Remember the YouTube incident?
- Churn can have peaks of thousands per seconds
- Churn increases the need processing power

Monolithic...

"Addressing can follow topology

or

topology can follow addressing. Choose one."

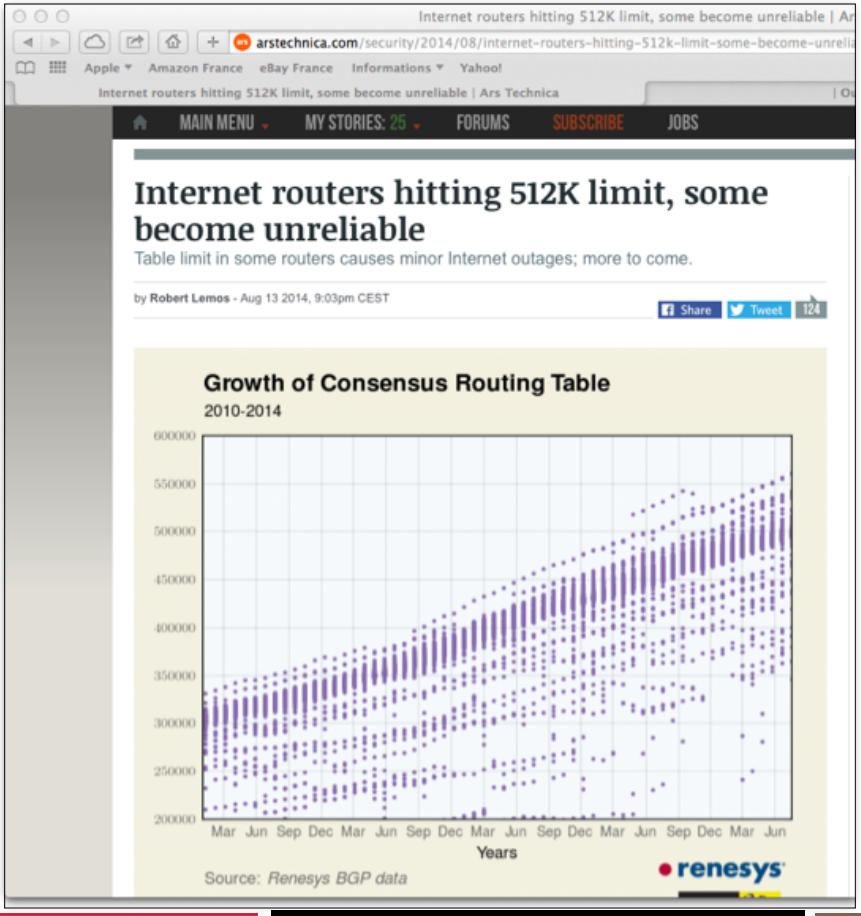
Rekhter's Law

The Location is the ID, the ID is the Location

- The overloaded IP address Semantic
- An IP Address tells:
  - Who you are
    - —Hi! I am *Luigi Iannone 46, Rue Barrault 75013 Paris France*
  - Where you are
    - —Hi! I am *Luigi Iannone 46, Rue Barrault 75013 Paris France*
- This design was OK in the 70s-80s
  - Because was easier to implement
  - Because the Internet was a small academic network of networks

Internet's Scaling Issues

"It is commonly recognized that today's Internet routing and addressing system is facing serious scaling problems."



D. Meyer, L. Zhang, K. Fall, "Report from IAB Workshop on Routing and Addressing", RFC 4984, IETF, September 2007.

From *"Divide and Conquer"* ....
....to *"Split and Scale"*

"The Research Group has rough consensus that separating identity from location is desirable and technically feasible. However, the Research Group does NOT have consensus on the best engineering approach to such an identity/location split."

From RFC 6115: Recommendation for a Routing Architecture

Along with a plethora of proposals:

Locator/ID Separation Protocol (LISP)

Routing Architecture for the Next Generation Internet (**RANGI**)

Internet Vastly Improved Plumbing (**Ivip**)

Hierarchical IPv4 Framework (**hIPv4**)

Name Overlay (**NOL**) Service for Scalable Internet Routing

Compact Routing in a Locator Identifier Mapping System (**CRM**)

Layered Mapping System (**LMS**)

Two-Phased Mapping

Global Locator, Local Locator, and Identifier Split (**GLI-Split**)

Tunneled Inter-Domain Routing (**TIDR**)

Identifier-Locator Network Protocol (**ILNP**)

Enhanced Efficiency of Mapping Distribution protocols in Map-and-Encap Schemes (**EEMDP**)

Evolution

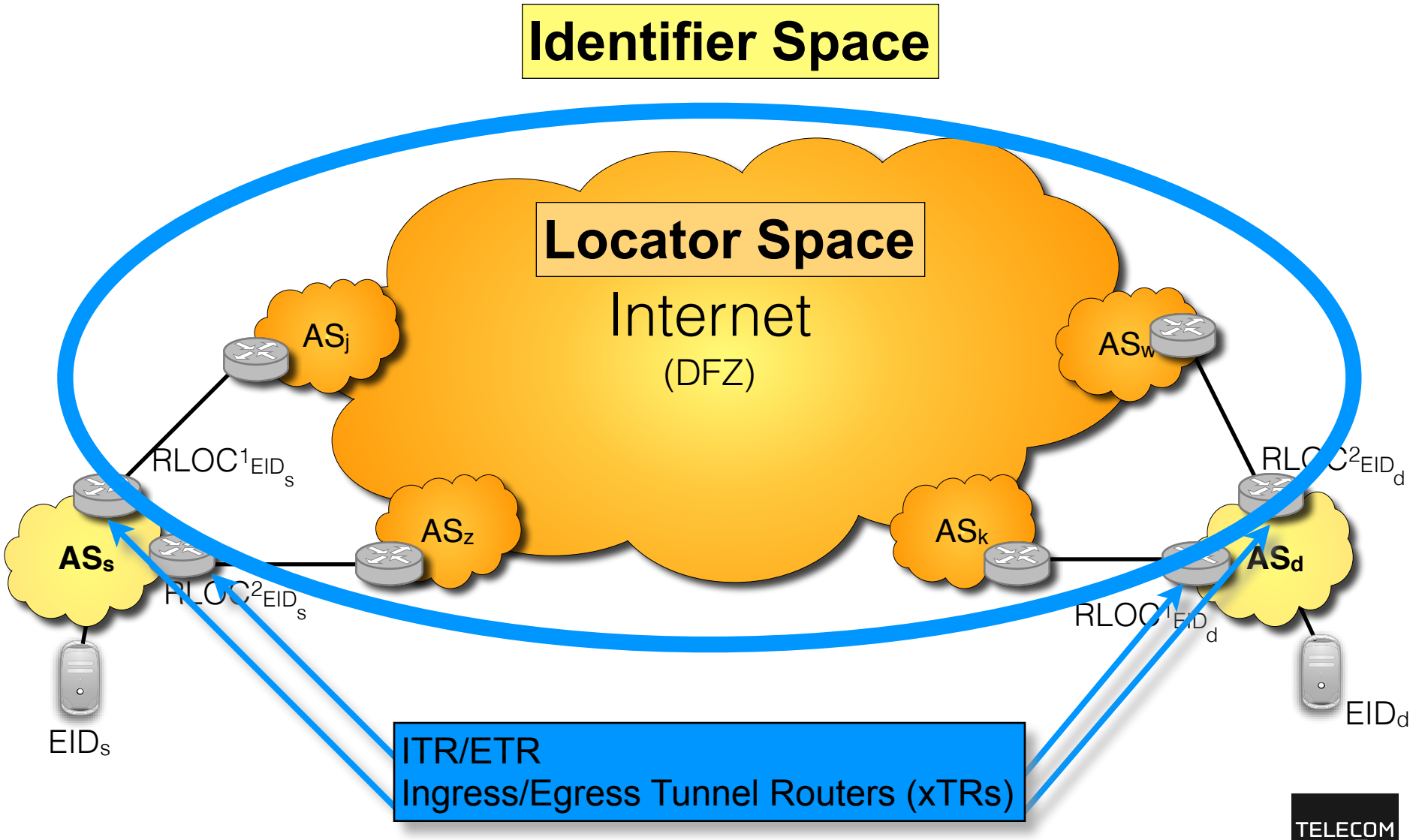
Name-Based Sockets

Routing and Addressing in Networks with Global Enterprise Recursion (**IRON-RANGER**)

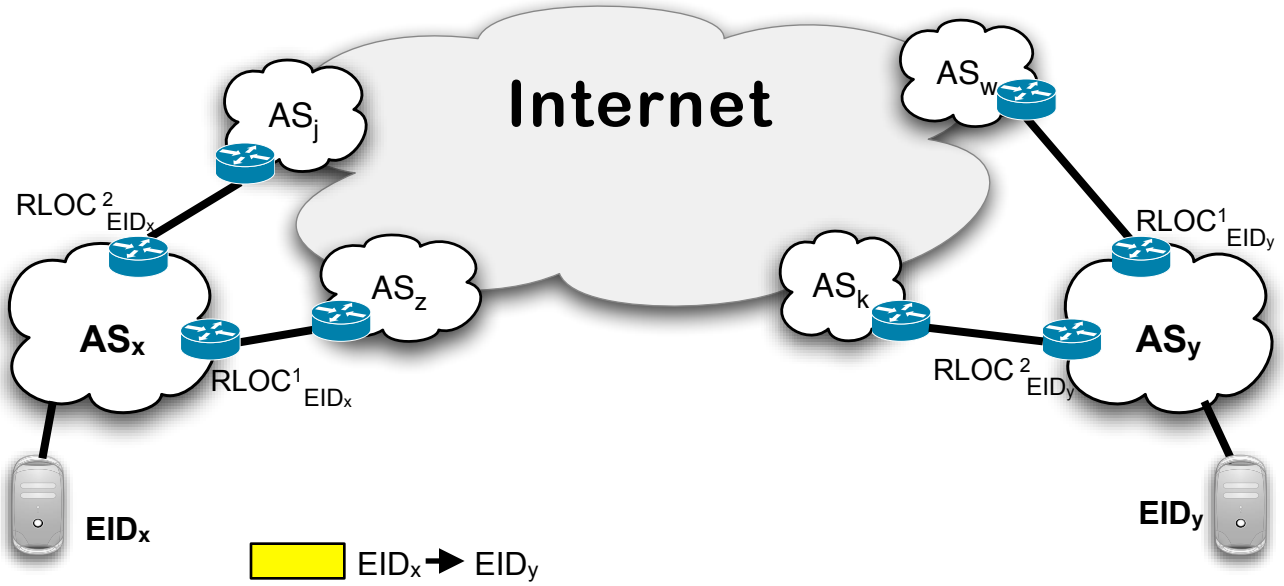
Hierarchical Architecture for Internet Routing (**HAIR**)

LISP Data Plane (RFC 6830)

At the border of ID and Location



Life of a Packet in a LISP World..



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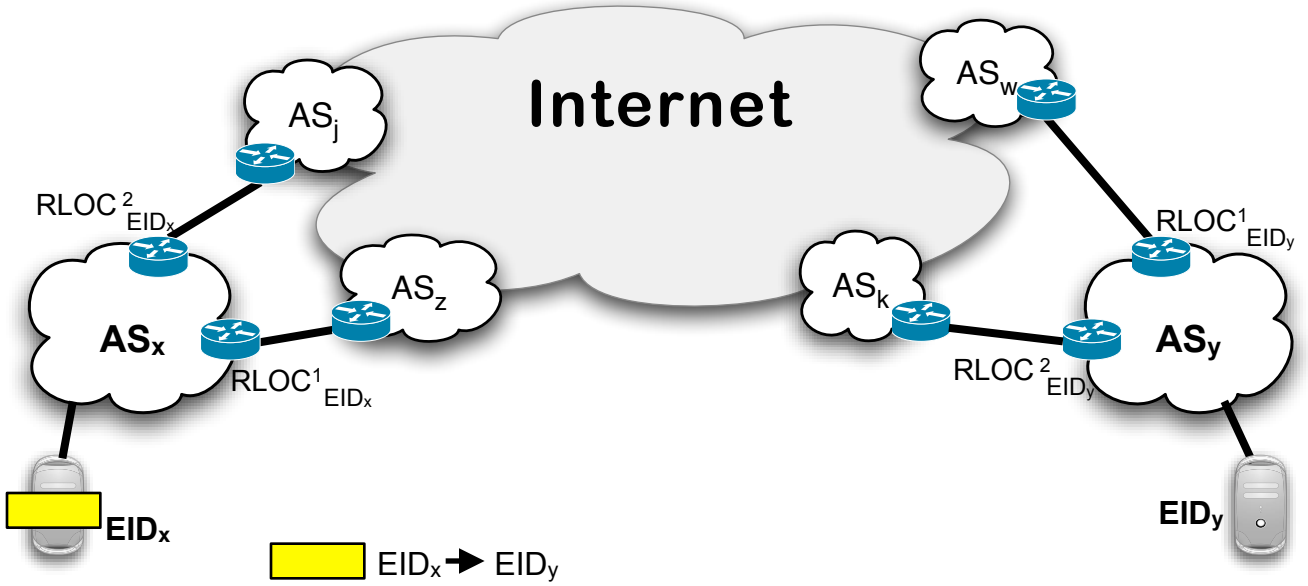

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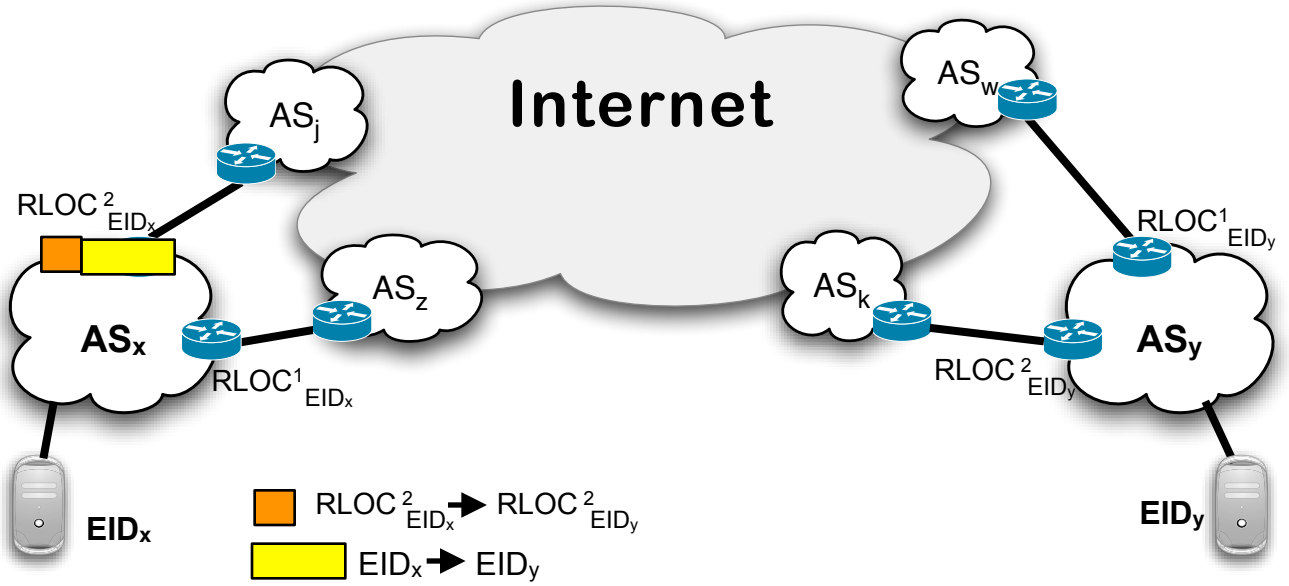

- Bindings between ID and Locators: *Mappings*
  - **EID$_x$** → RLOC^1 EID$_x$ RLOC^2 EID$_x$
  - **EID$_y$** → RLOC^1 EID$_y$ RLOC^2 EID$_y$

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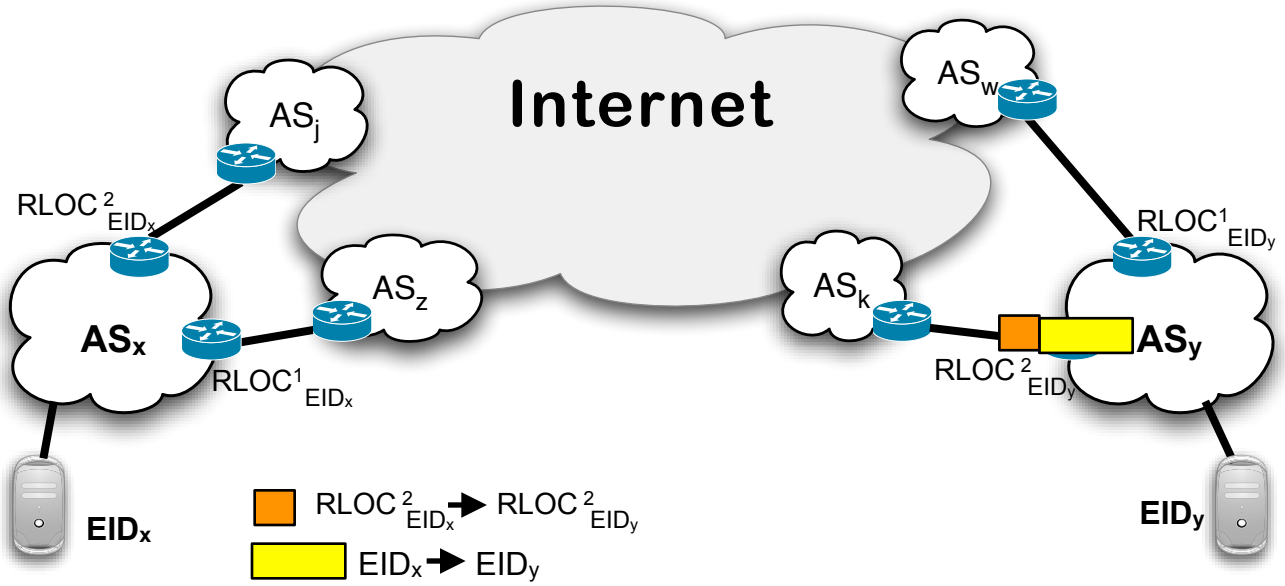

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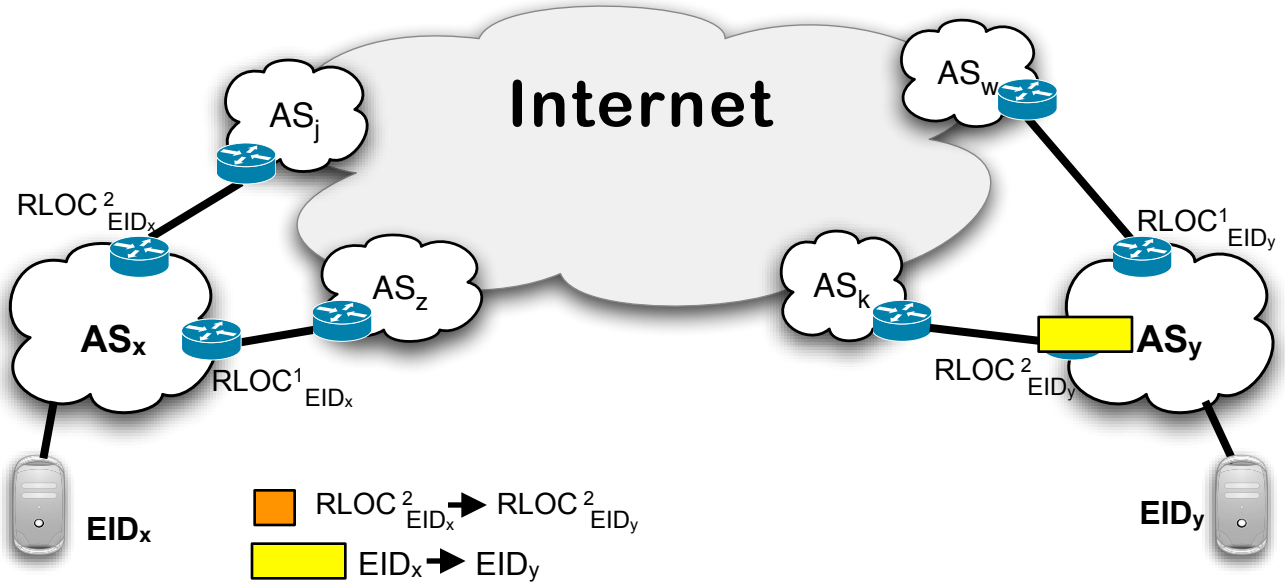

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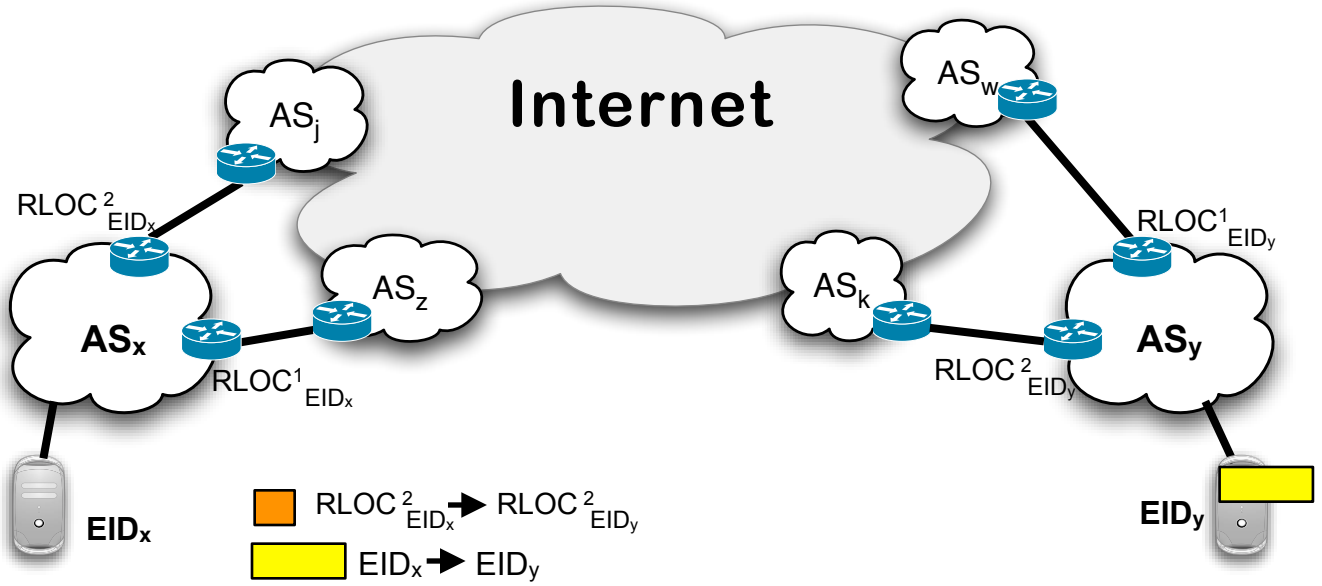

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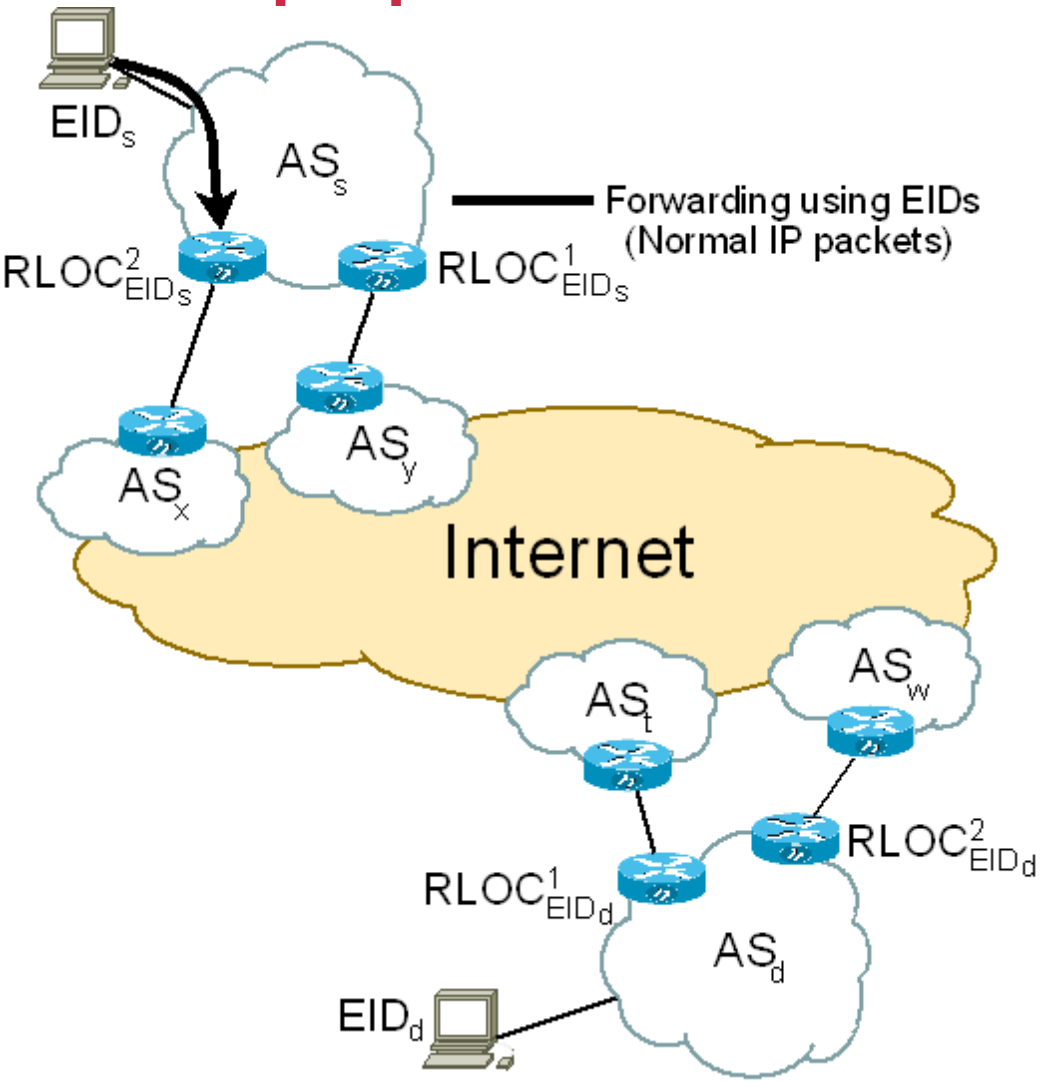
Map & Encap Operations: source side



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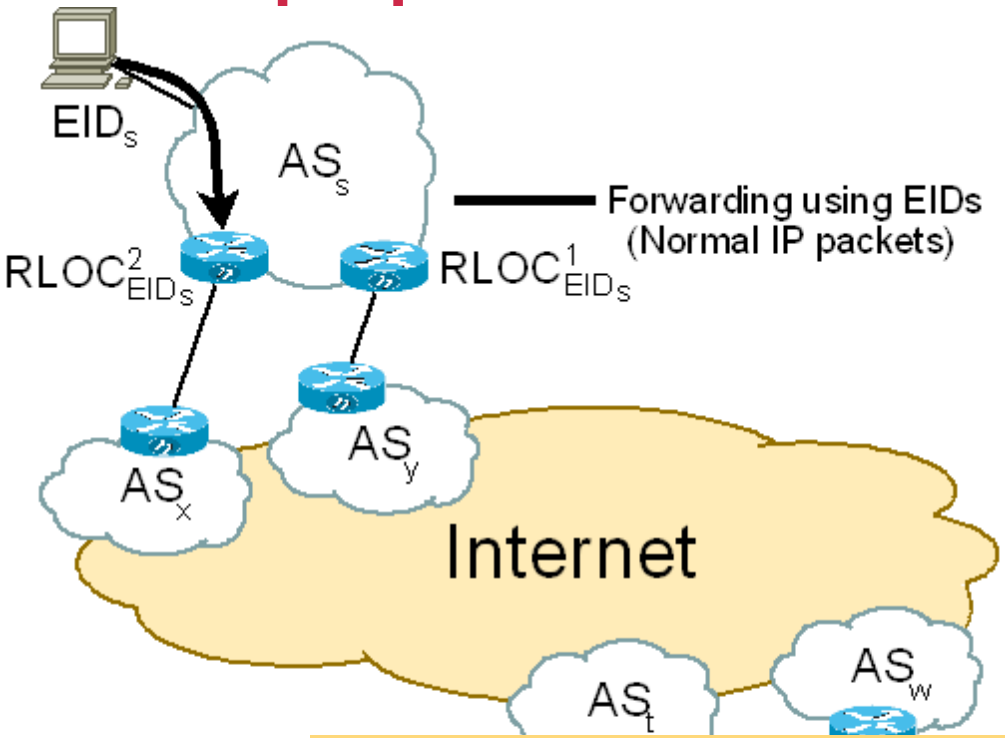

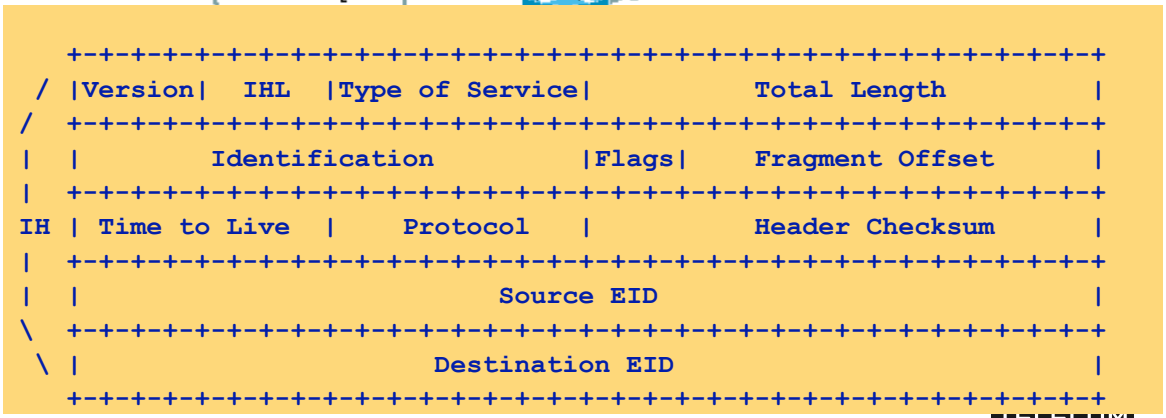

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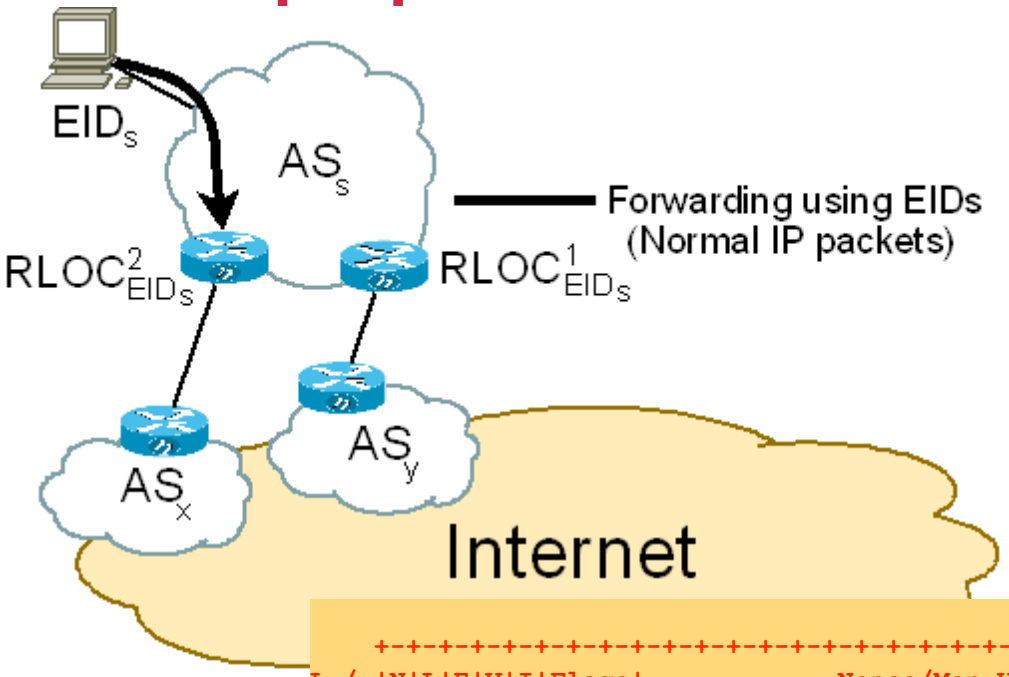

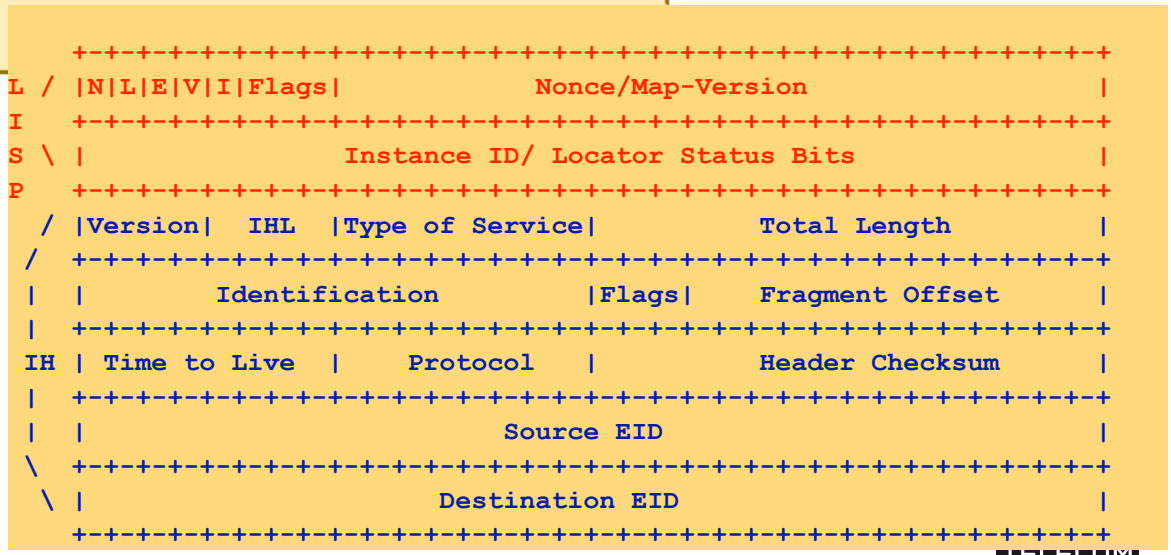

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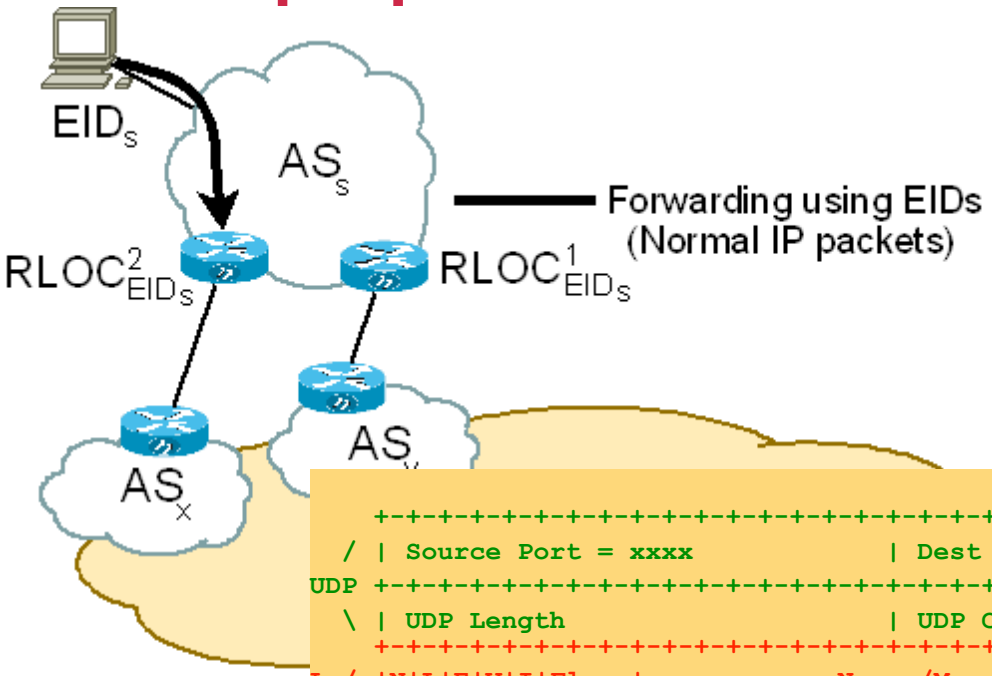


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                  / | Source Port = xxxx            | Dest Port = 4341              |
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            I       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
            S     \ |                Instance ID/ Locator Status Bits                |
            P       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
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                 |  |        Identification         |Flags|    Fragment Offset      |
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                IH  | Time to Live  |    Protocol   |          Header Checksum      |
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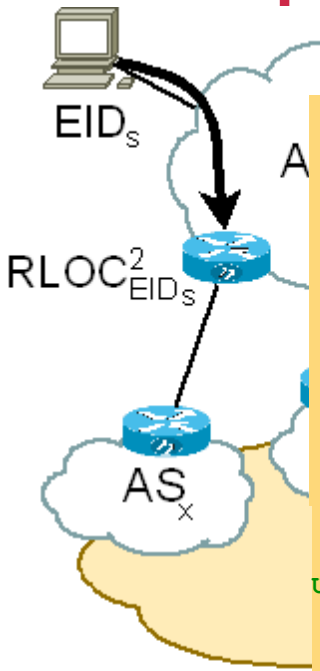

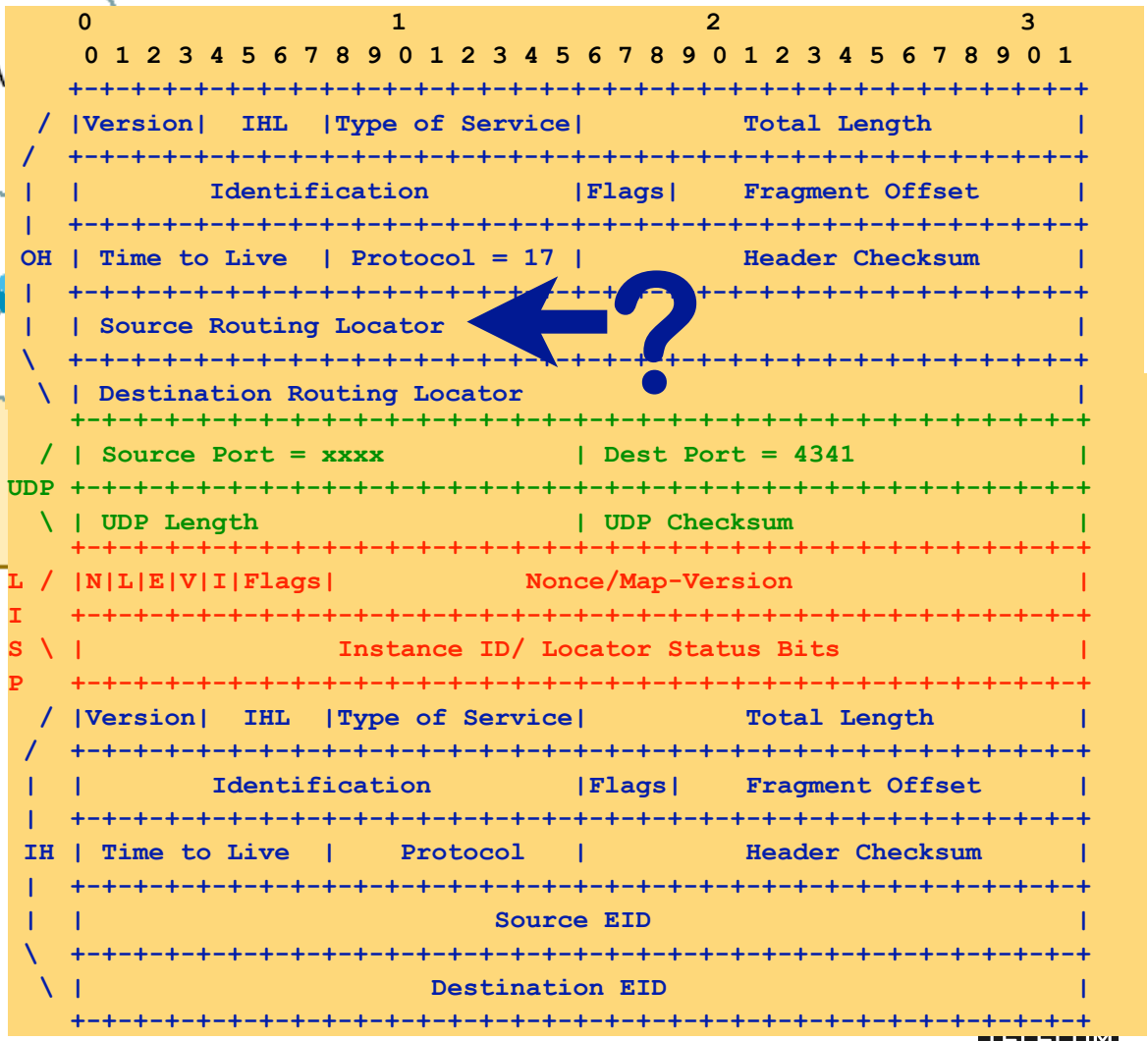

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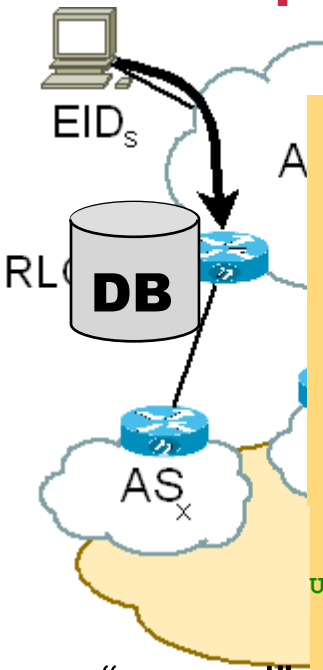

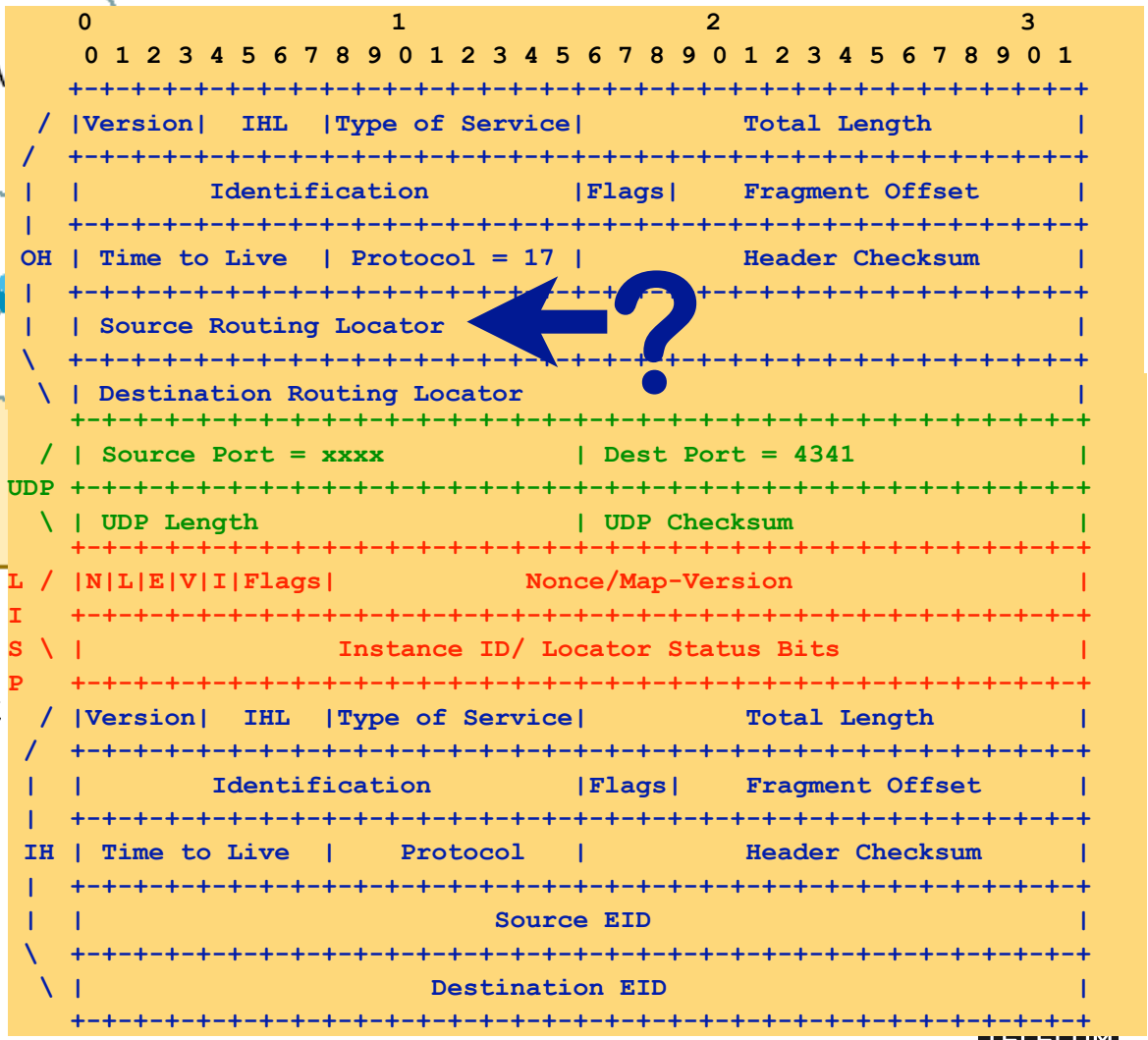

LISP-Database:

- Contains mappings "owned" locally
- Used to select source RLOC

$$EID_s - Prefix \Rightarrow \left(RLOC^1_{EID_s}, RLOC^2_{EID_s}\right)$$

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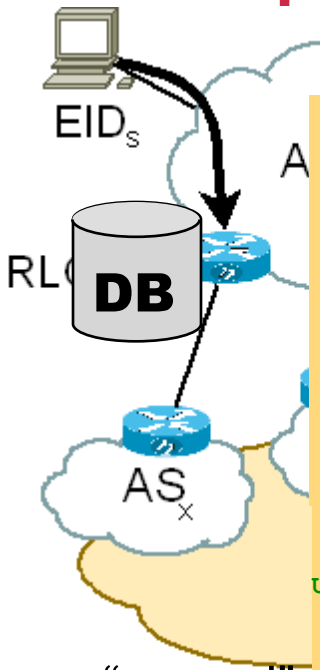

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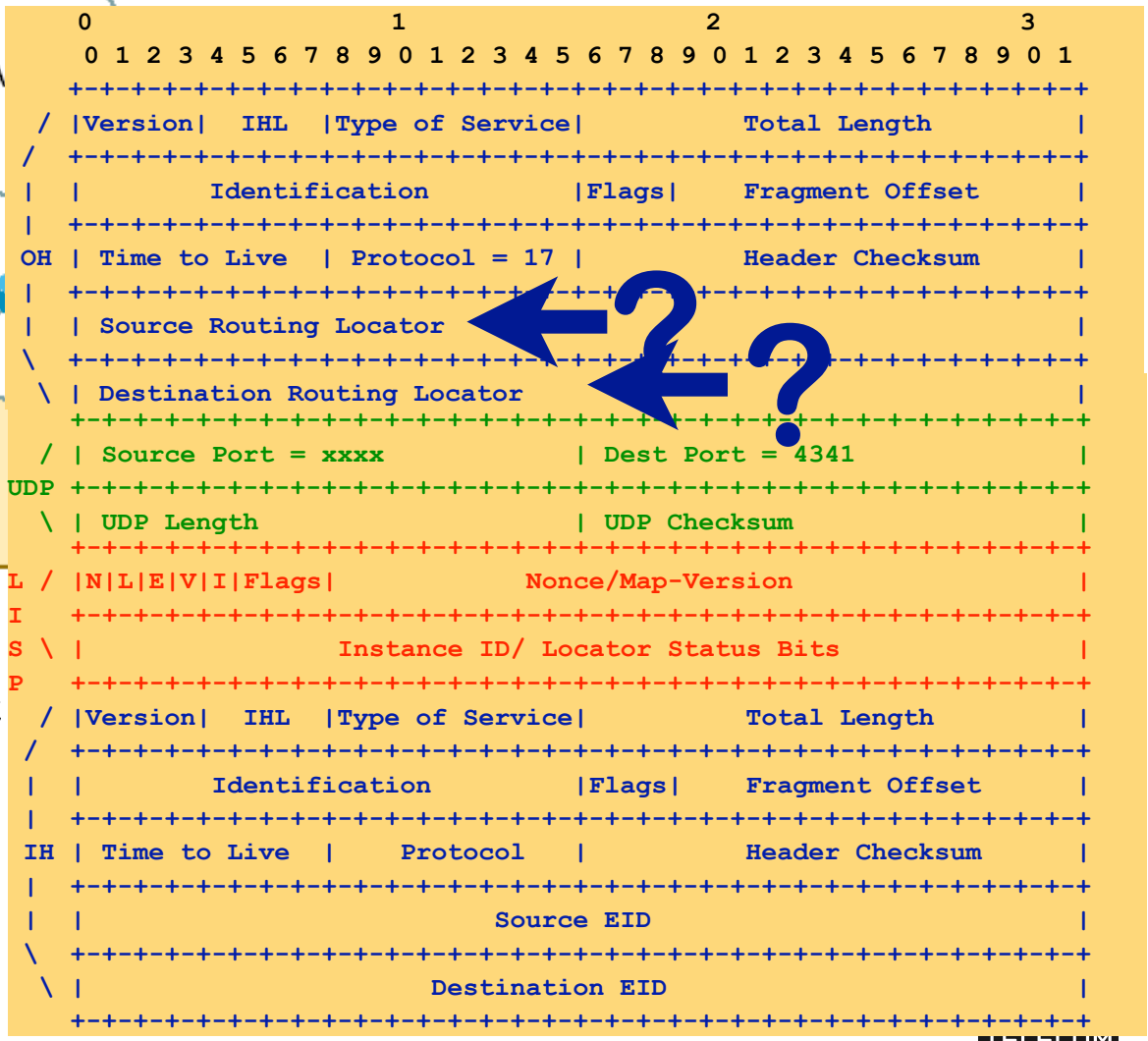
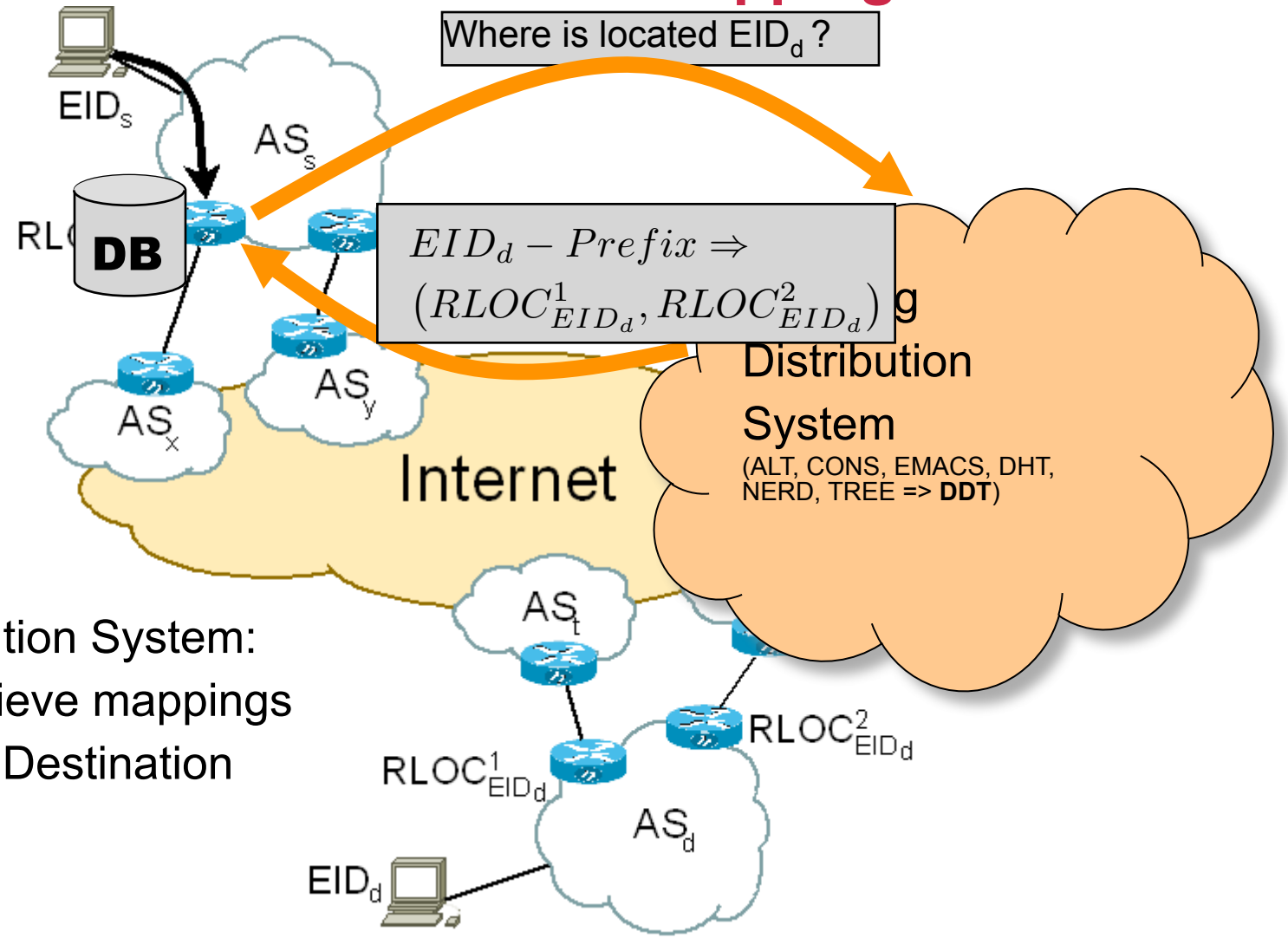


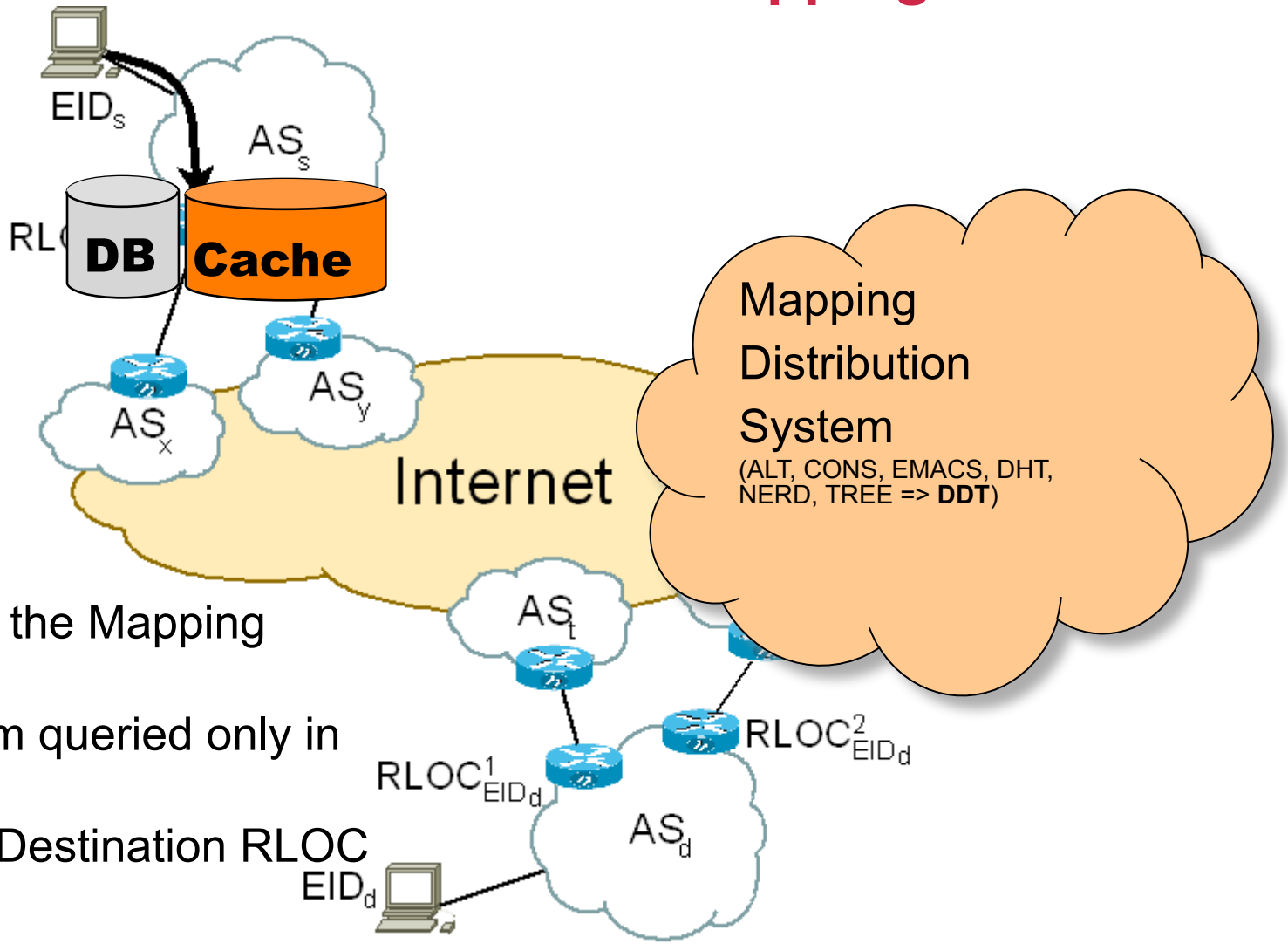
Where does LISP find the Mappings?



Mapping Distribution System:

- Queried to retrieve mappings
- Used to select Destination RLOC

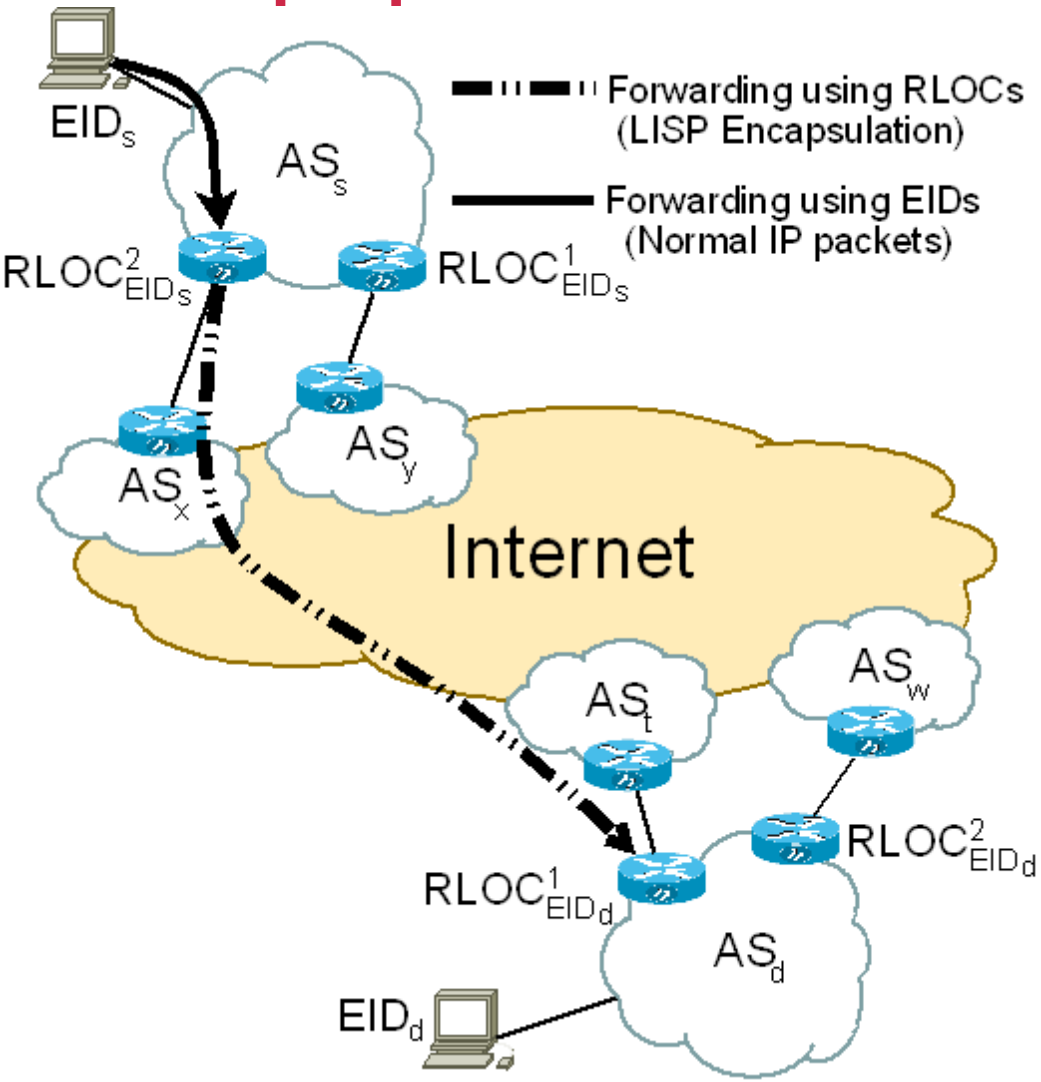
Where does LISP store the Mappings?



LISP-Cache:

- Queried before the Mapping system
- Mapping system queried only in case of miss
- Used to select Destination RLOC

Map & Encap Operations: destination side



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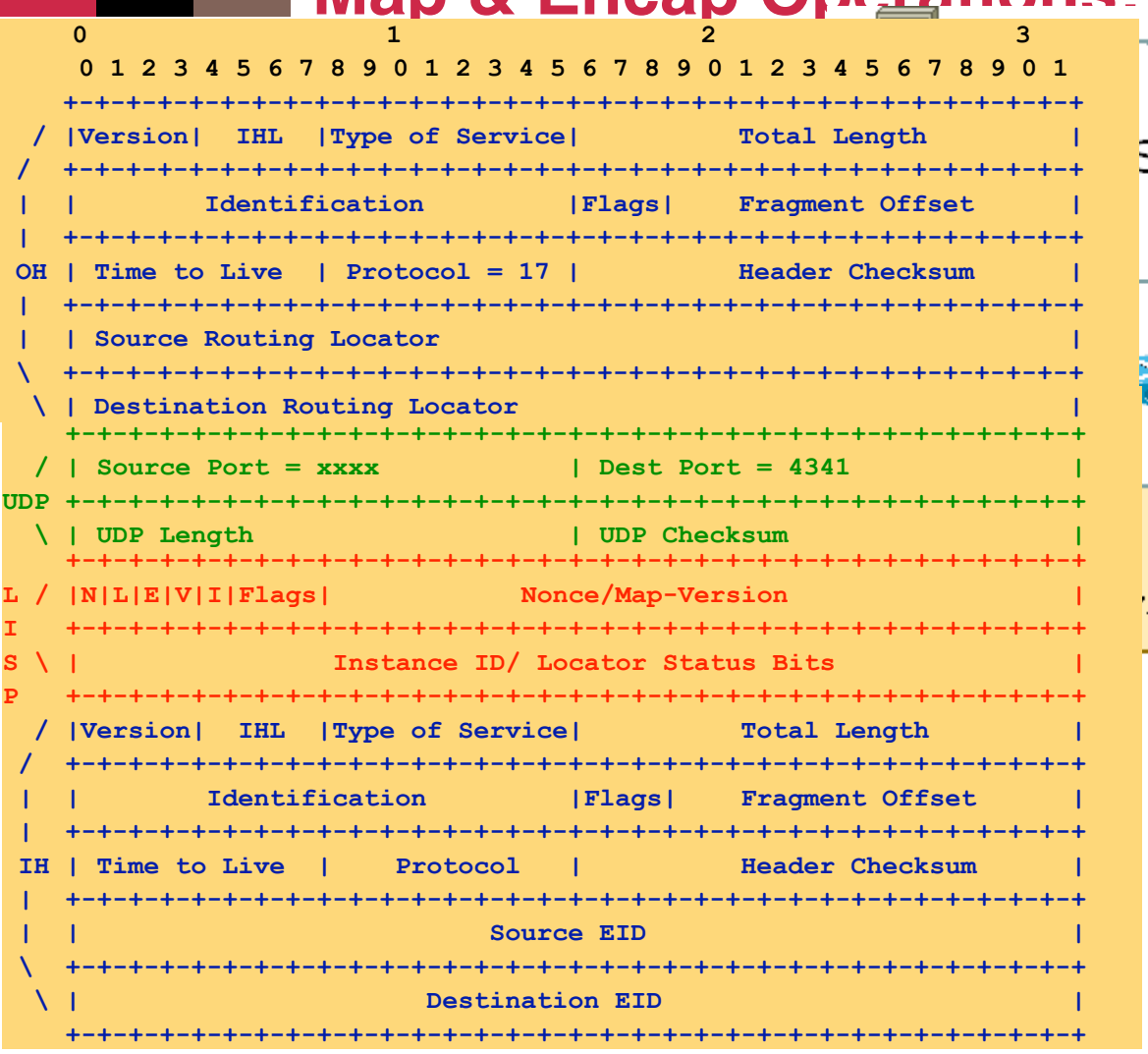

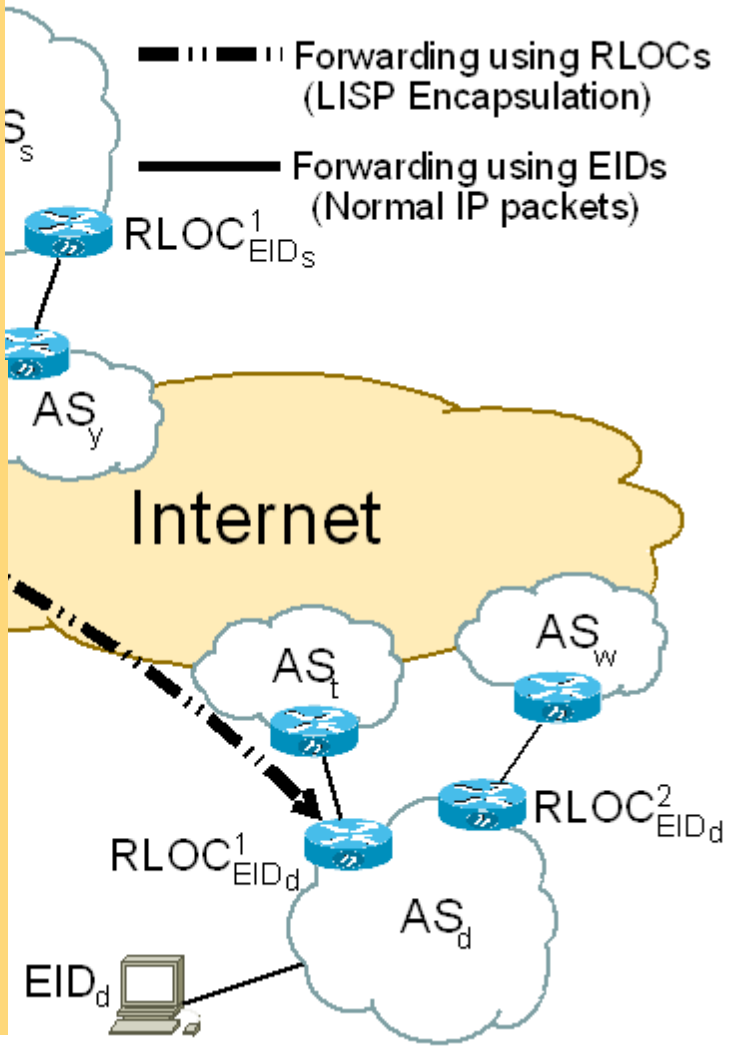

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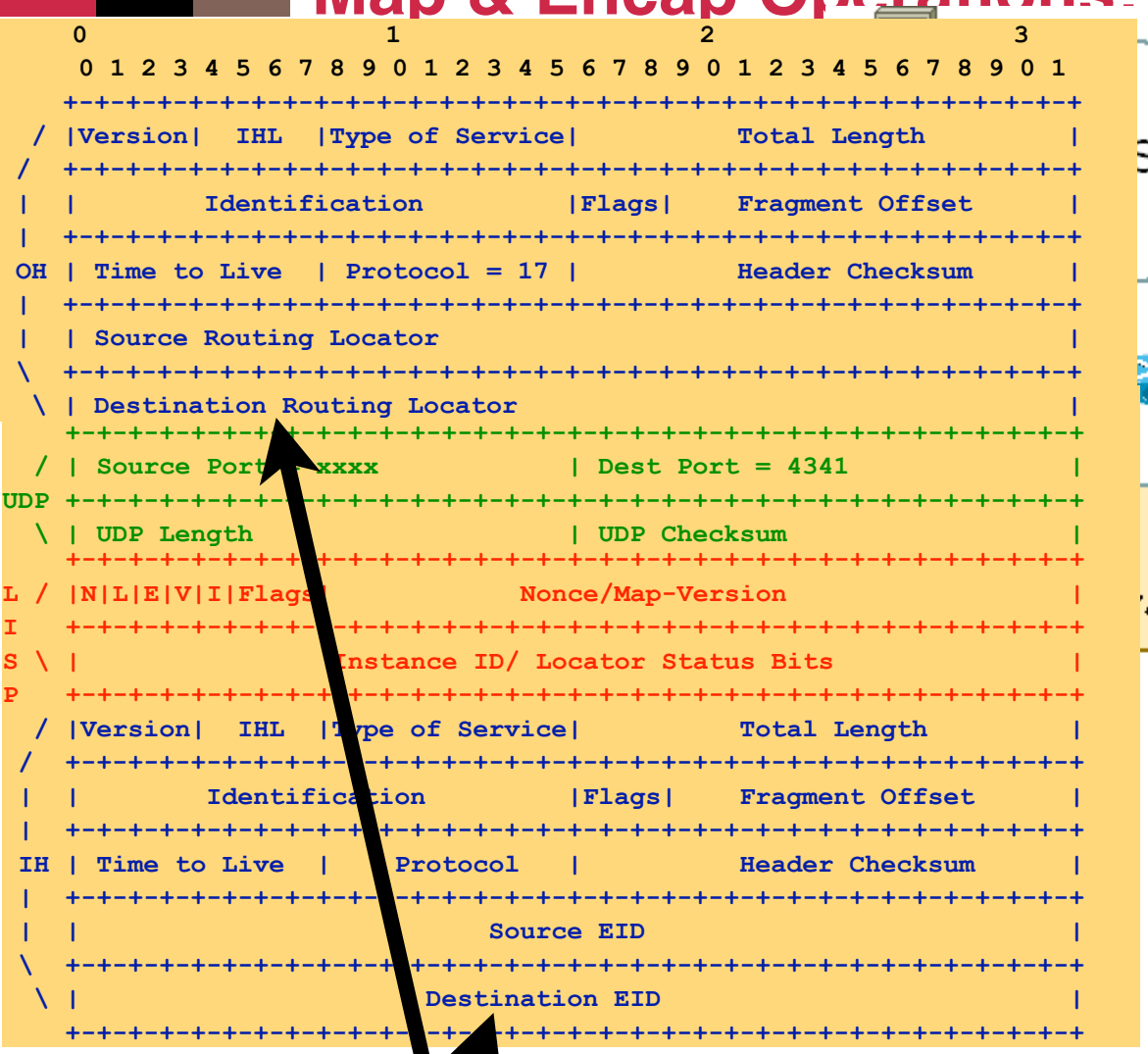
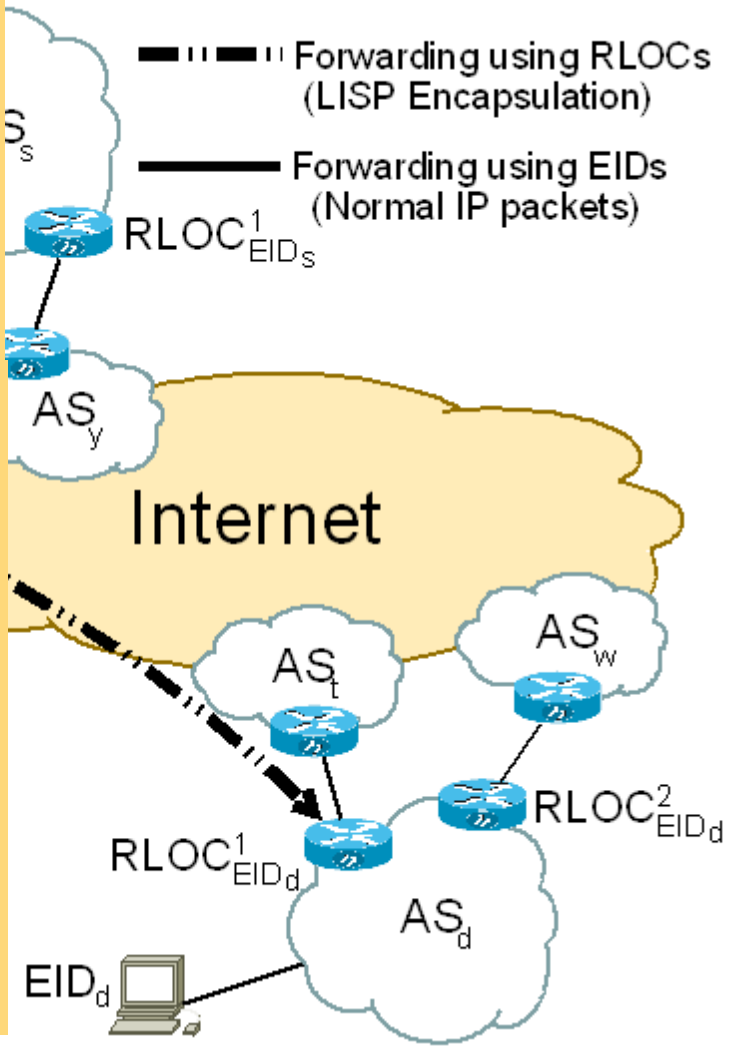
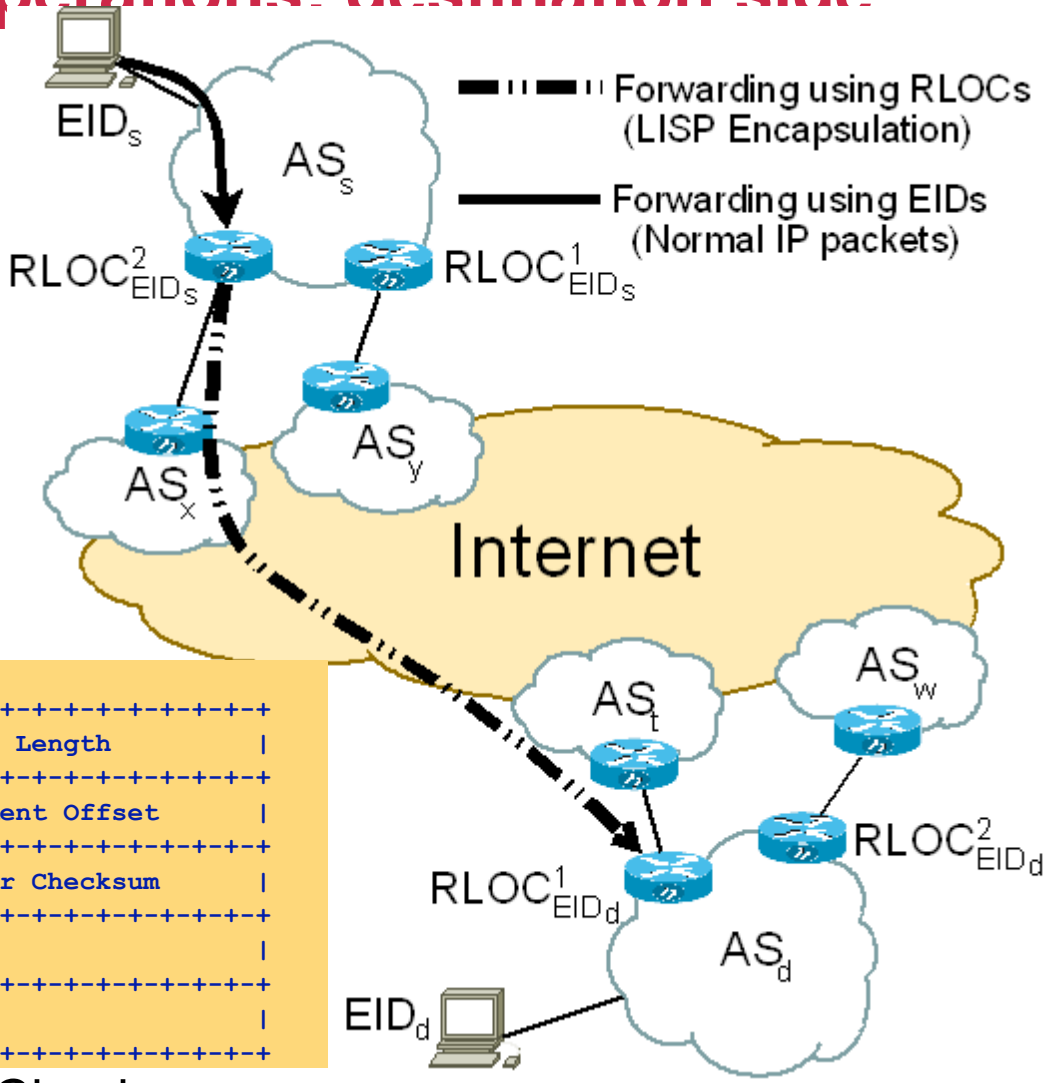




Consistency Checks:

- Check DB: Am I the correct RLOC for the destination EID?

Map & Encap Operations: destination side

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 / |Version|  IHL  |Type of Service|          Total Length         |
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IH | Time to Live  |    Protocol   |          Header Checksum      |
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 \ |                      Destination EID                          |
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Consistency Checks:

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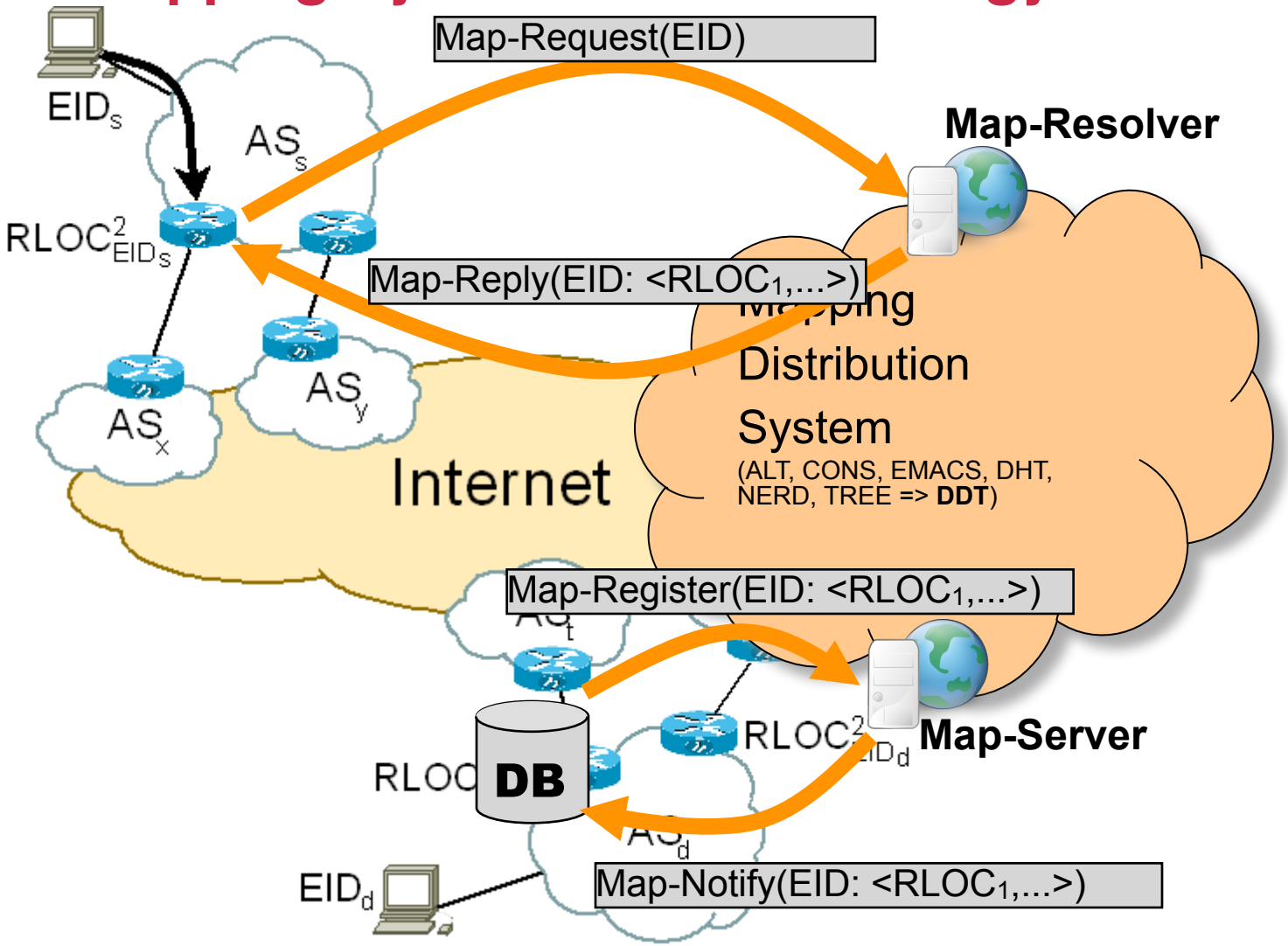
LISP Mapping Distribution System

LISP-MS (RFC 6833)
LISP+ALT (RFC 6836)
LISP-NERD (RFC 6837)
LISP-DDT (draft-ietf-lisp-ddt-01.txt)

MS: A Mapping System API Terminology

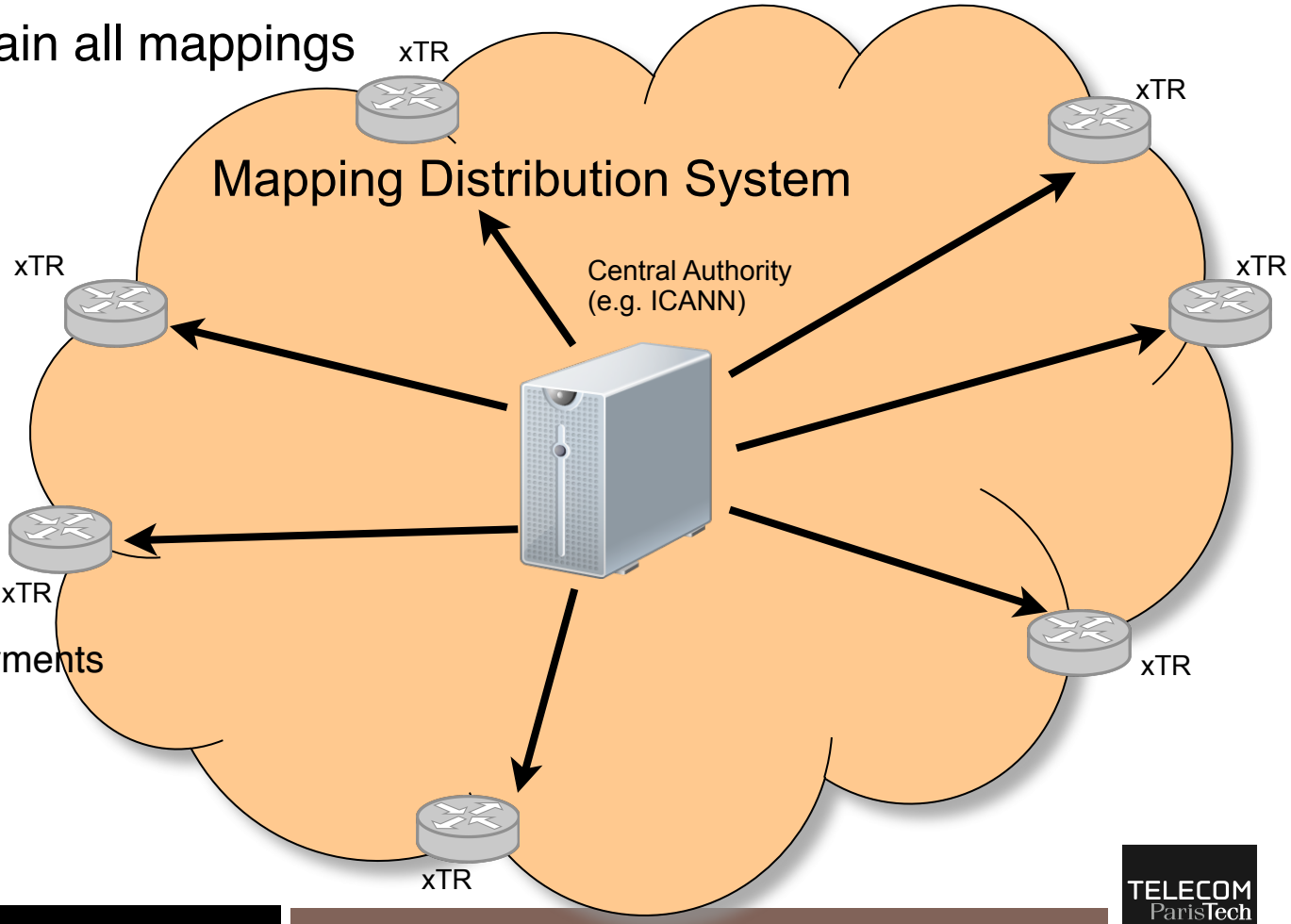


Existing/Proposed Mapping Distribution Systems

Mapping System	Distribution Model	Propagated Information	Aggregation	Sensitive to Churn
LISP-DHT LISP Distributed Hash Table	Pull	EID-Prefix	No	No
LISP-CONS Content distribution Overlay Network Service	Hybrid Push/Pull	EID-Prefix	Yes	Yes
LISP-EMACS EID Mapping multicast Across Cooperating Systems	Pull	-	No	No
LISP-NERD Not so novel EID-to-RLOC Database	Push	Entire Mapping Database	No	No (updates on a fixed time schedule)
LISP+ALT LISP ALternative Topology	Hybrid Push/Pull	EID-Prefix	Yes	Yes
LISP-TREE (DDT) DNS-Based lookup infrastructure	Pull	EID-Prefix	Yes	No

LISP-NERD
Not-so-novel Eid-to-Rloc Database

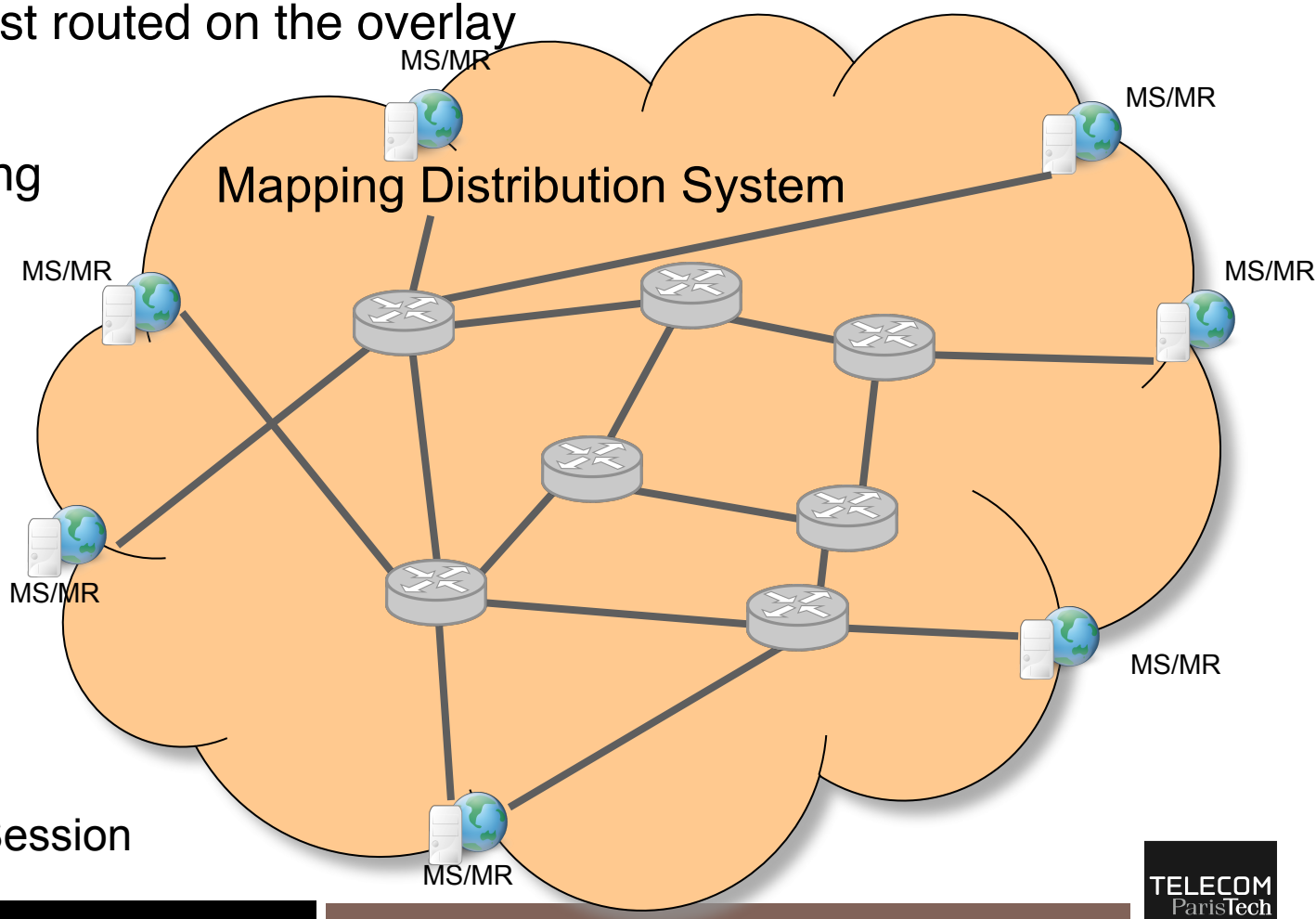
- Centralized approach based on one (or more) authority(ies)
  - xTRs periodic update request
  - Updates contain all mappings



- Pros
  - Simple
    - —Bootstrap
    - —Data Center
    - —Private Deployments
- Cons
  - Not scalable
  - Static

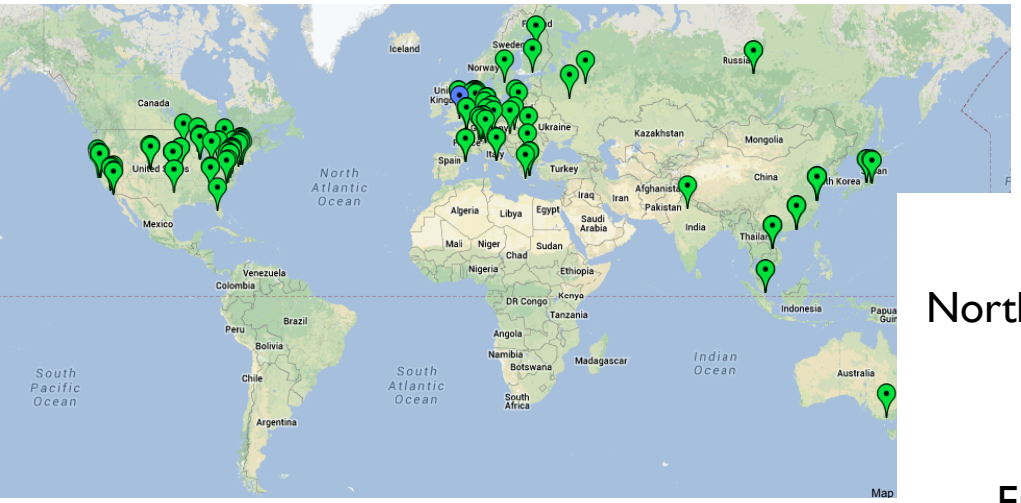
LISP+ALT
Alternative Logical Topology

- BGP over GRE overlay
  - EID-Prefix (aggregated) advertisements
  - Map-Request routed on the overlay
- Pros
- Based on existing well-known technology
- Cons
- PITA

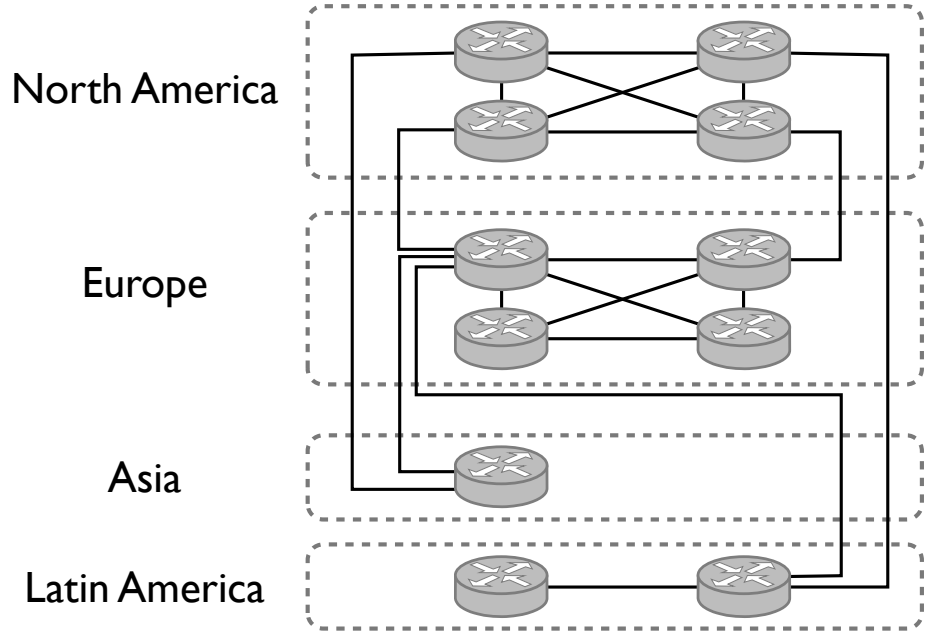


LISP+ALT Failure

- Used on an international testbed (www.lisp4.net)
  - Rapidly resulted in very cumbersome maintenance



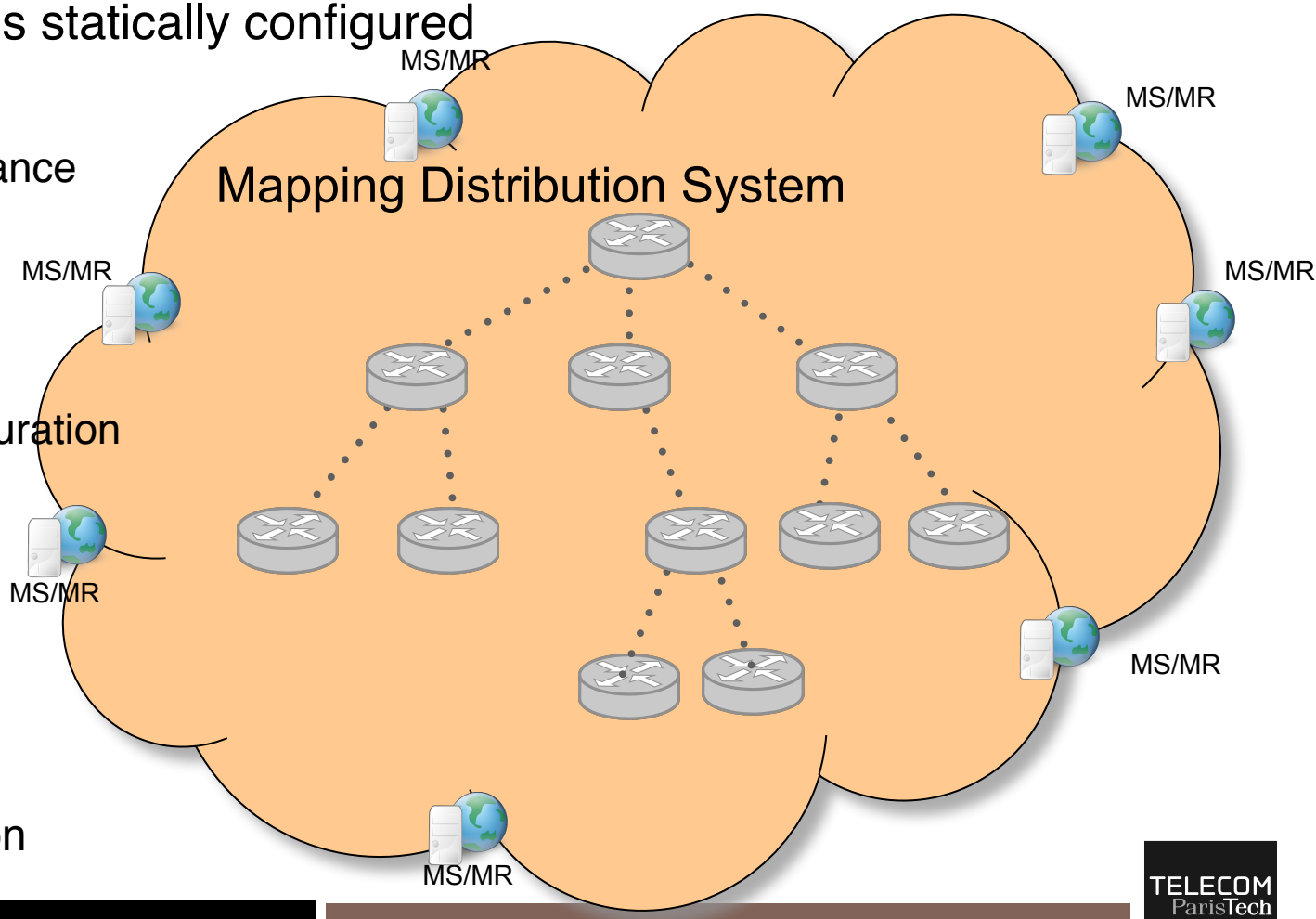
www.lisp4.net



LISP+ALT Topology early 2012

LISP-DDT
Delegated Database Tree

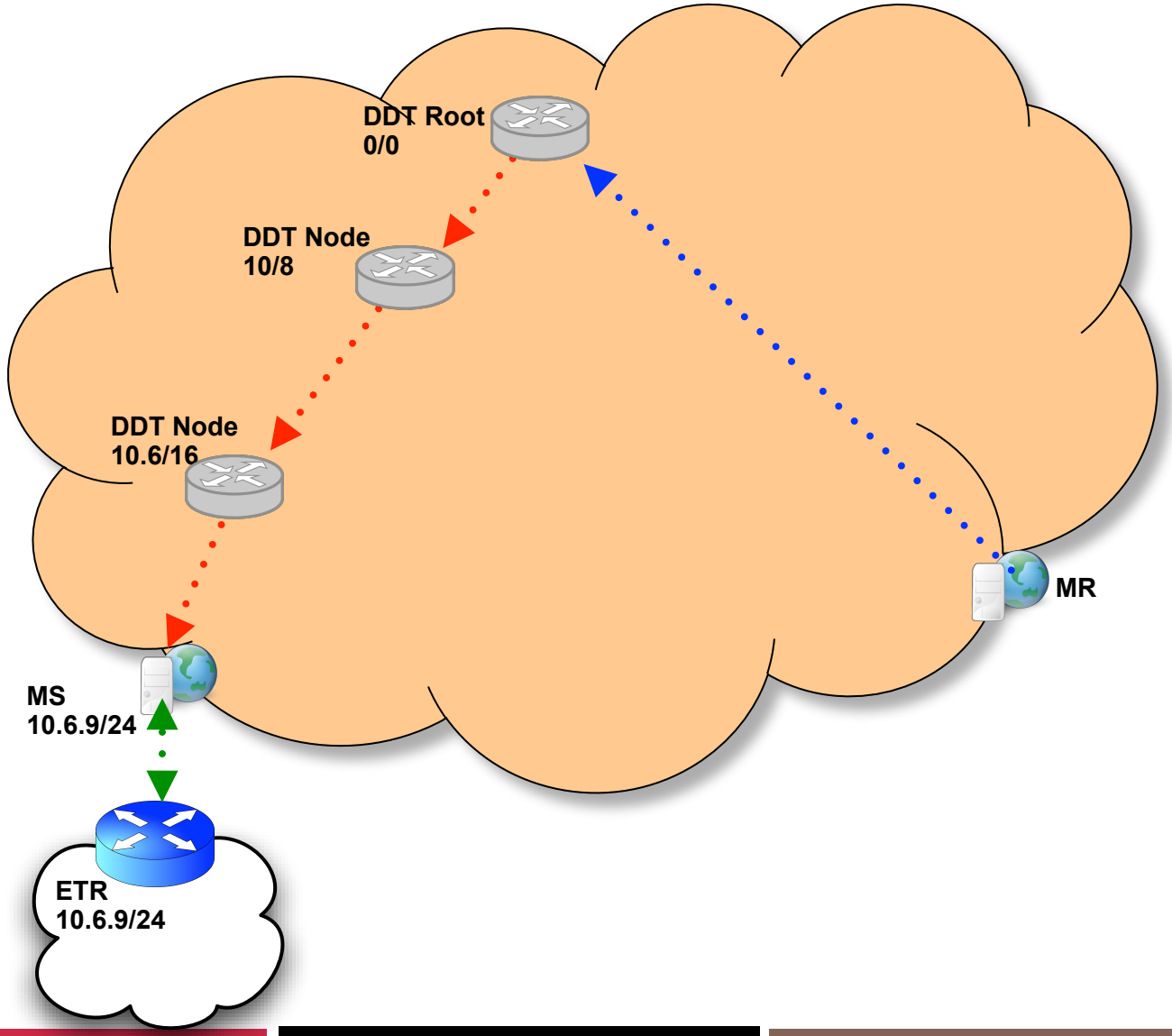
- DNS-Like logical hierarchy
  - EID-Prefix more specific delegated
  - Delegation is statically configured
- Pros
  - Easy maintenance
  - Economics
  - Security
- Cons
  - manual configuration
  - static tree



DDT Node

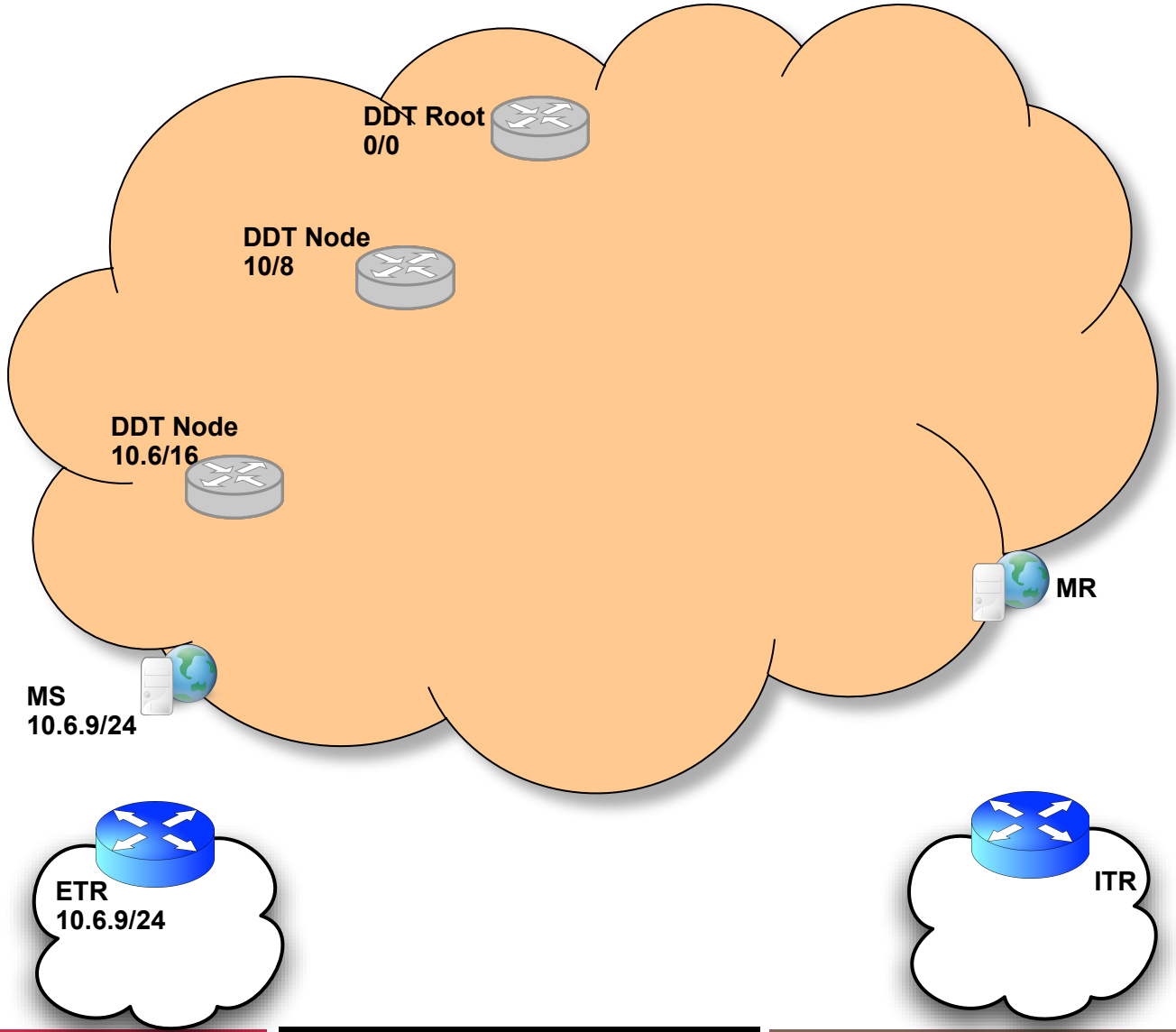
. . . Logical Delegation

LISP-DDT Configuration

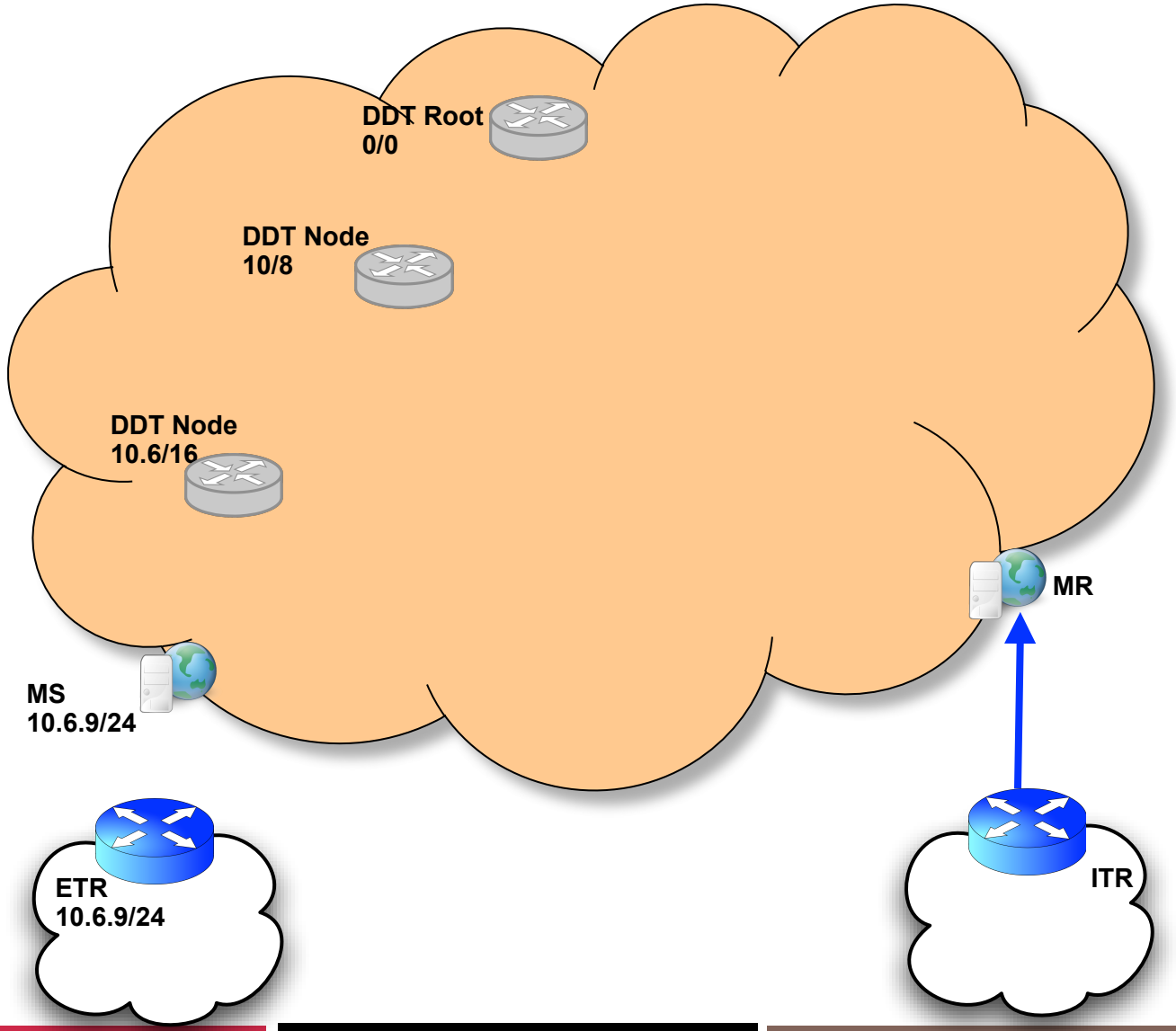


- **MR**
  Static pointer to root
- **DDT Nodes**
  Static pointers to children authoritative of more-specific (leafs are MS)
- **ETR**
  Registers to statically configured MS

LISP-DDT
Mapping Retrieval (cold start)

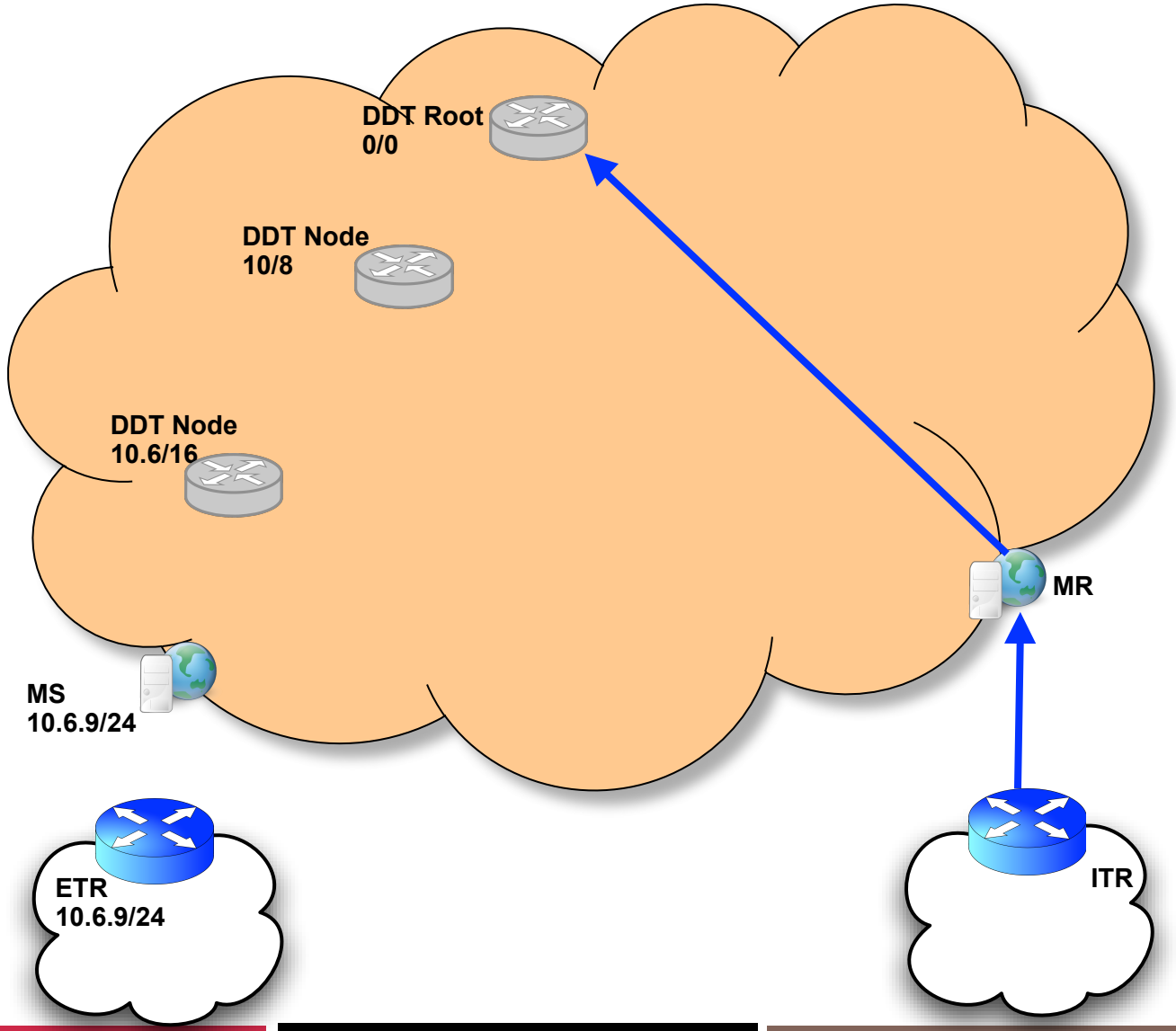


LISP-DDT
Mapping Retrieval (cold start)



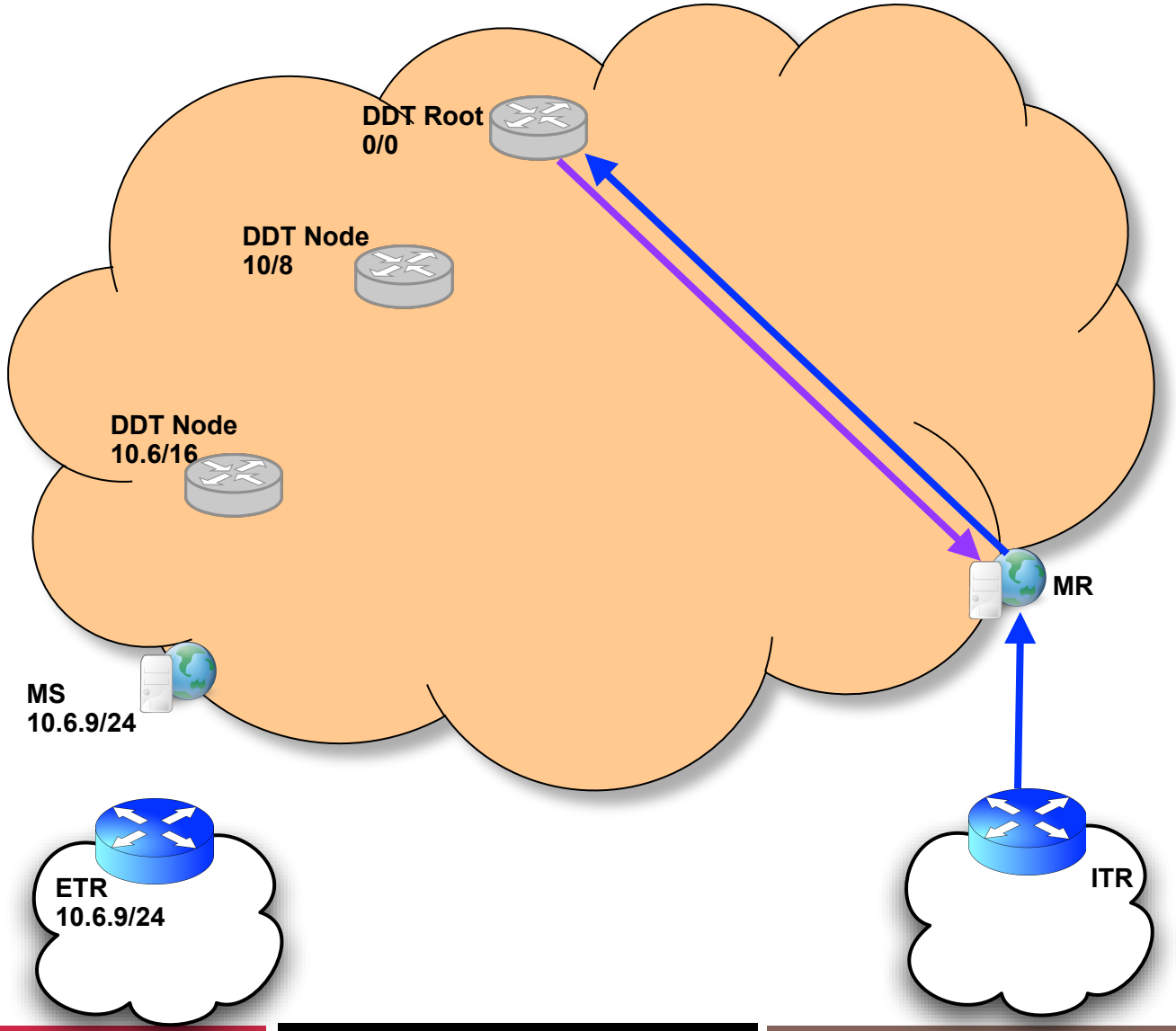
1. ITR sends Map-Request to its configured MR

LISP-DDT
Mapping Retrieval (cold start)



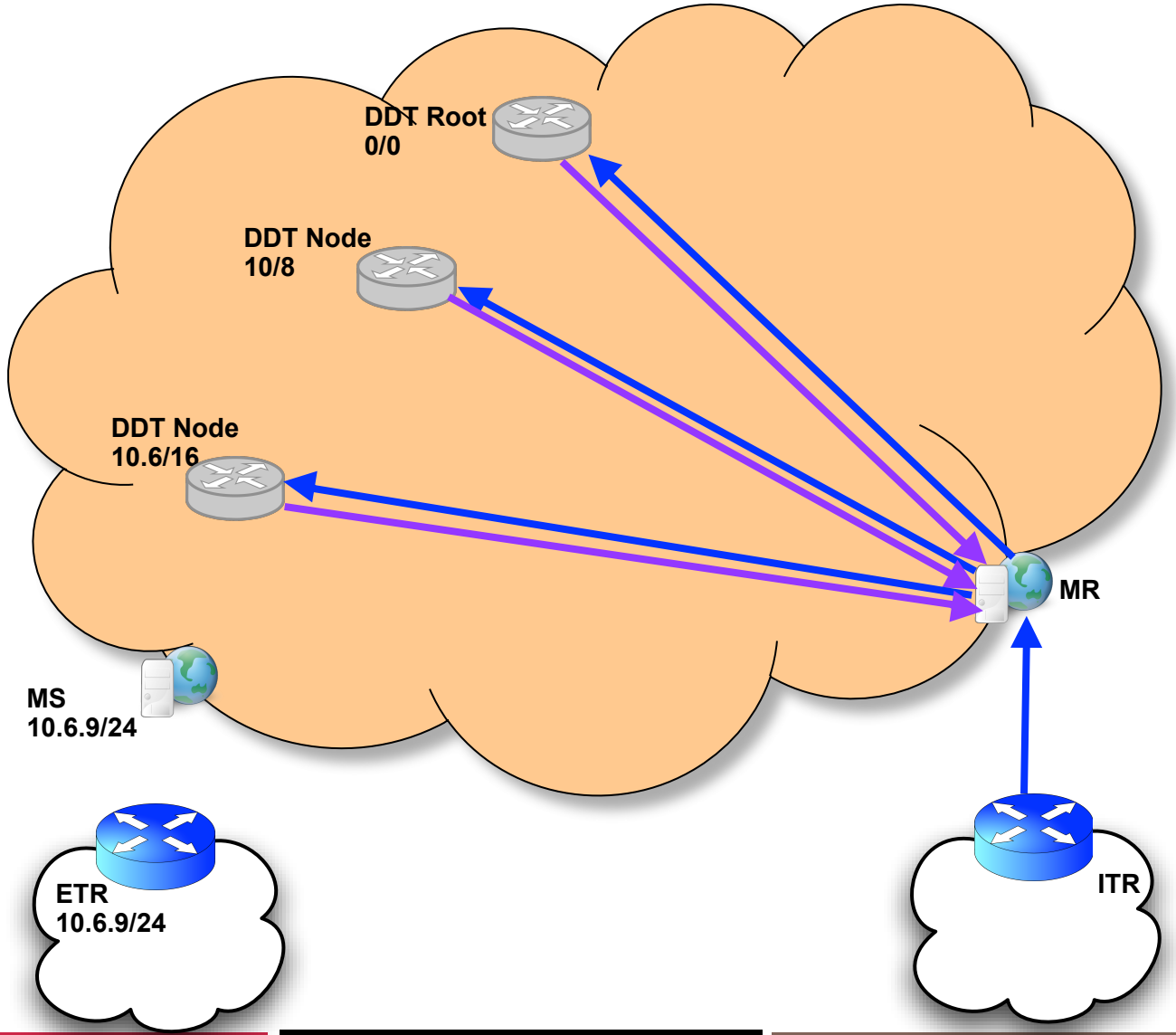
1. ITR sends Map-Request to its configured MR
2. MR sends Map-Request to configured Root Server

LISP-DDT
Mapping Retrieval (cold start)



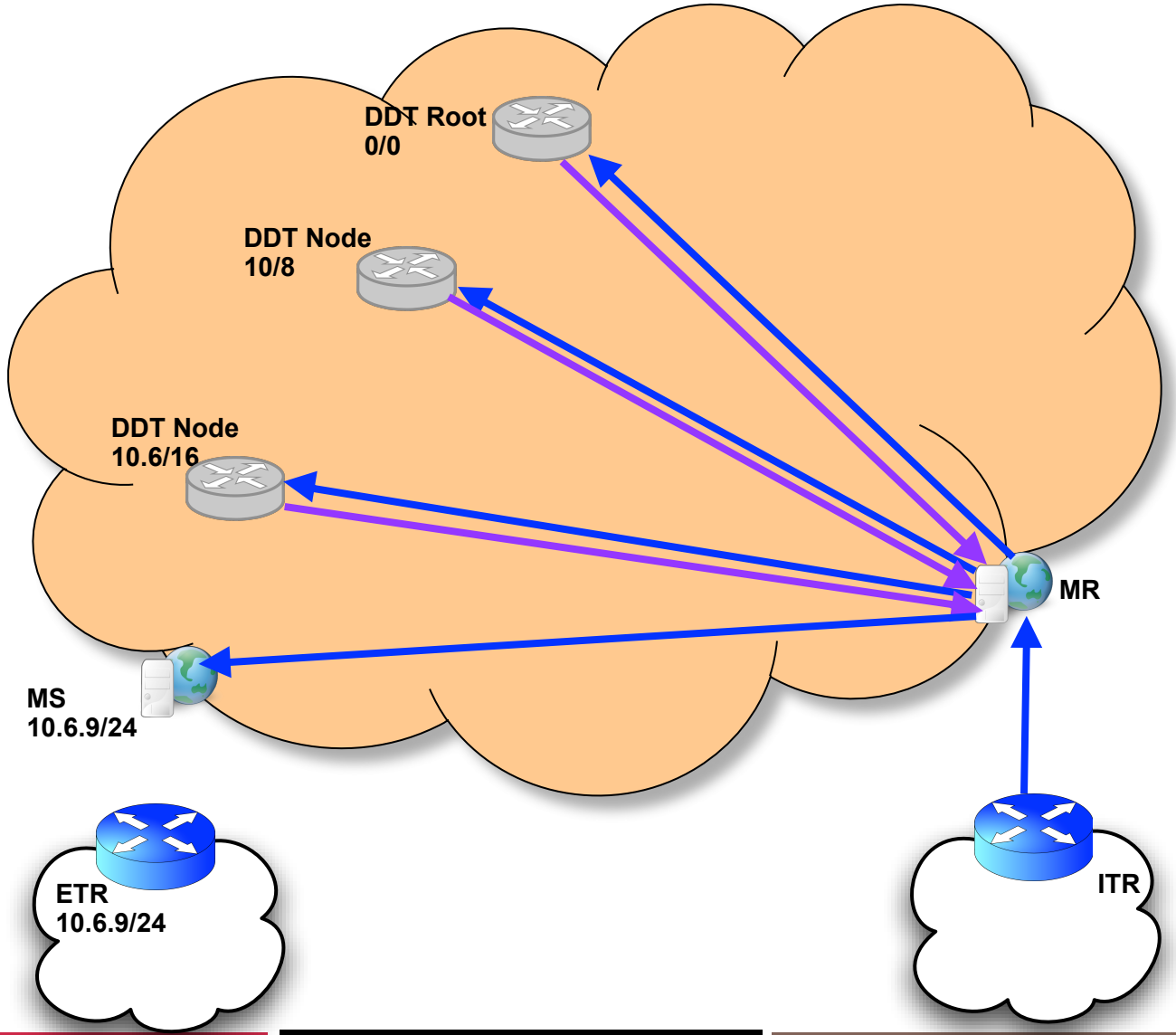
1. ITR sends Map-Request to its configured MR
2. MR sends Map-Request to configured Root Server
3. Root Server sends back Map-Referral to configured DDT Node authoritative on more specific

LISP-DDT
Mapping Retrieval (cold start)



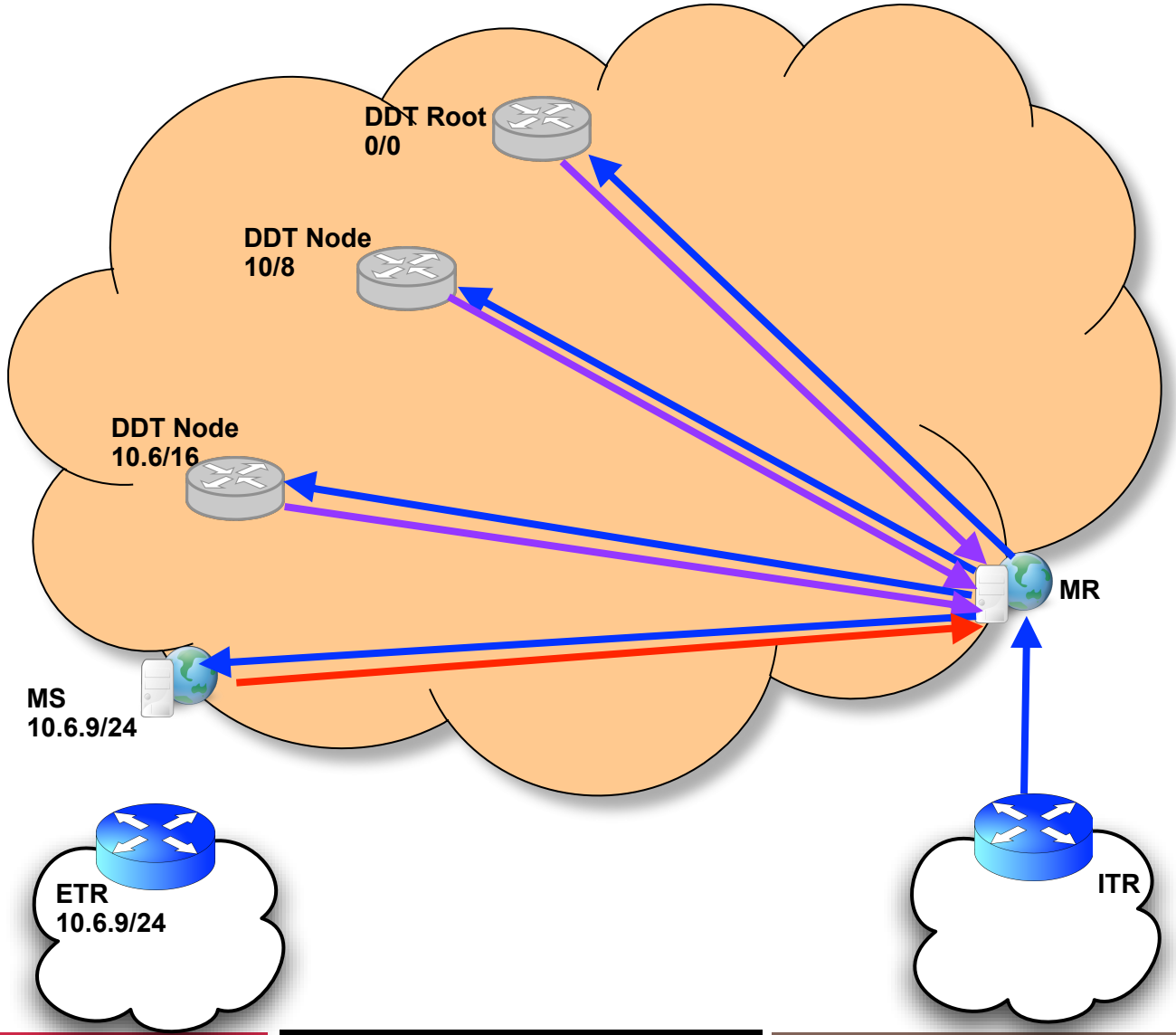
1. ITR sends Map-Request to its configured MR
2. MR sends Map-Request to configured Root Server
3. Root Server sends back Map-Referral to configured DDT Node authoritative on more specific
4. Repeat 2 and 3 until MS reached

LISP-DDT
Mapping Retrieval (cold start)



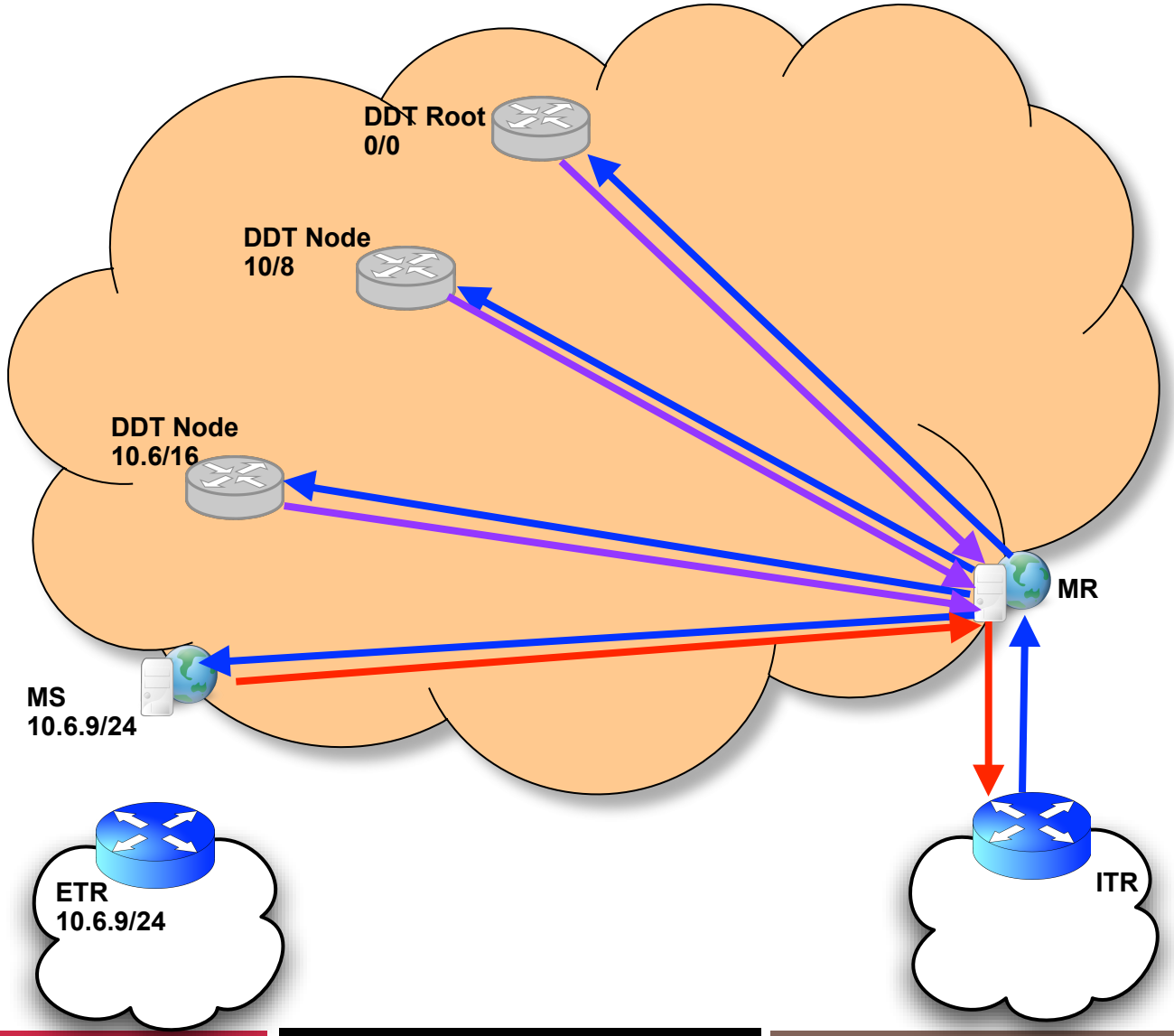
1. ITR sends Map-Request to its configured MR
2. MR sends Map-Request to configured Root Server
3. Root Server sends back Map-Referral to configured DDT Node authoritative on more specific
4. Repeat 2 and 3 until MS reached
5. MR sends Map-Request to authoritative MS

LISP-DDT
Mapping Retrieval (cold start)



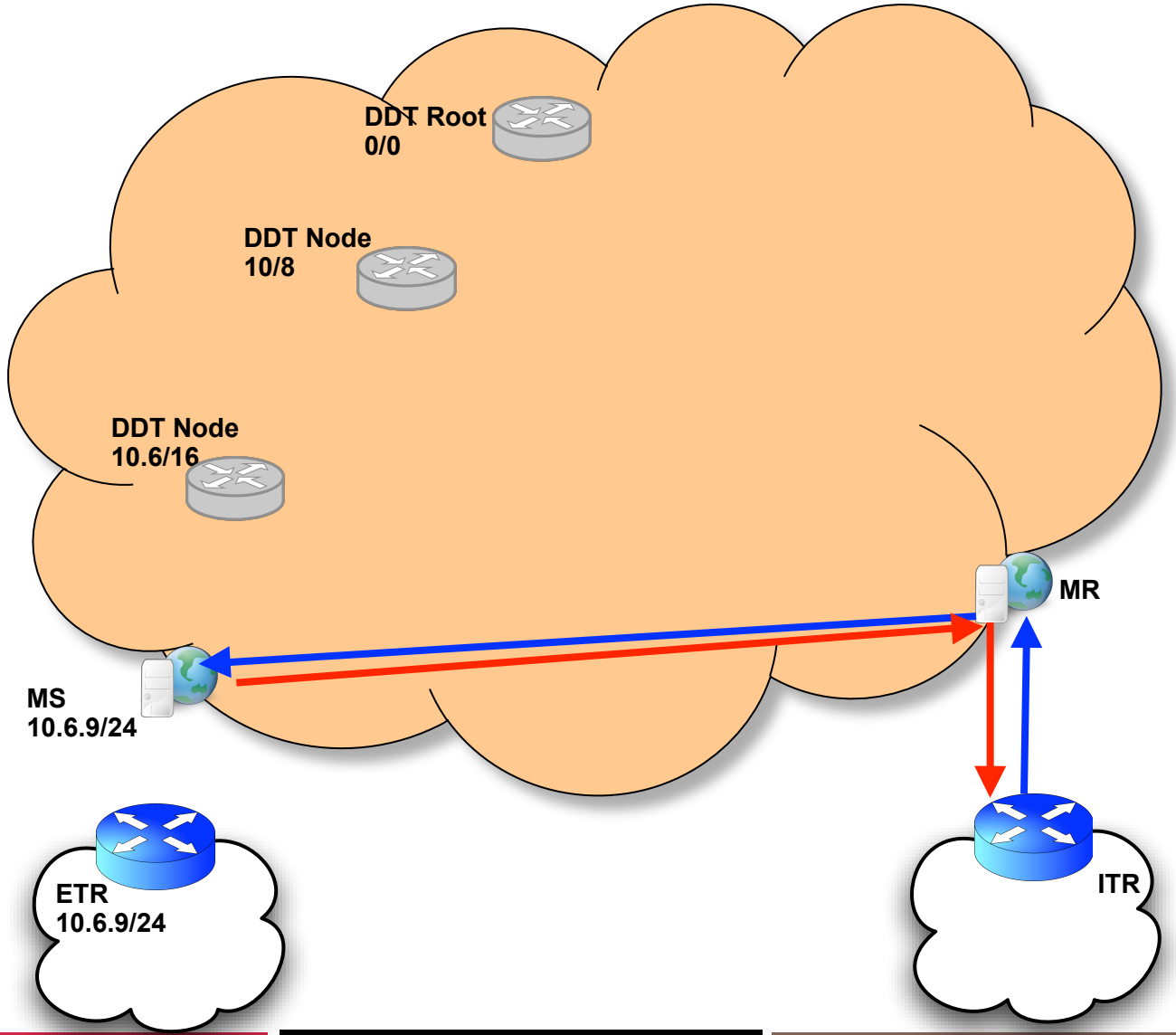
1. ITR sends Map-Request to its configured MR
2. MR sends Map-Request to configured Root Server
3. Root Server sends back Map-Referral to configured DDT Node authoritative on more specific
4. Repeat 2 and 3 until MS reached
5. MR sends Map-Request to authoritative MS
6. MS sends back Map-Reply with requested mapping to MR

LISP-DDT
Mapping Retrieval (cold start)



1. ITR sends Map-Request to its configured MR
2. MR sends Map-Request to configured Root Server
3. Root Server sends back Map-Referral to configured DDT Node authoritative on more specific
4. Repeat 2 and 3 until MS reached
5. MR sends Map-Request to authoritative MS
6. MS sends back Map-Reply with requested mapping to MR
7. MR sends Map-Reply with requested mapping to ITR

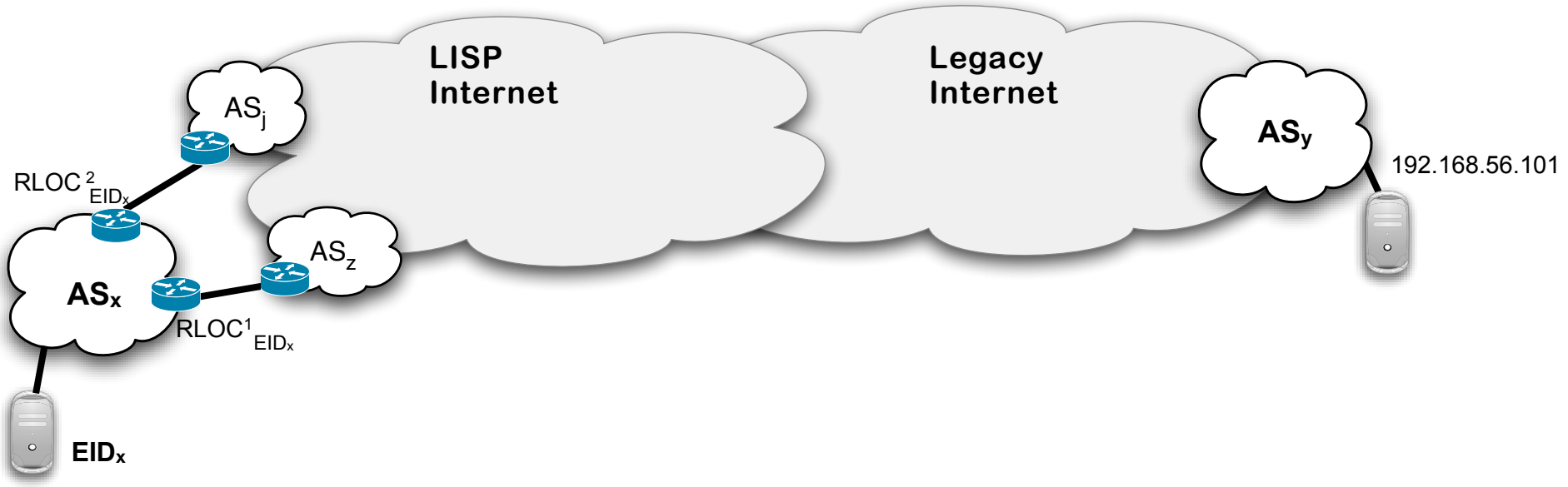
LISP-DDT
Mapping Retrieval (regular case)



1. ITR sends Map-Request to its configured MR
2. MR sends Map-Request to cached authoritative MS
3. MS sends back Map-Reply with requested mapping to MR
4. MR sends Map-Reply with requested mapping to ITR

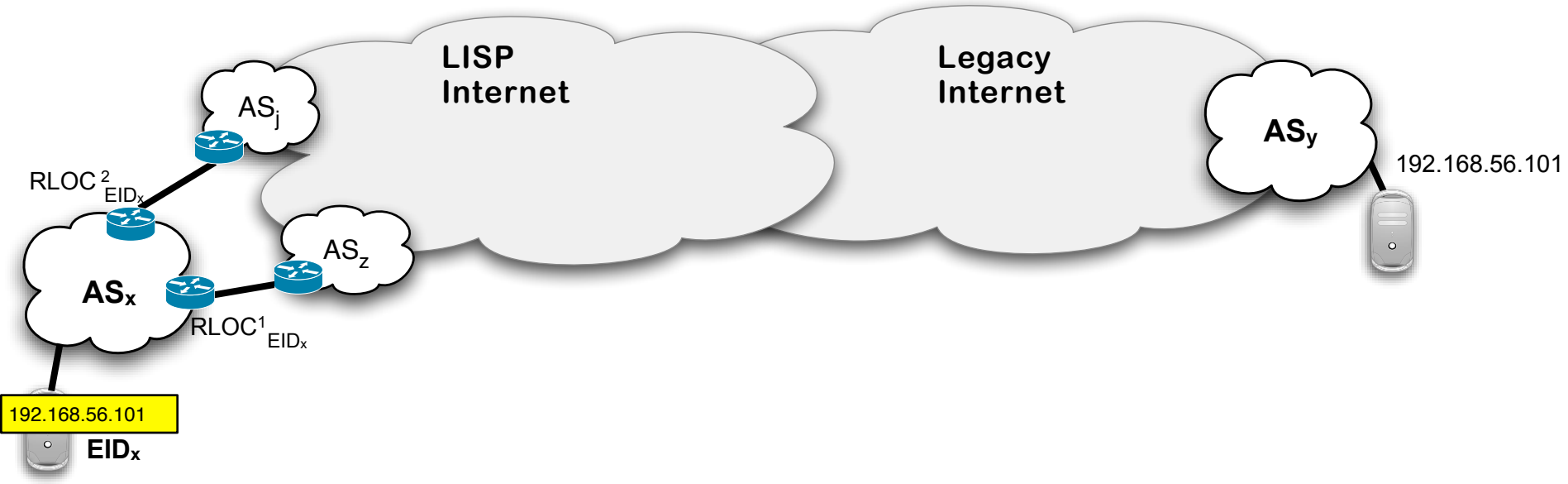
LISP-Interworking (RFC 6832)

The problem of Interworking between LISP and Legacy Internet



- How to forward packets from an ITR to a non-LISP site?
- How to forward packets from a non-LISP site to an EID?

The problem of Interworking between LISP and Legacy Internet



- How to forward packets from an ITR to a non-LISP site?
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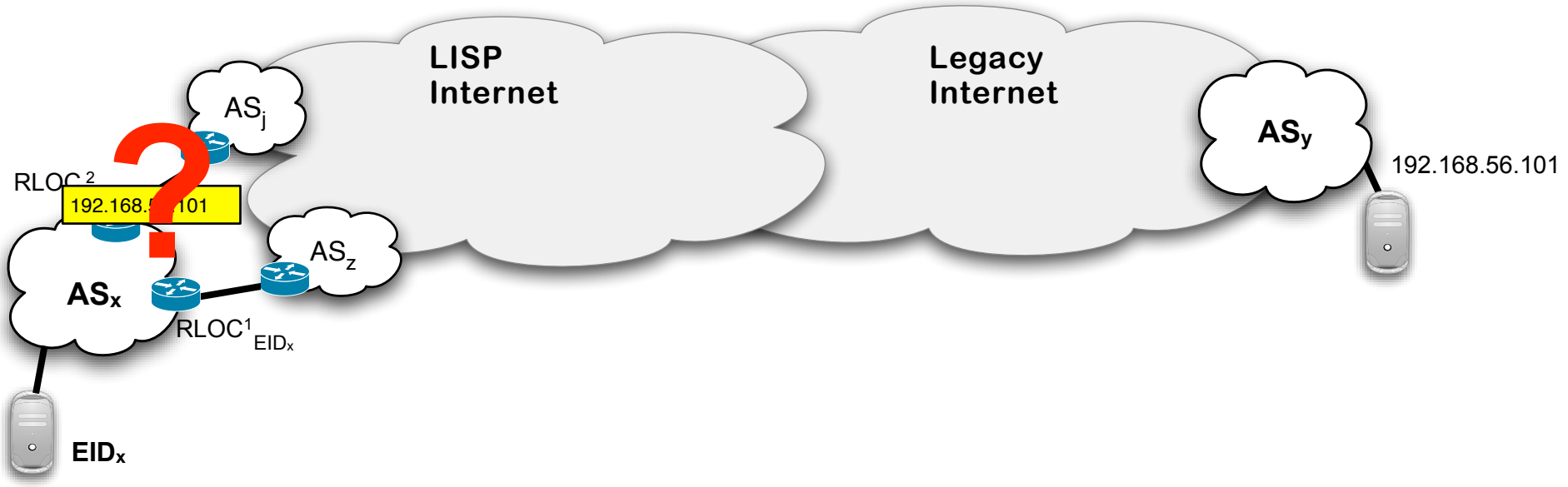
The problem of Interworking between LISP and Legacy Internet



- How to forward packets from an ITR to a non-LISP site?
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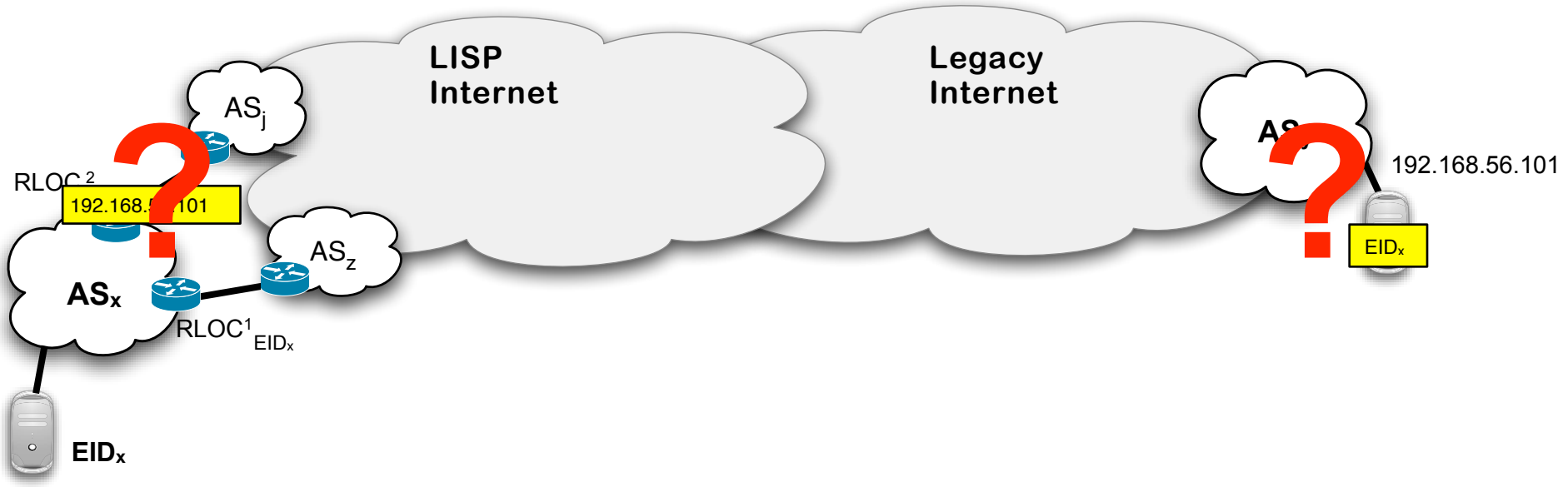
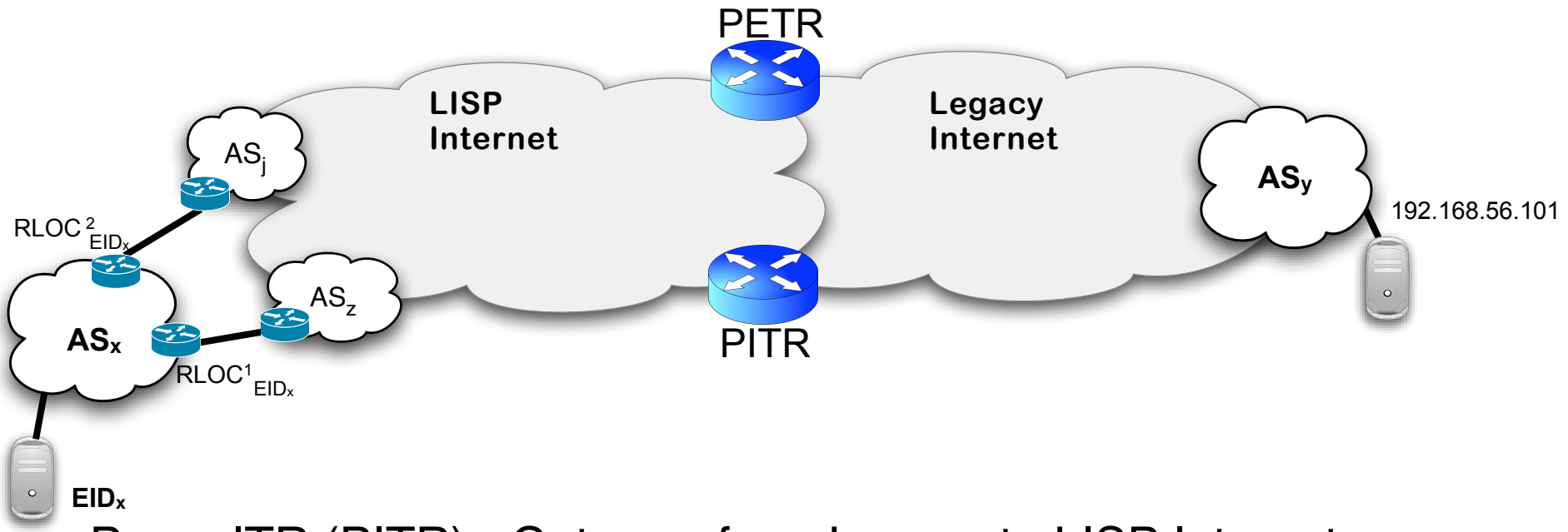
The problem of Interworking between LISP and Legacy Internet



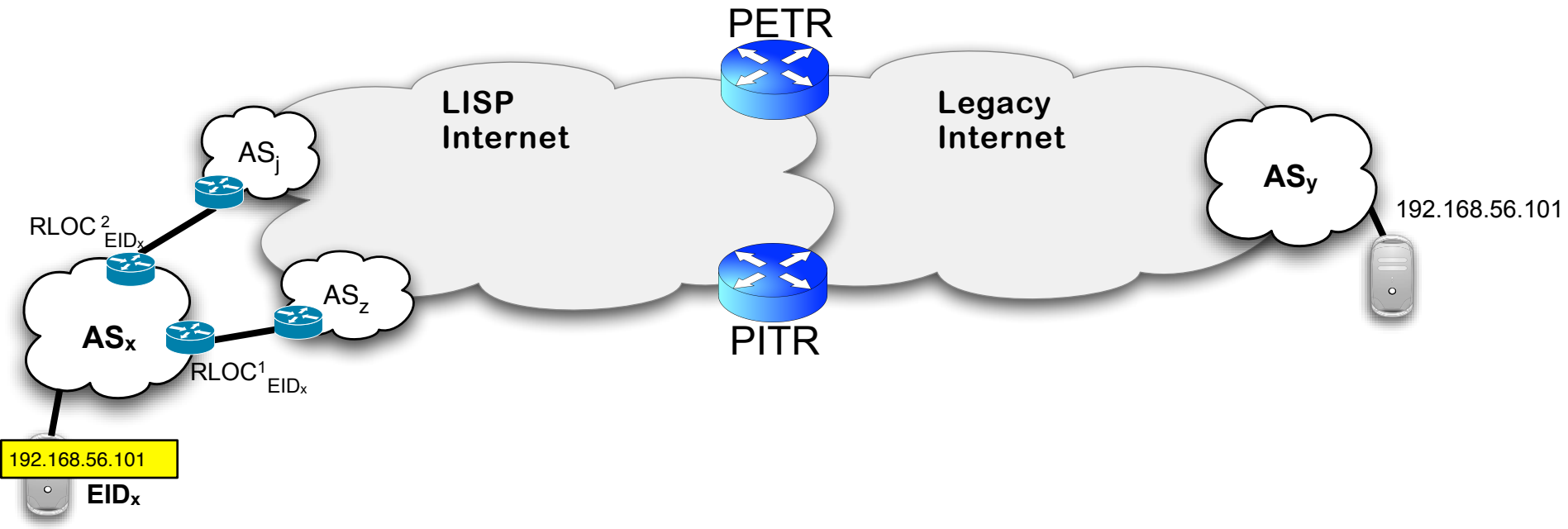
- How to forward packets from an ITR to a non-LISP site?
- How to forward packets from a non-LISP site to an EID?

Proxy-xTRs (PxTRs)

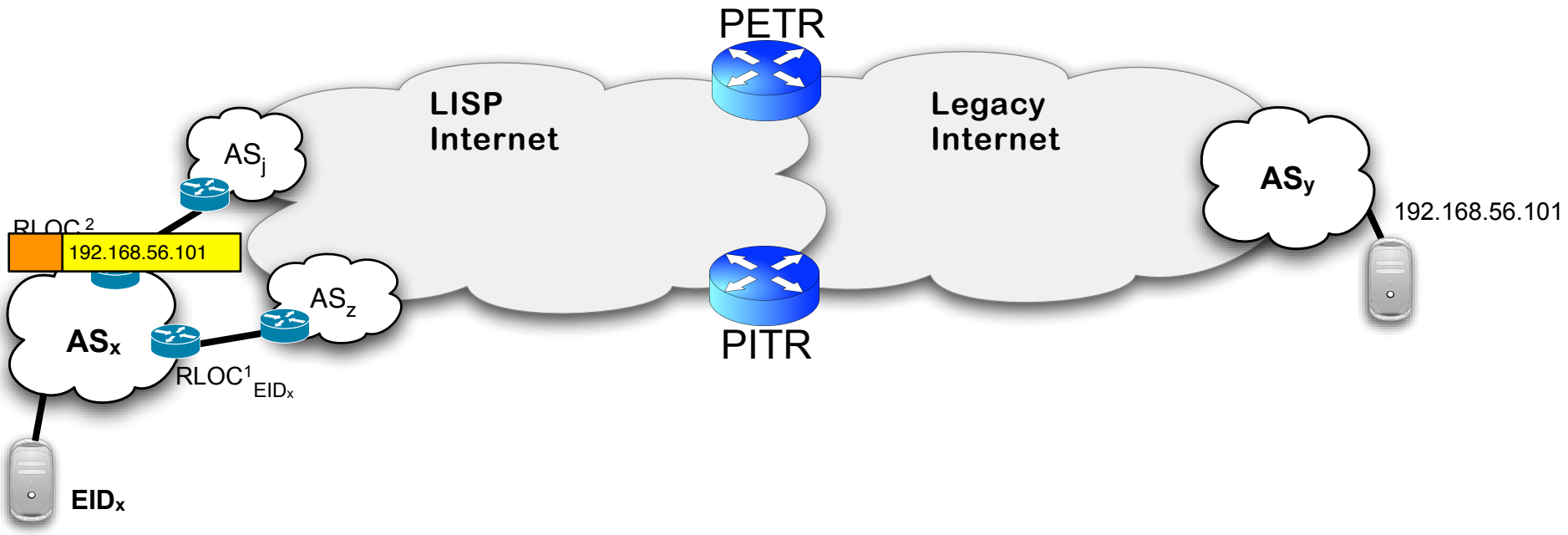


- Proxy-ITR (PITR) - Gateway from Legacy to LISP Internet
  - Announce large aggregates of EID-Prefixes into the legacy BGP
- Proxy-ETR (PETR) - Gateway from LISP to Legacy Internet
  - Could a static configuration (similar to default route)
  - Could be obtained from Mapping System

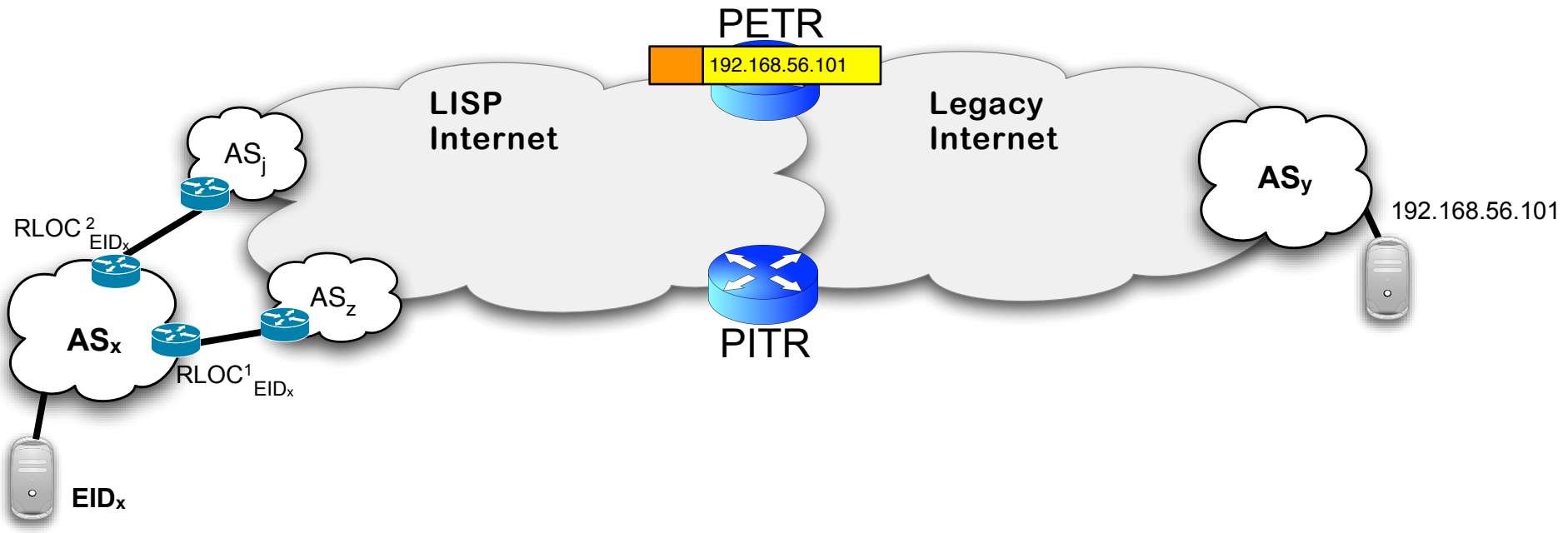
PxTRs and asymmetric traffic flow



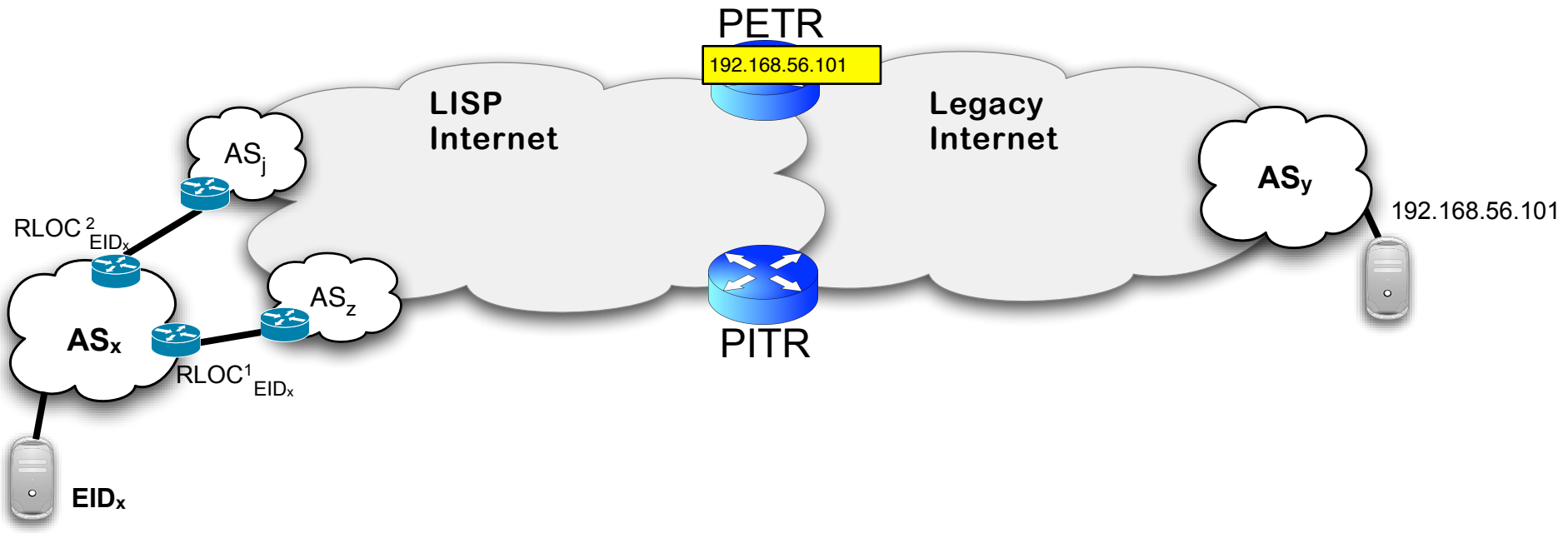
PxTRs and asymmetric traffic flow



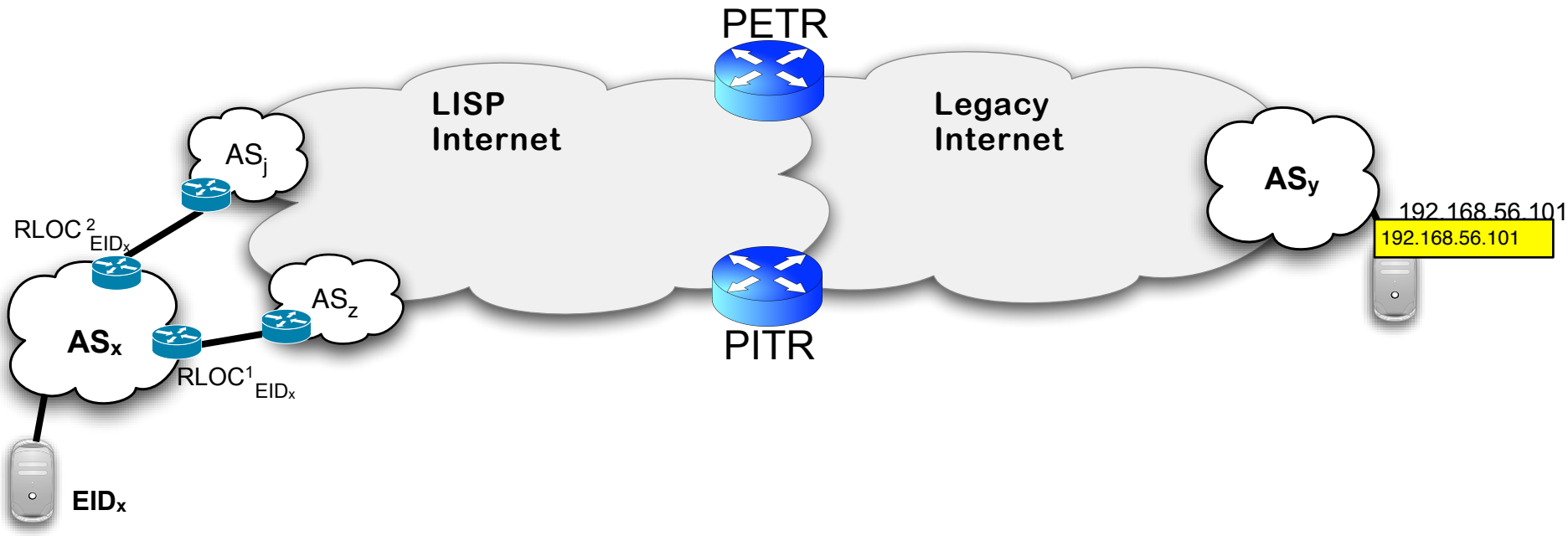
PxTRs and asymmetric traffic flow



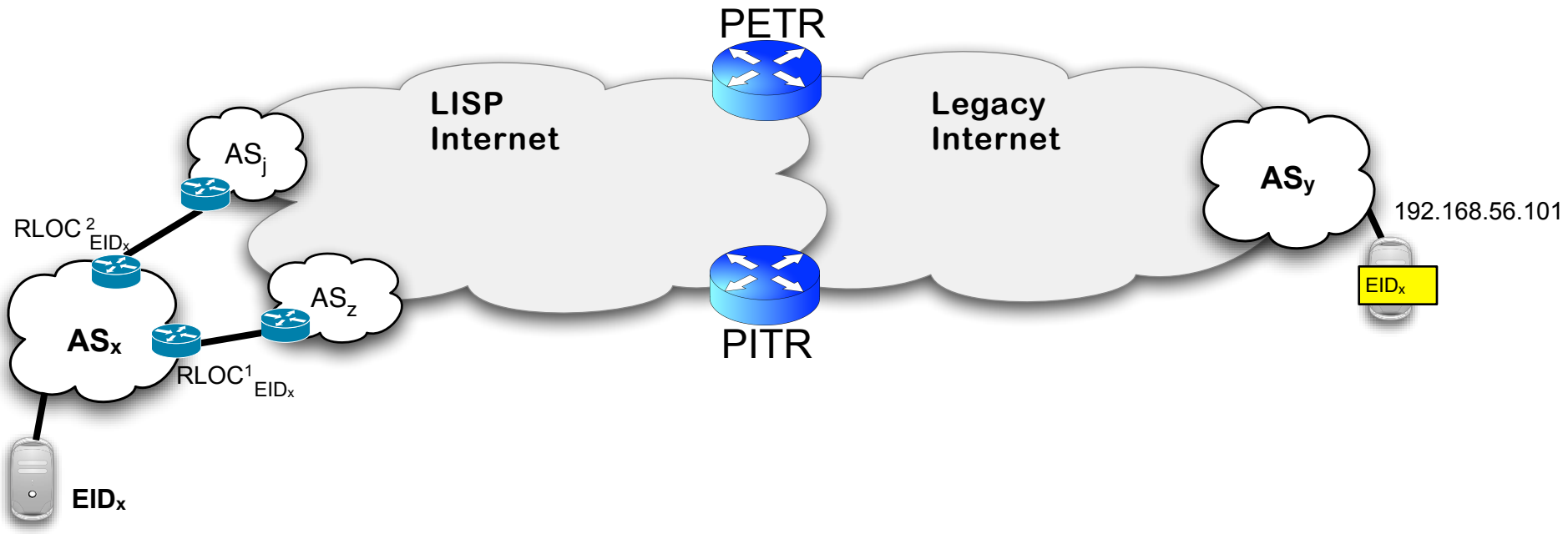
PxTRs and asymmetric traffic flow



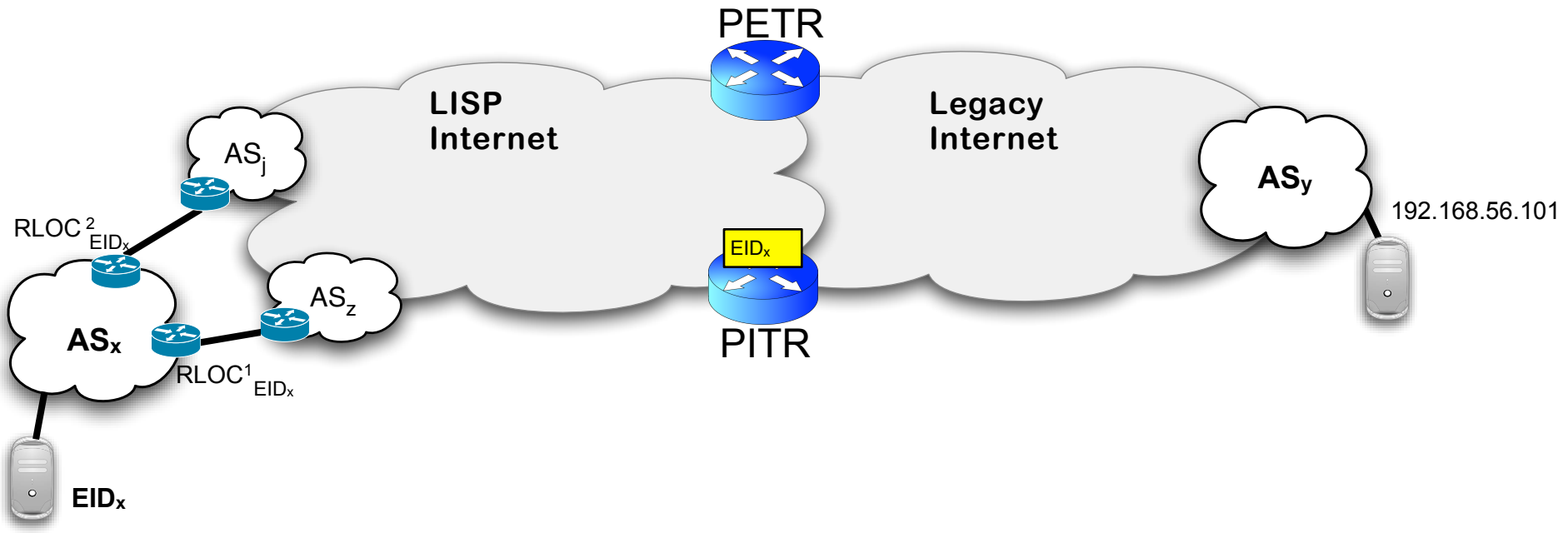
PxTRs and asymmetric traffic flow



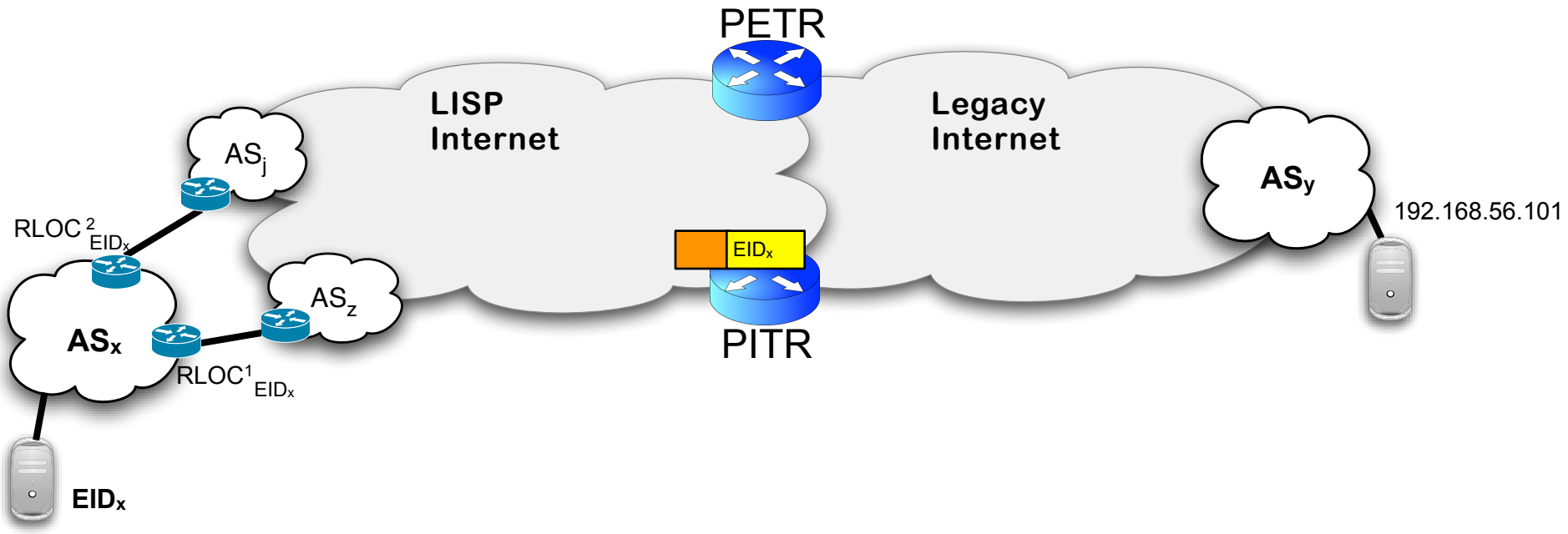
PxTRs and asymmetric traffic flow



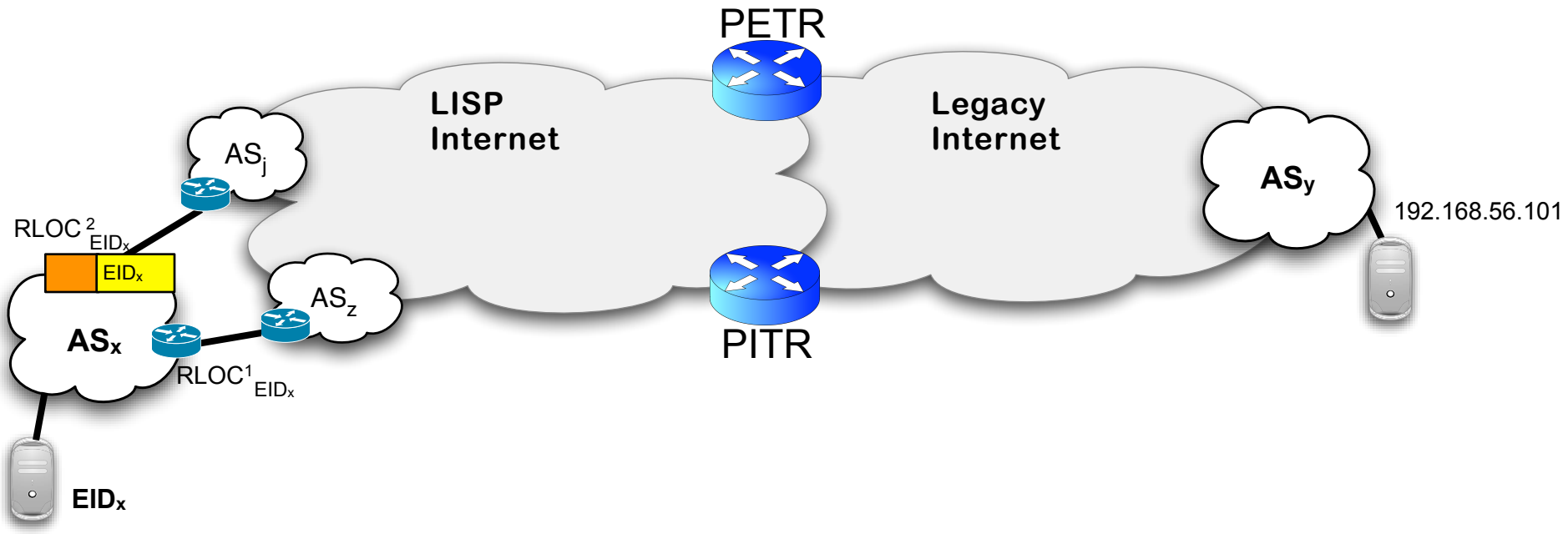
PxTRs and asymmetric traffic flow



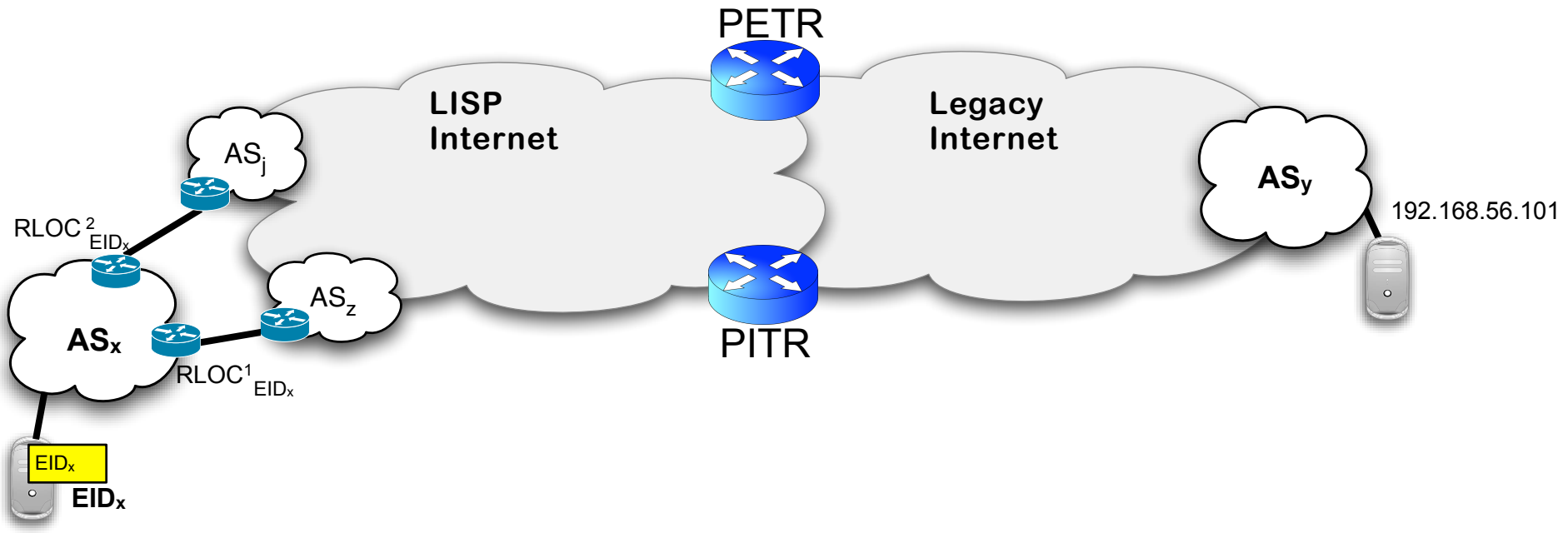
PxTRs and asymmetric traffic flow



PxTRs and asymmetric traffic flow

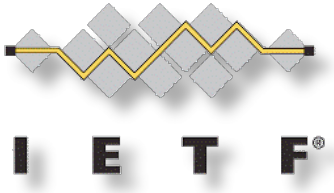


PxTRs and asymmetric traffic flow



Few Pointers...

- datatracker.ietf.org/wg/lisp/



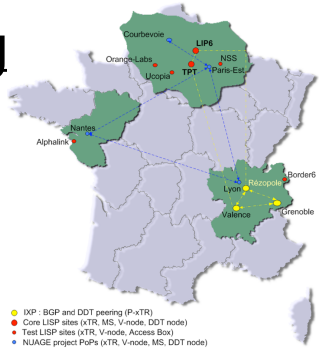
- www.lisp4.net

- www.openlisp.org

- www.lisp-lab.org

Lisp-Lab

Building Today the Internet of Tomorrow



Coming Soon…….

TELECOM ParisTech