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Vers un renforcement de l'architecture Internet : le protocole LISP ("Locator/ID Separation Protocol")

JCSA 2013

Luigi Iannone

Road Map

- Why LISP???
- LISP Data Plane
  - RFC 6830
- LISP Control Plane
  - RFC 6833; RFC 6836; draft-ietf-lisp-ddt-01.txt
- The Big Picture

Why LISP?????

Internet's Scaling Issues

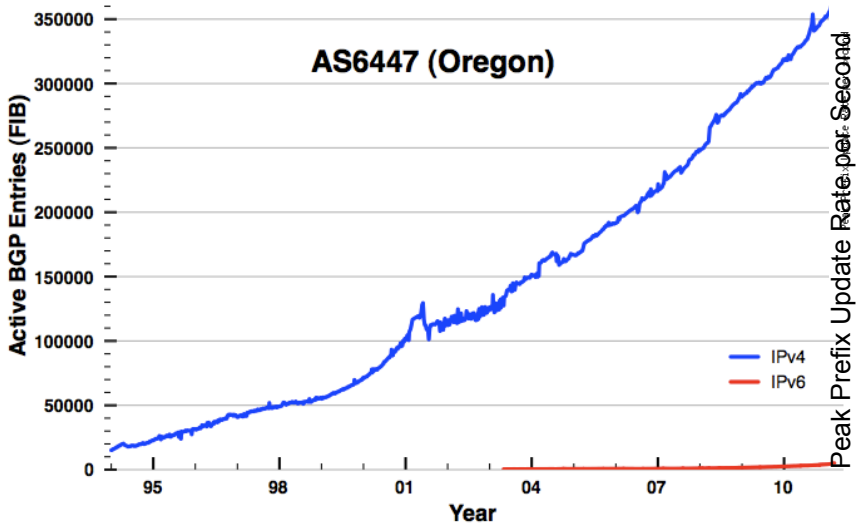
"It is commonly recognized that today's Internet routing and addressing system is facing serious scaling problems."

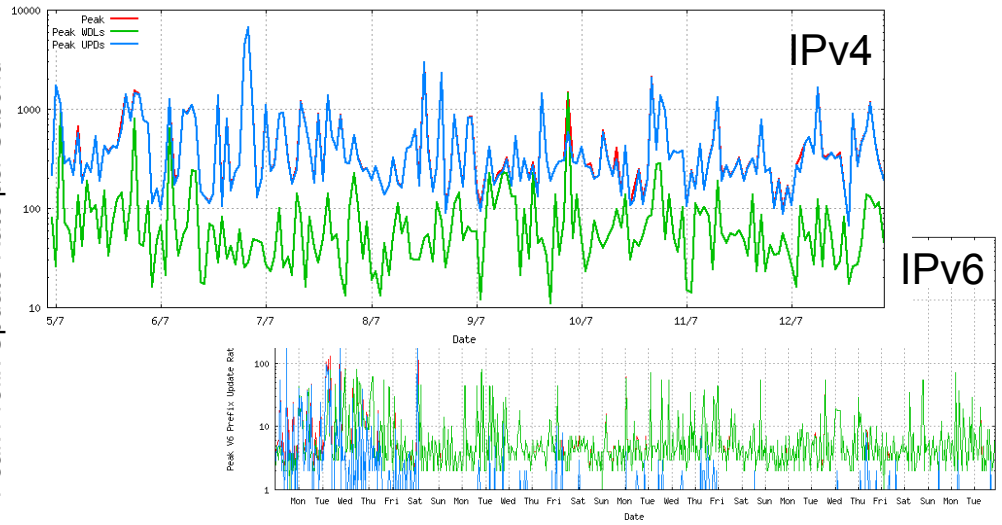
- D. Meyer, L. Zhang, K. Fall, "Report from IAB Workshop on Routing and Addressing", RFC 4984, IETF, September 2007.

The BGP's FIB inflation problem

No... it is not just natural Internet growth

01-Jan-94 to 14-March-11 Source: http://bgp.potaroo.net/index-bgp.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

Cause: The overloaded IP address semantic

- An IP Address tells:
  - Who you are
    - —Hi! I am *Luigi Iannone 46 Rue Barreault 75013 Paris France*
  - Where you are
    - —.... and I am in *Luigi Iannone 46 Rue Barreault 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

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:

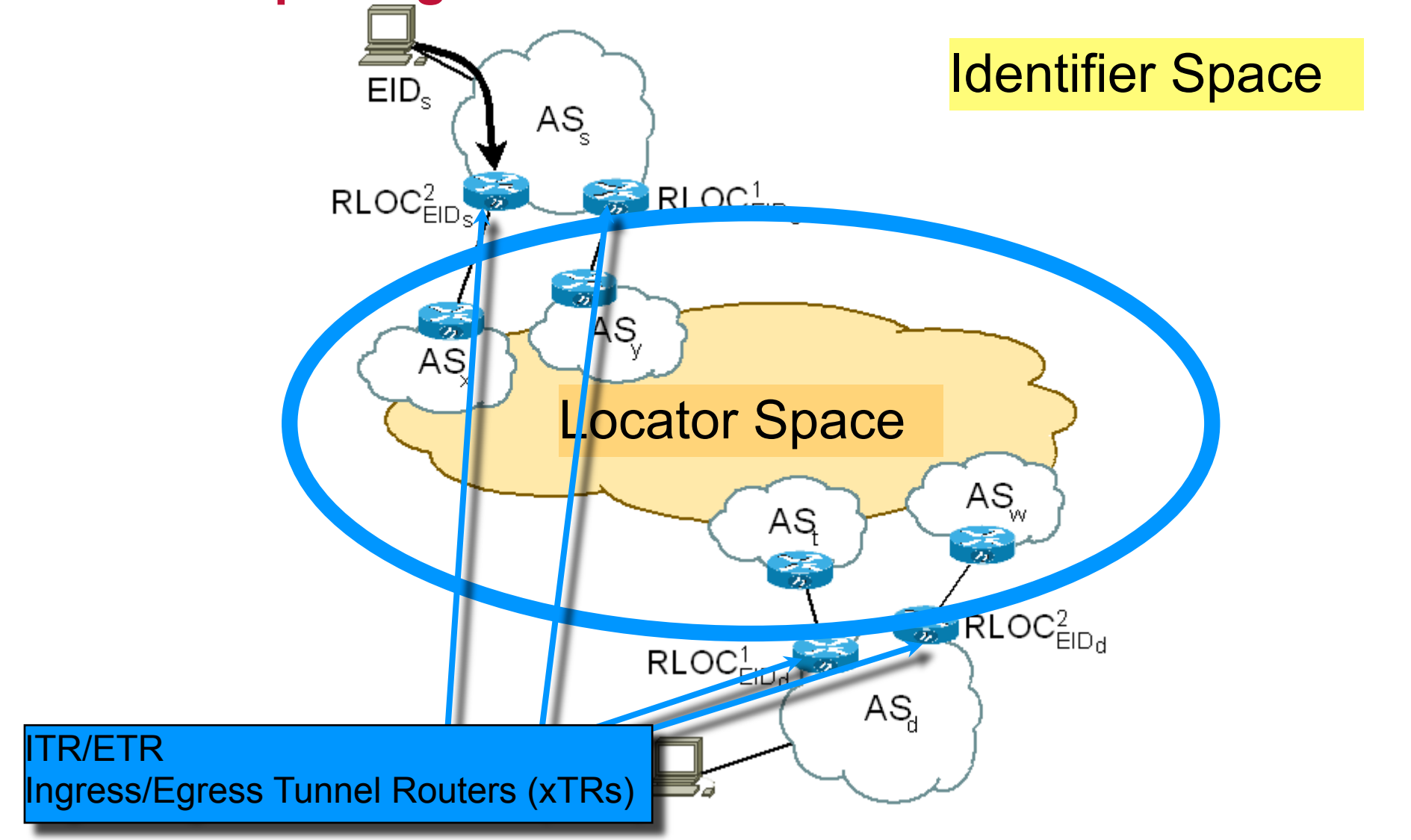
- **Locator/ID Separation Protocol (LISP)**
- Routing Architecture for the Next Generation Internet (RANGI)
- Internet Vastly Improved Plumbing (Ivip)
- Hierarchical IPv4 Framework (hIPv4)
- Name Overlay (NOL) Service for Scalable Internet Routing
- Compact Routing in a Locator Identifier Mapping System (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: Locator/ID Separation Protocol

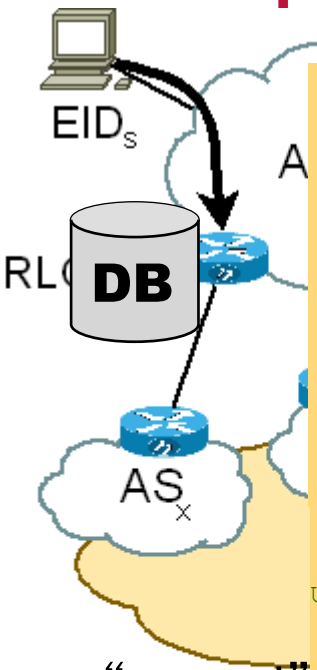
- **RFC 6830**: The Locator/ID Separation Protocol (LISP)
- **RFC 6831**: The Locator/ID Separation Protocol (LISP) for Multicast Environments
- **RFC 6832**: Interworking between Locator/ID Separation Protocol (LISP) and Non-LISP Sites
- **RFC 6833**: Locator/ID Separation Protocol (LISP) Map-Server Interface
- **RFC 6834**: Locator/ID Separation Protocol (LISP) Map-Versioning
- **RFC 6835**: The Locator/ID Separation Protocol Internet Groper (LIG)
- **RFC 6836**: Locator/ID Separation Protocol (LISP) Alternative Logical Topology (LISP+ALT)
- **RFC 6837**: NERD: A not-so-novel Endpoint ID (EID) to Routing Locator (RLOC) Database

LISP Data Plane (RFC 6830)

Splitting ID and Location



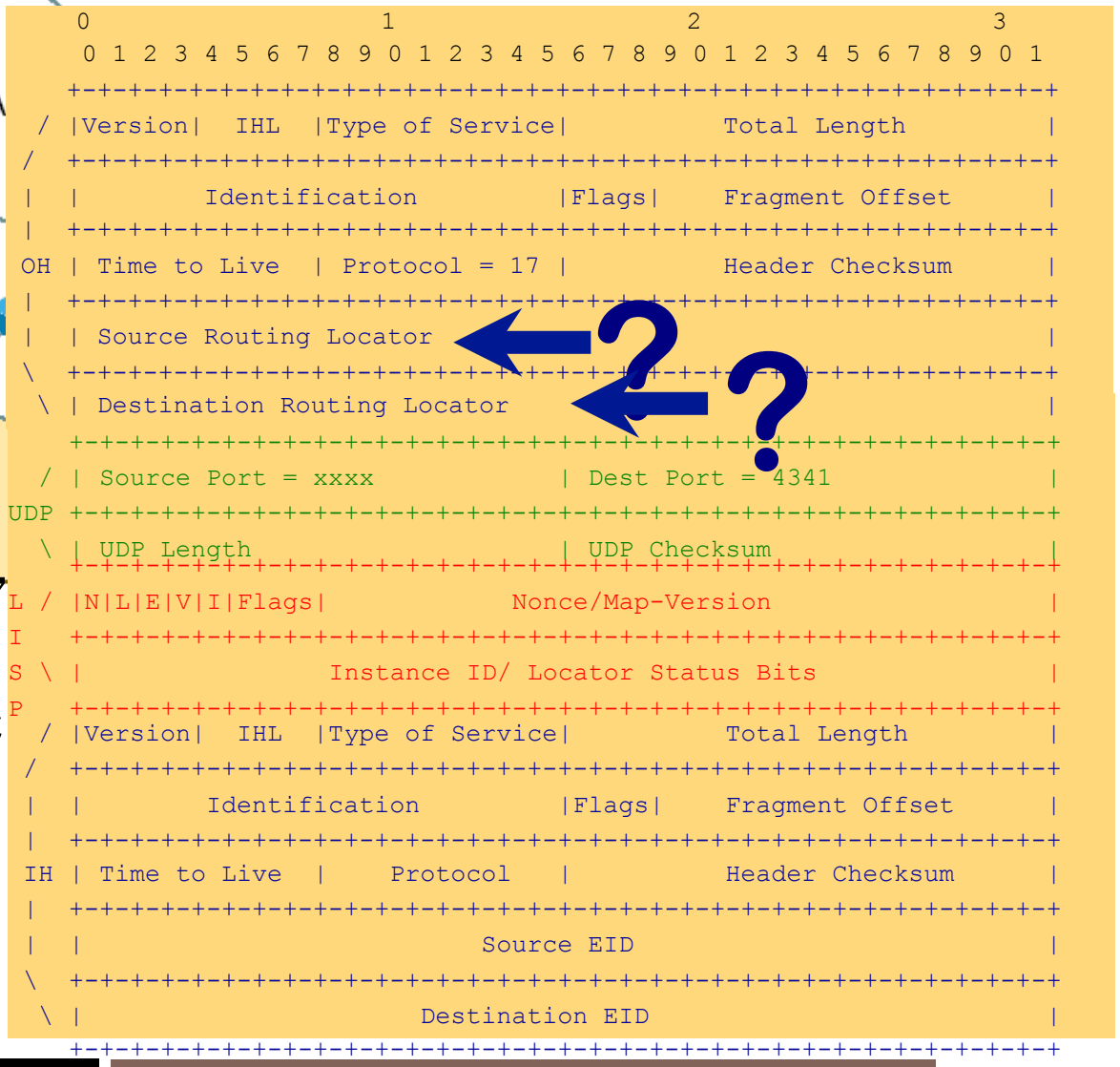
Map & Encap Operations: source side



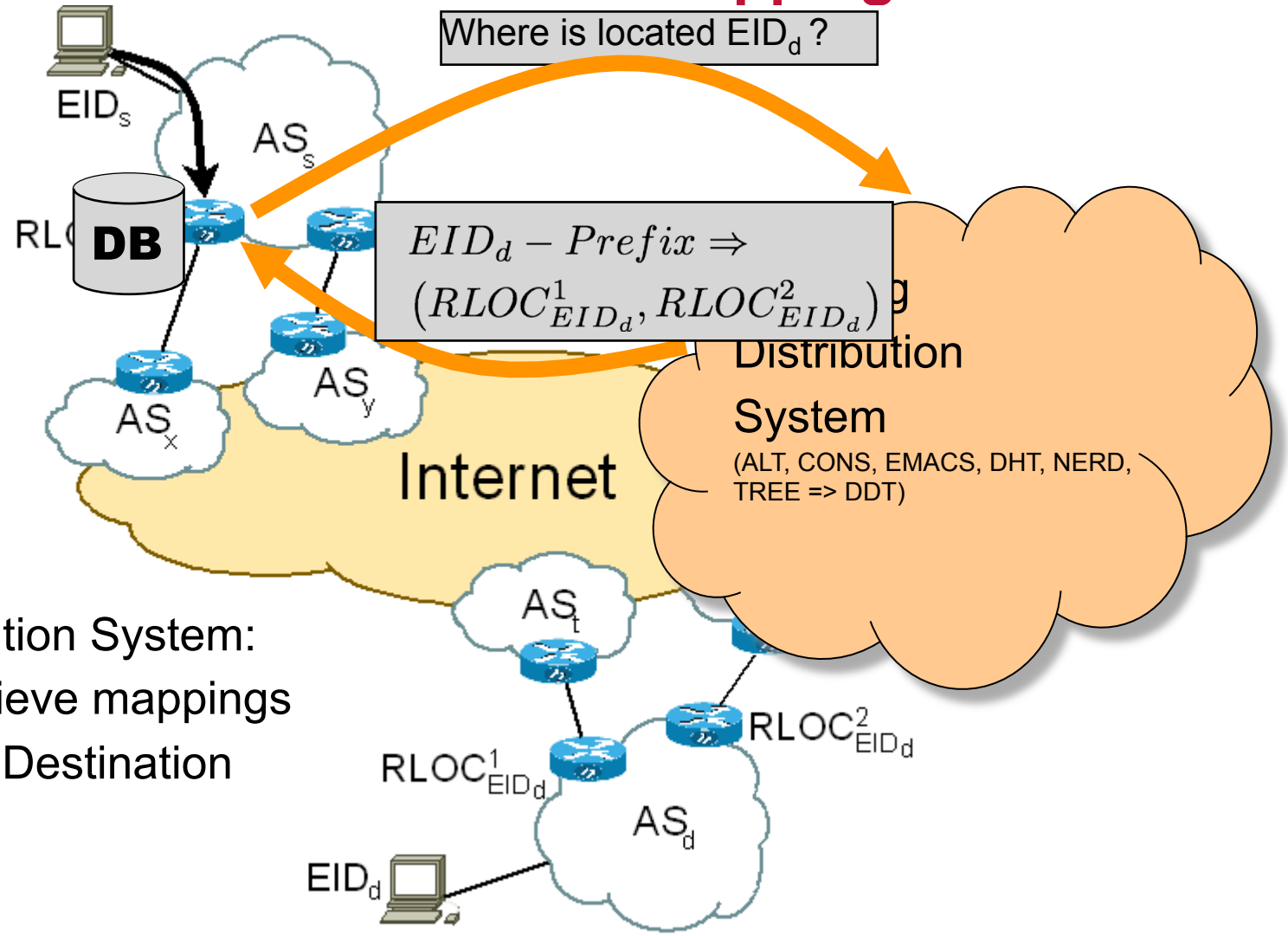
LISP-Database:

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

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



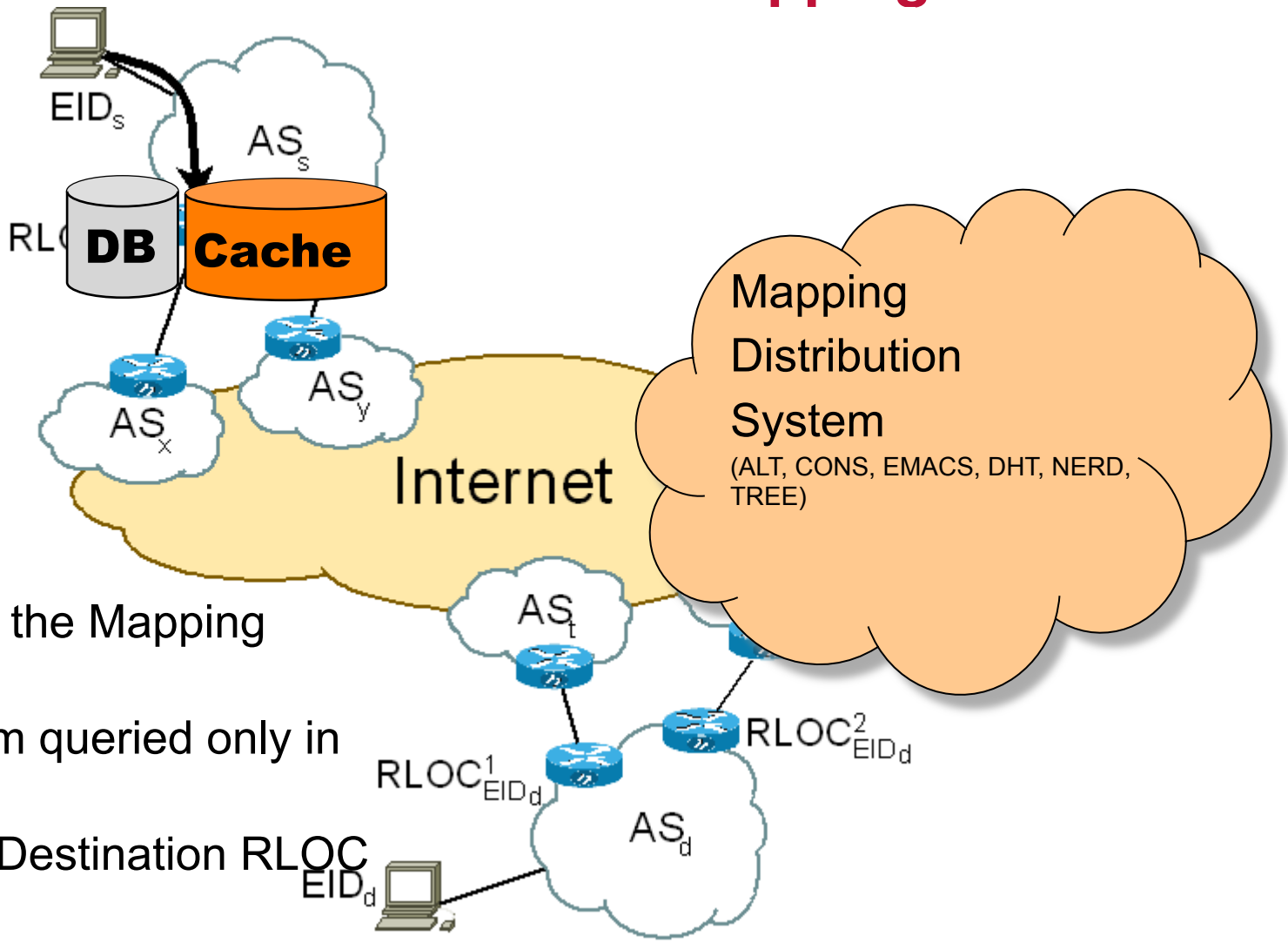
Where does LISP find the Mappings?



Mapping Distribution System:

- Queried to retrieve mappings
- Used to select Destination RLOC

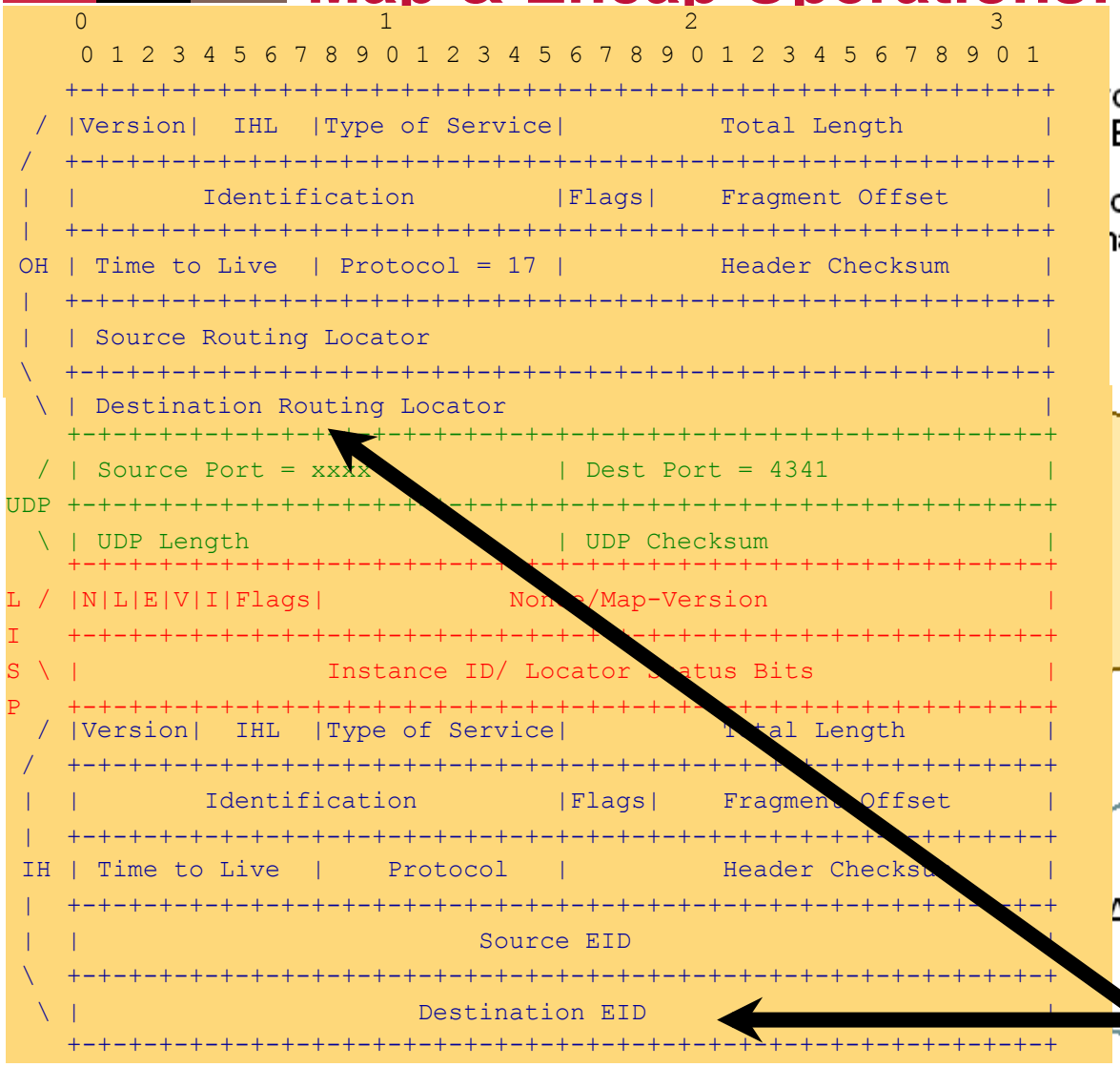
Where does LISP store the Mappings?



LISP-Cache:

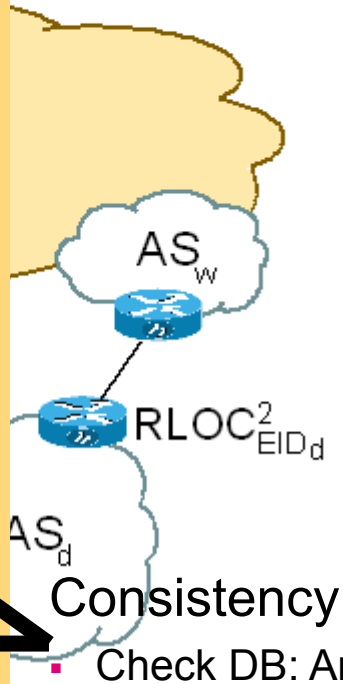
- Queried before the Mapping system
- Mapping system queried only in case of miss
- Used to select Destination RLOC

Map & Encap Operations: destination side



ding using RLOCs
Encapsulation)

ding using EIDs
nal IP packets)



Consistency Checks:

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

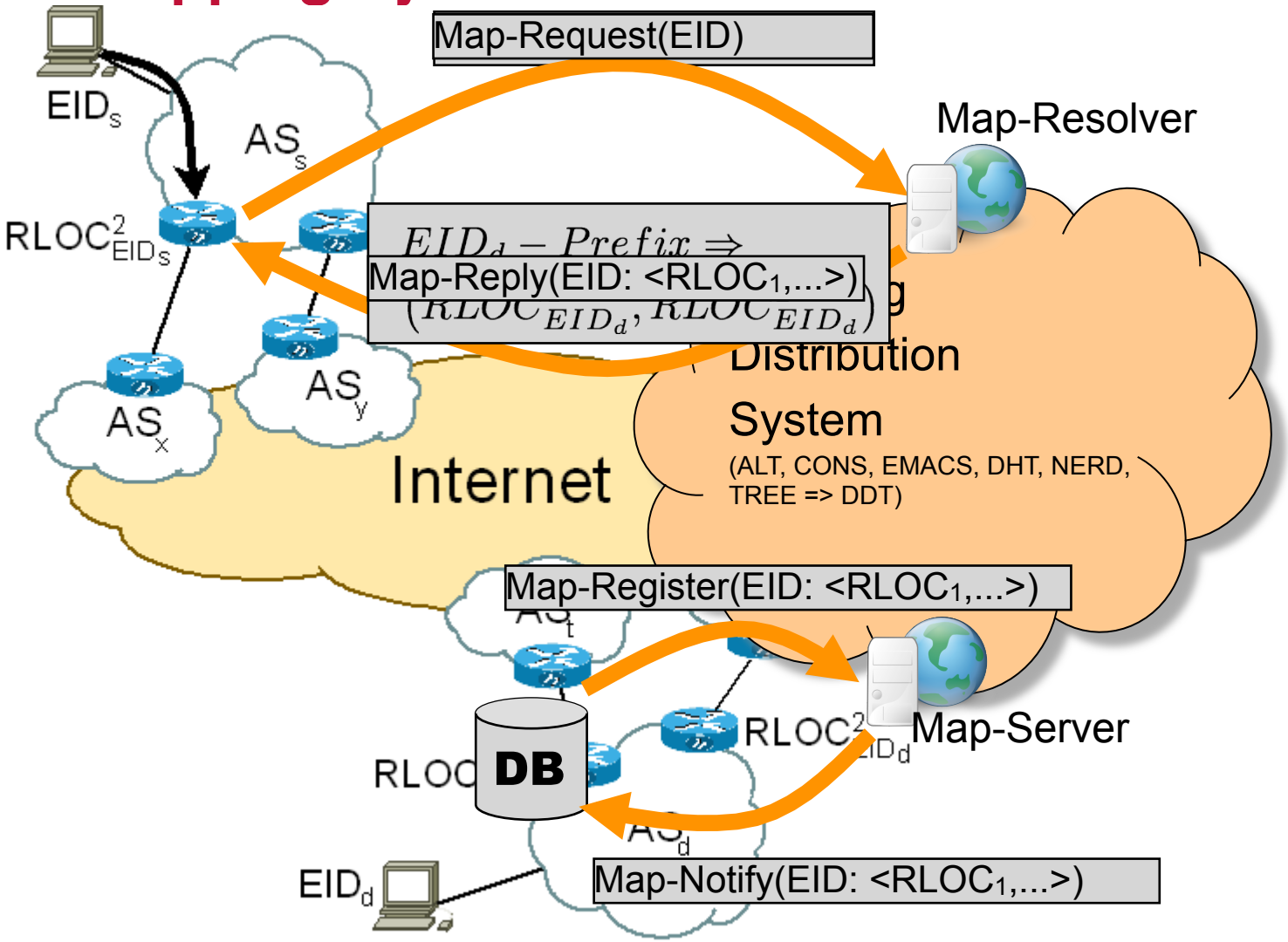
LISP Mapping Distribution System

LISP-MS (RFC 6833)

LISP+ALT (RFC 6836)

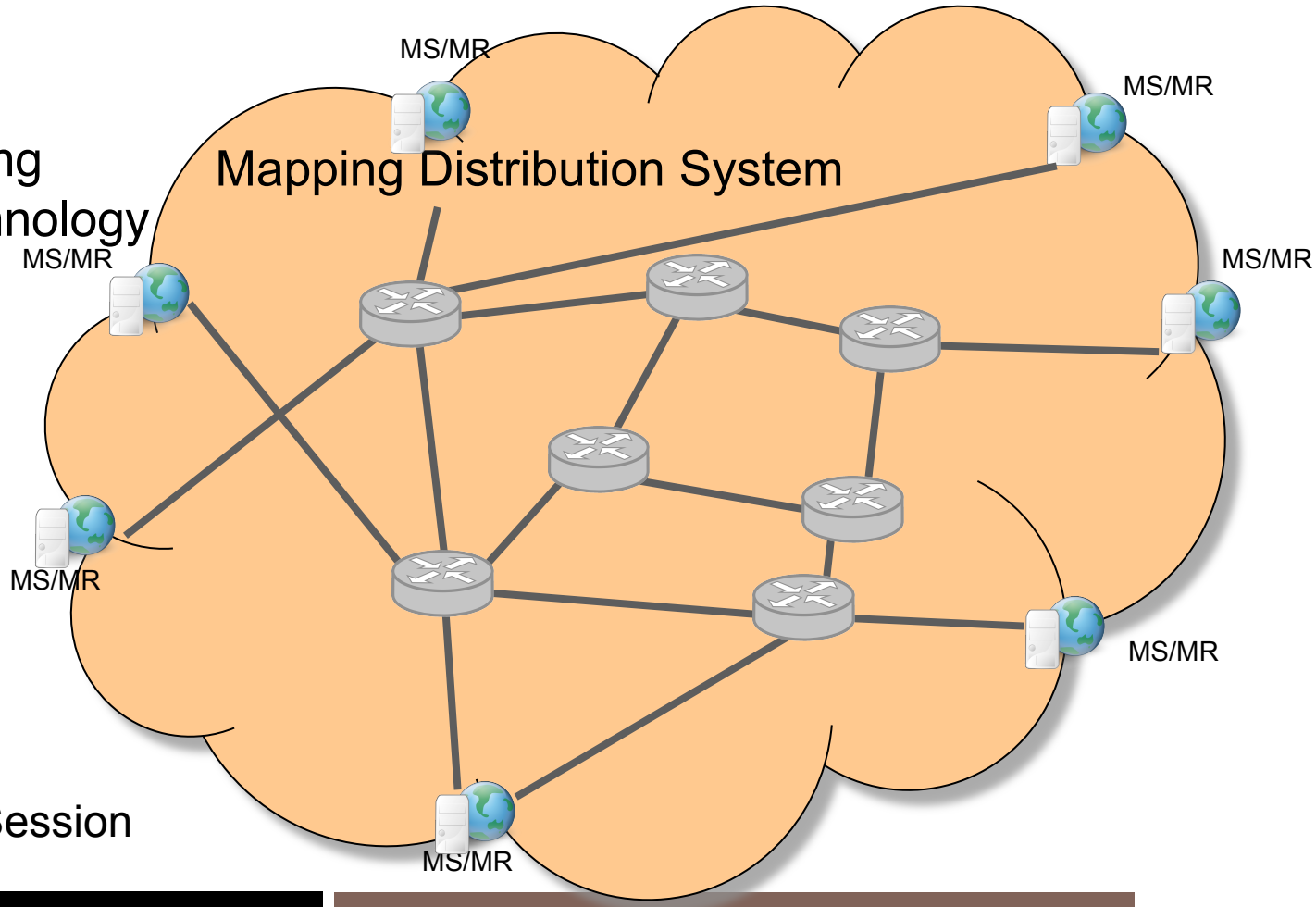
LISP-DDT (draft-ietf-lisp-ddt-01.txt)

MS: A Mapping System API



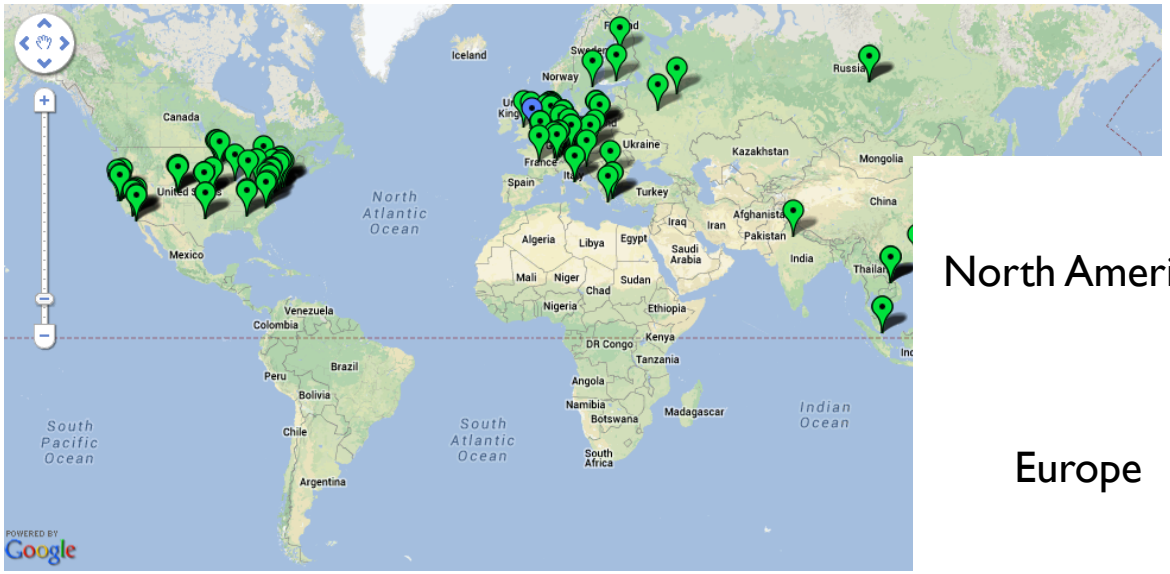
LISP+ALT
Alternative Logical Topology

- Pros
  - Based on existing well-known technology
- Cons
  - PITA



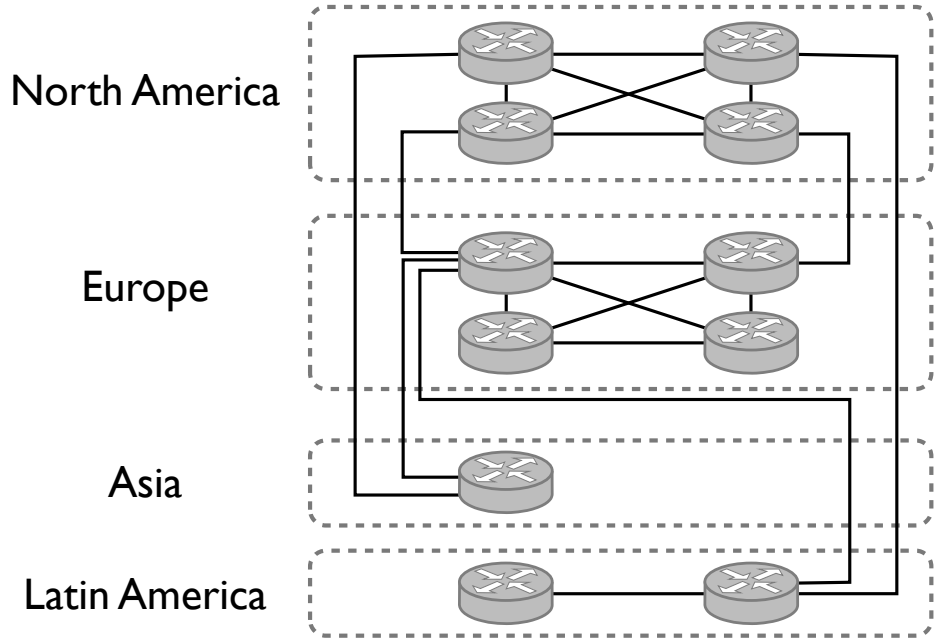
LISP+ALT Failure

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



Source: www.lispmon.net

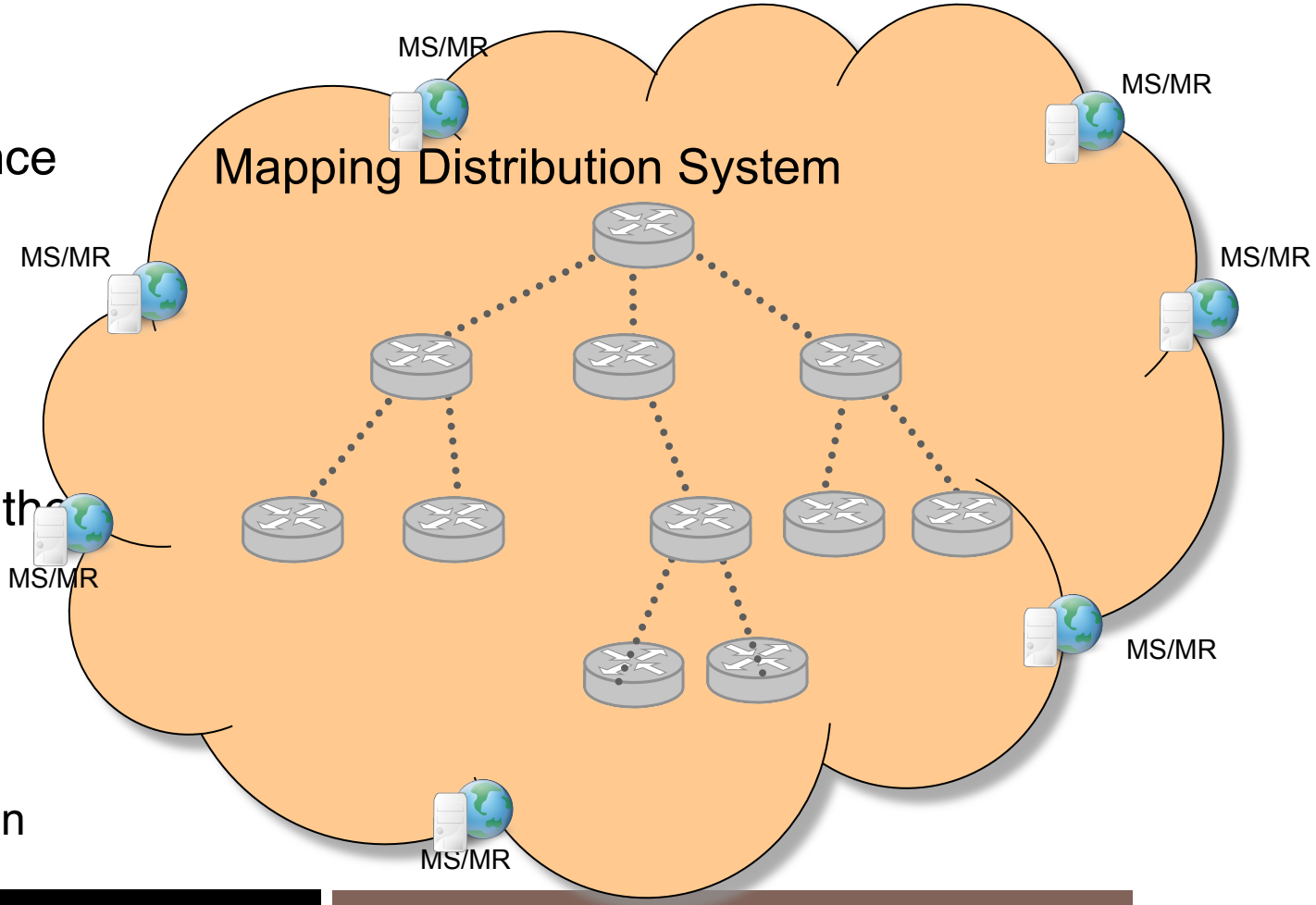
- **2nd Week March 2012**
- **LISP4.net switched to DDT**



LISP+ALT Topology early 2012

LISP-DDT
Delegated Database Tree

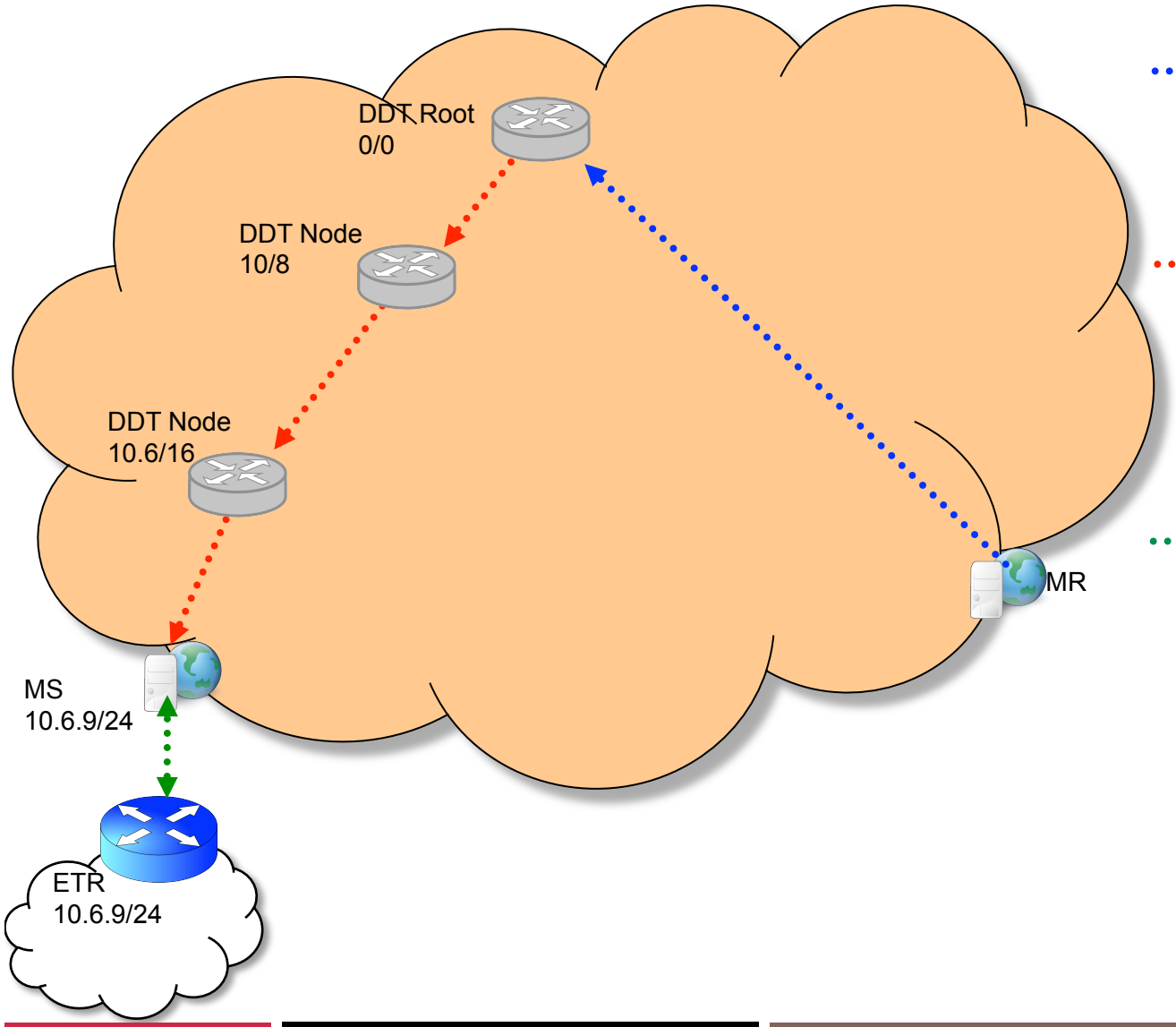
- Pros
- Easy maintenance
- Economics
- Security
- Cons
- static manual configuration of the tree



DDT Node

..... Logical Delegation

LISP-DDT Configuration



MR

Static pointer to root

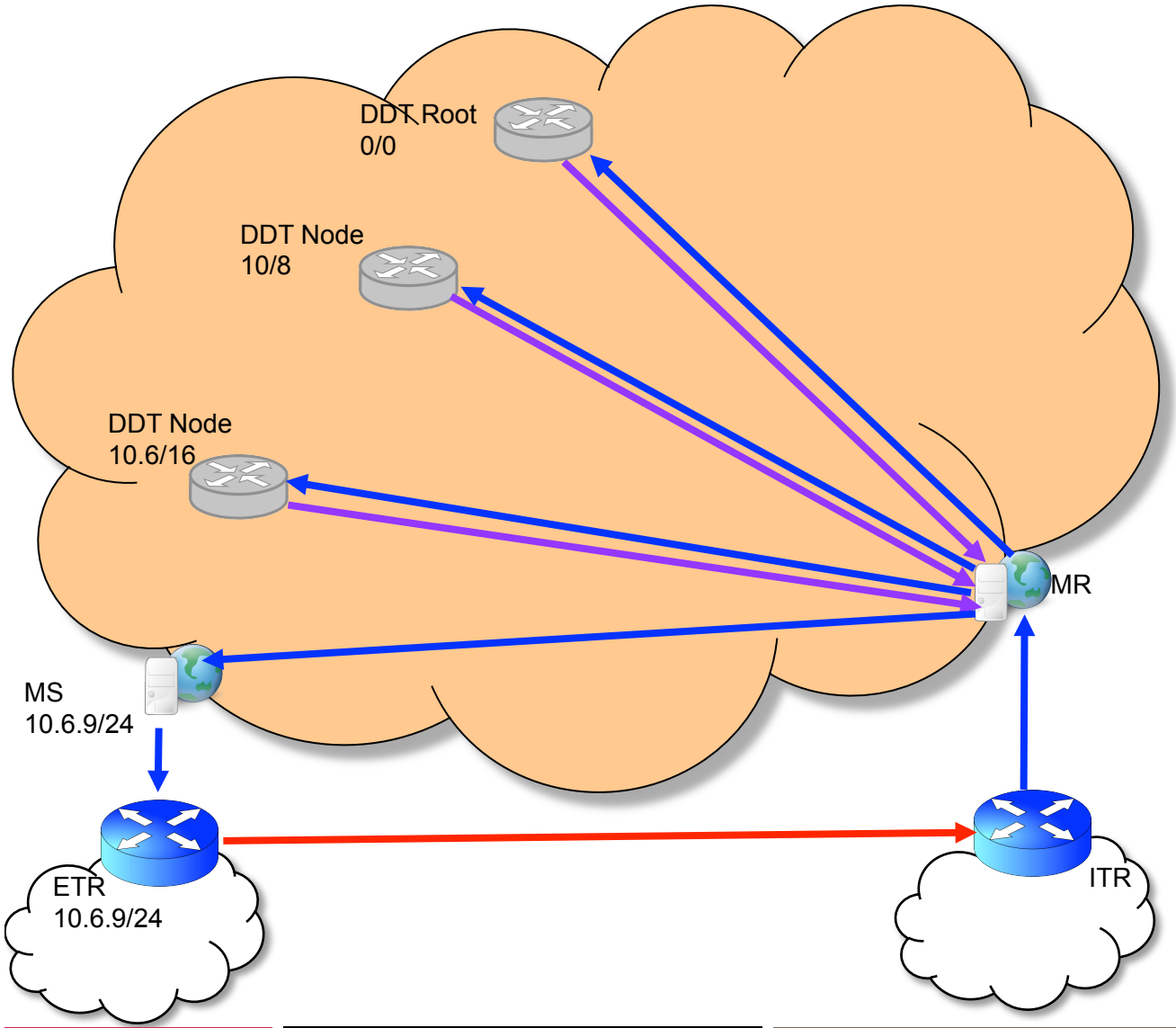
DDT Nodes

Static pointers to children authoritative of more-specific (leafs are MS)

ETR

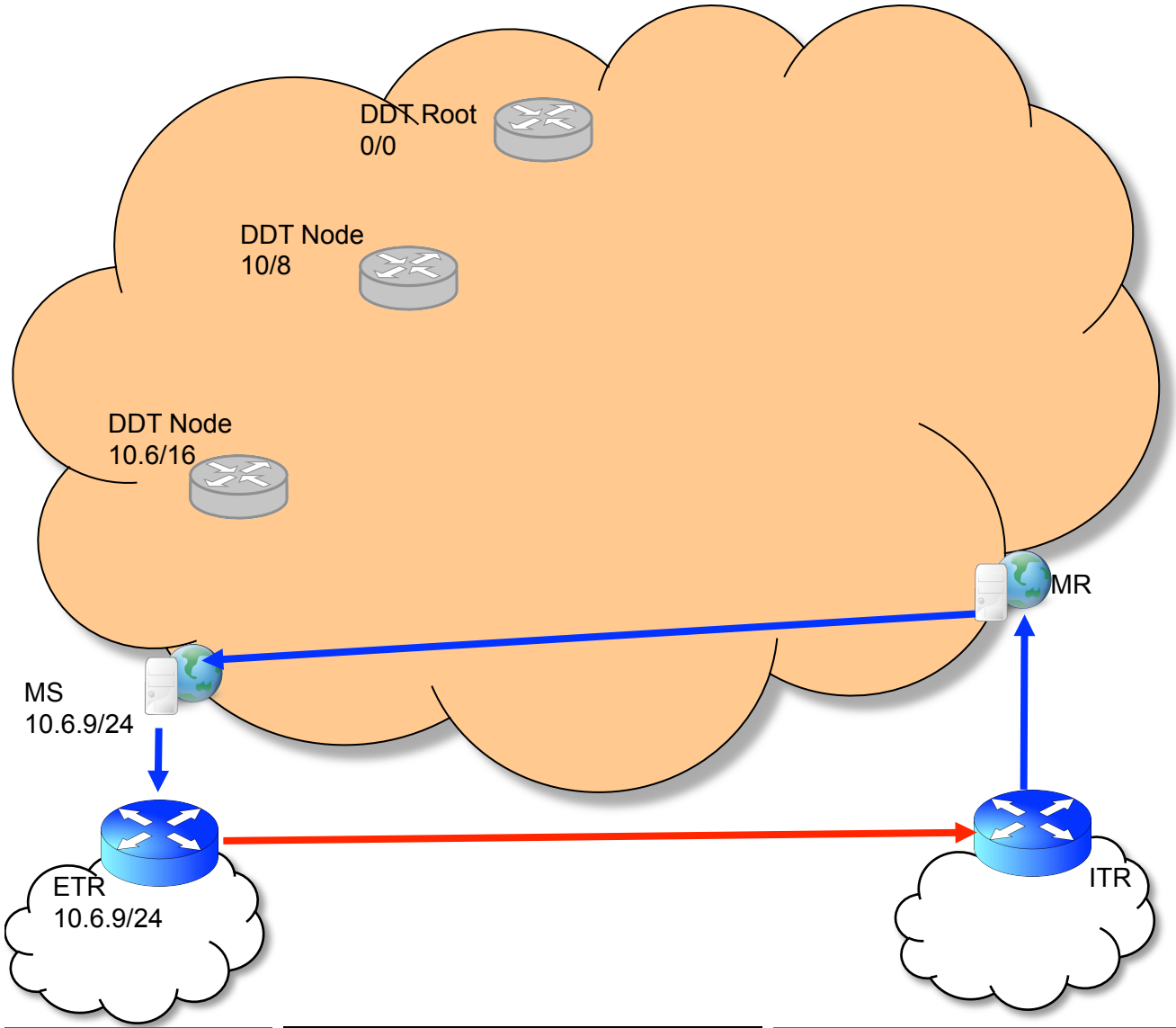
Registers to statically configured MS

LISP-DDT
Map Retrieval (cold start)



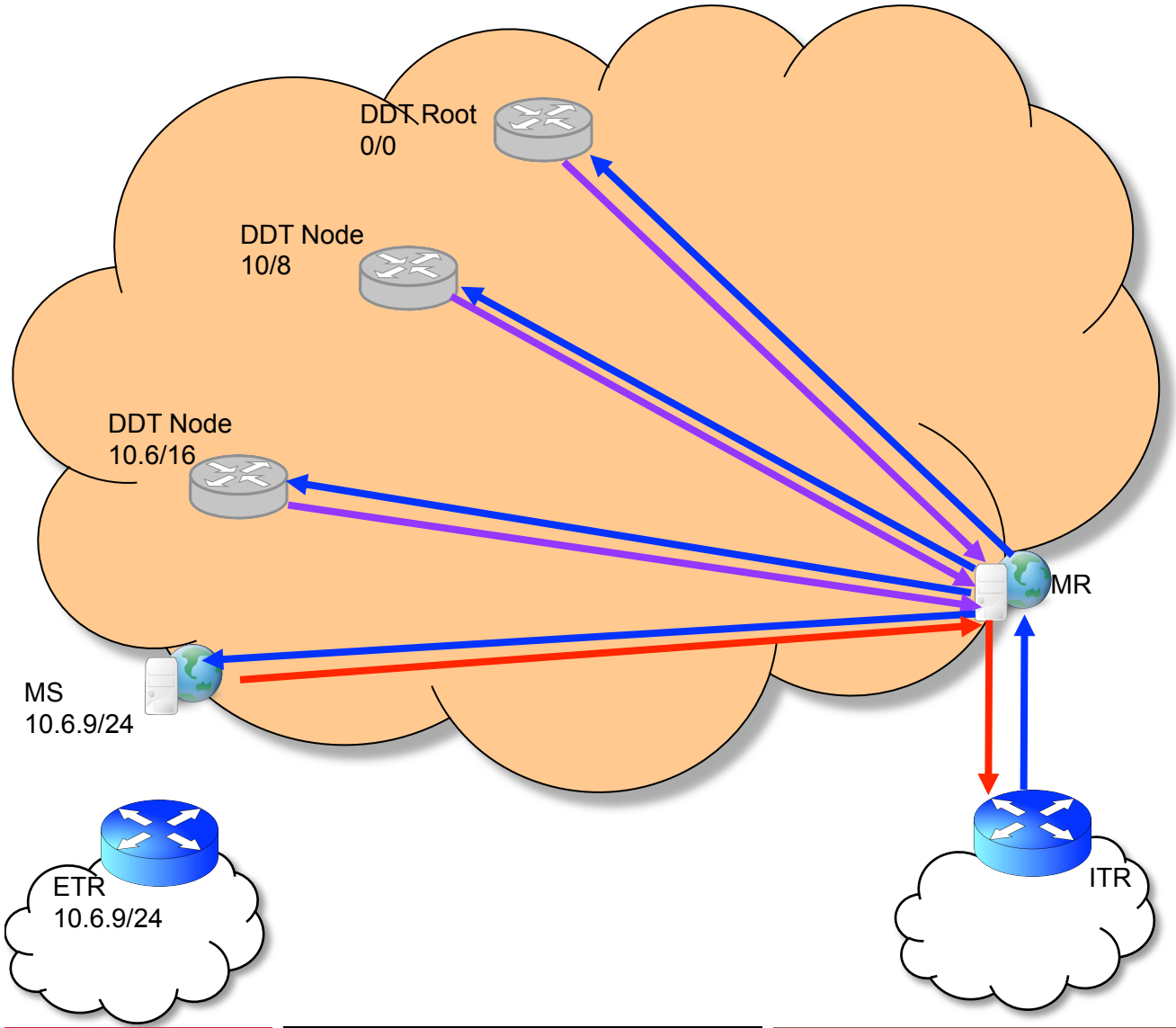
1. ITR sends Map-Request to its configured MR
2. MR sends Map-Request to configured Root Server
3. Root Server sends back Map-Referral to configured DDT Node authoritative on more specific
4. Repeat 2 and 3 until MS reached
5. MR sends Map-Request to MS
6. MS forwards Map-Request to authoritative ETR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

LISP-DDT
Map Retrieval (regular case)



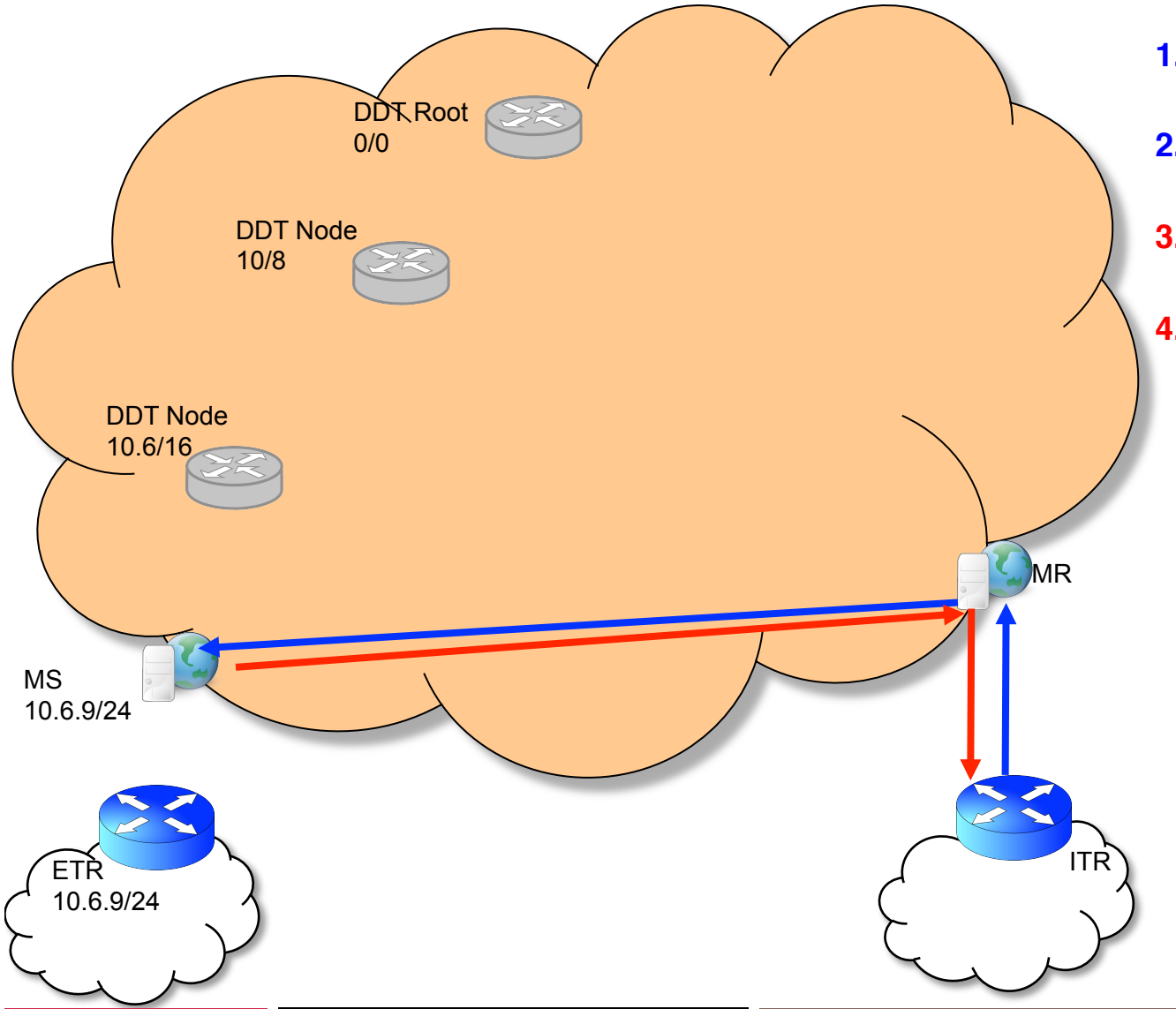
1. ITR sends Map-Request to its configured MR
2. MR sends Map-Request to cached MS
3. MS forwards Map-Request to authoritative ETR
4. ETR sends Map-Reply with requested mapping to ITR

LISP-DDT
Map Retrieval with Proxy Reply (cold start)



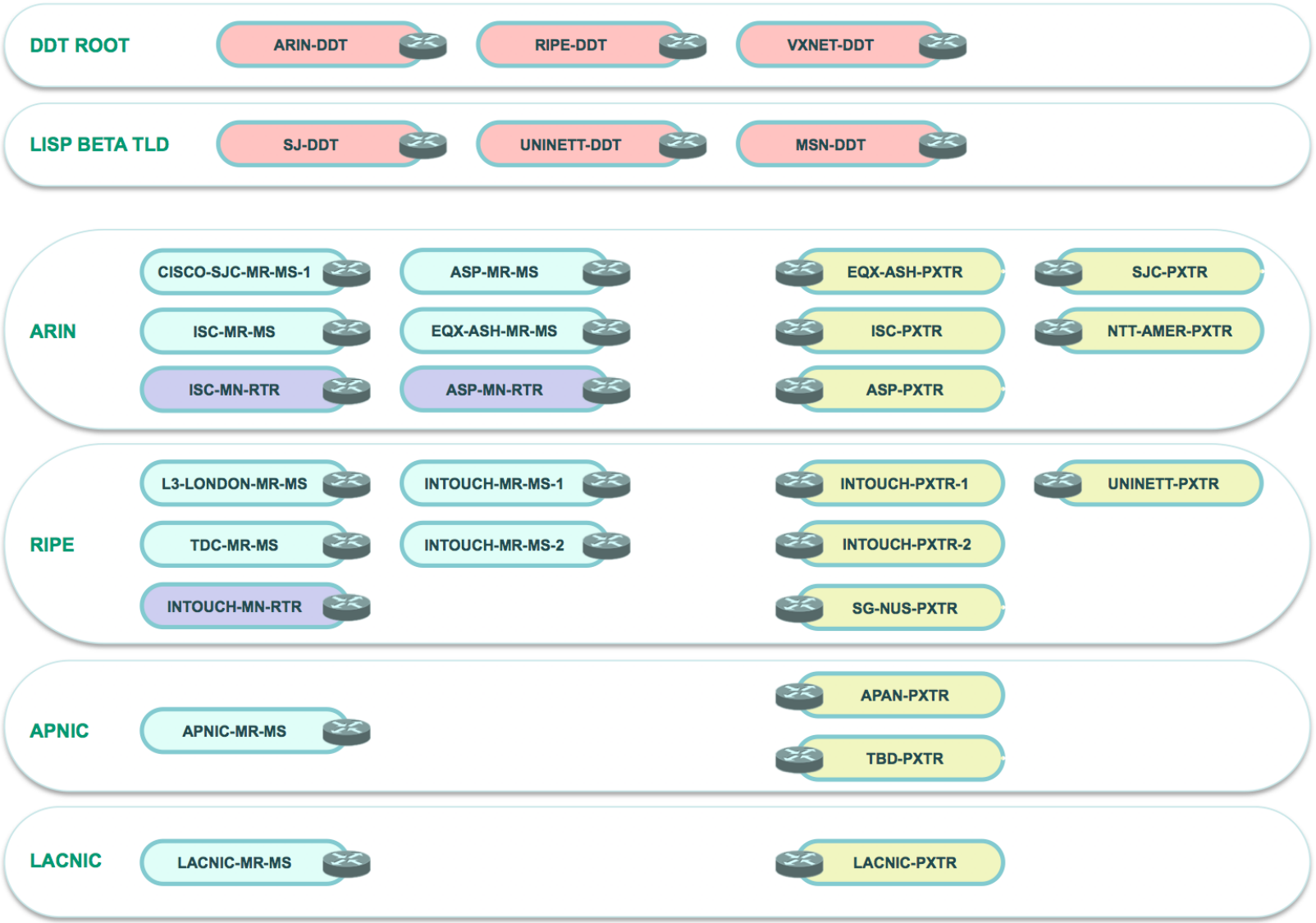
1. ITR sends Map-Request to its configured MR
2. MR sends Map-Request to configured Root Server
3. Root Server sends back Map-Referral to configured DDT Node authoritative on more specific
4. Repeat 2 and 3 until MS reached
5. MR sends Map-Request to authoritative MS
6. MS sends back Map-Reply with requested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

Map Retrieval with Proxy Reply (regular case) start)

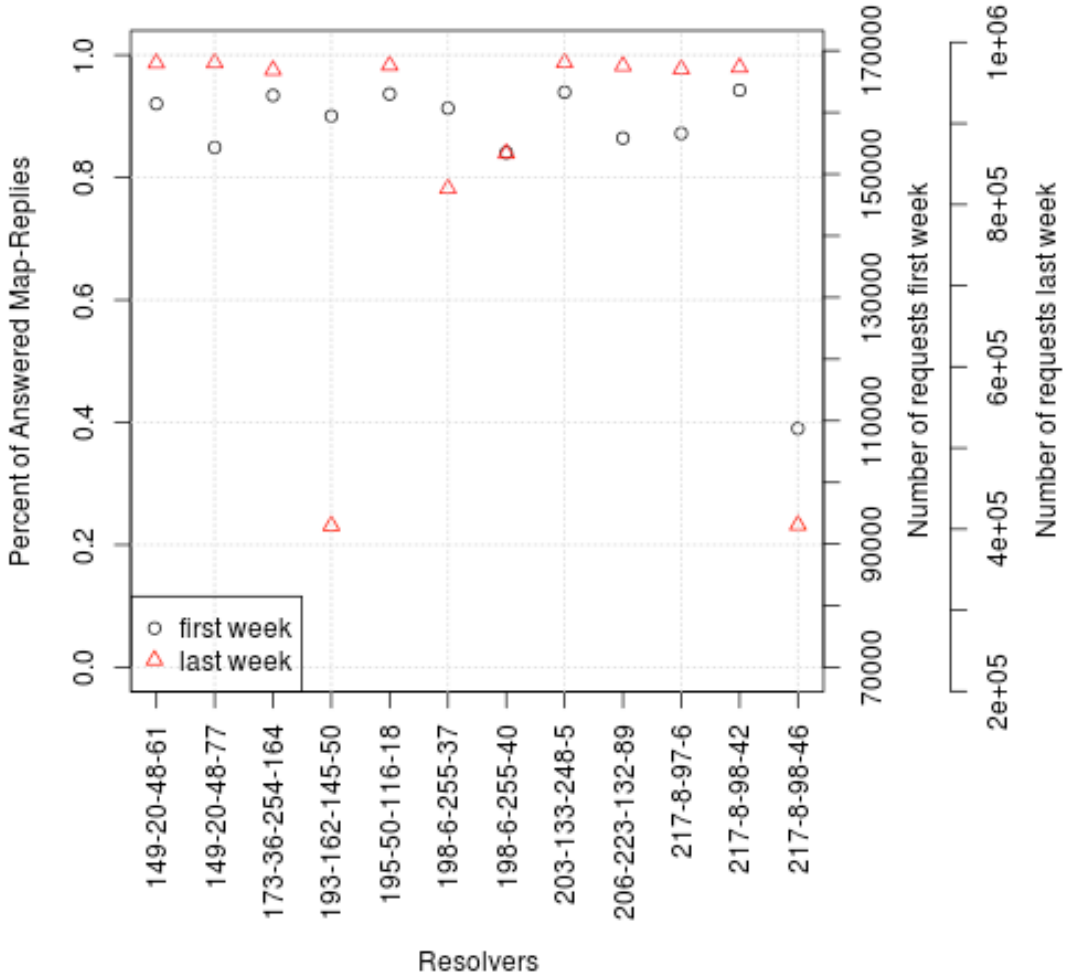


1. ITR sends Map-Request to its configured MR
2. MR sends Map-Request to cache MS
3. MS sends back Map-Reply with requested mapping to MR
4. MR sends Map-Reply with requested mapping to ITR

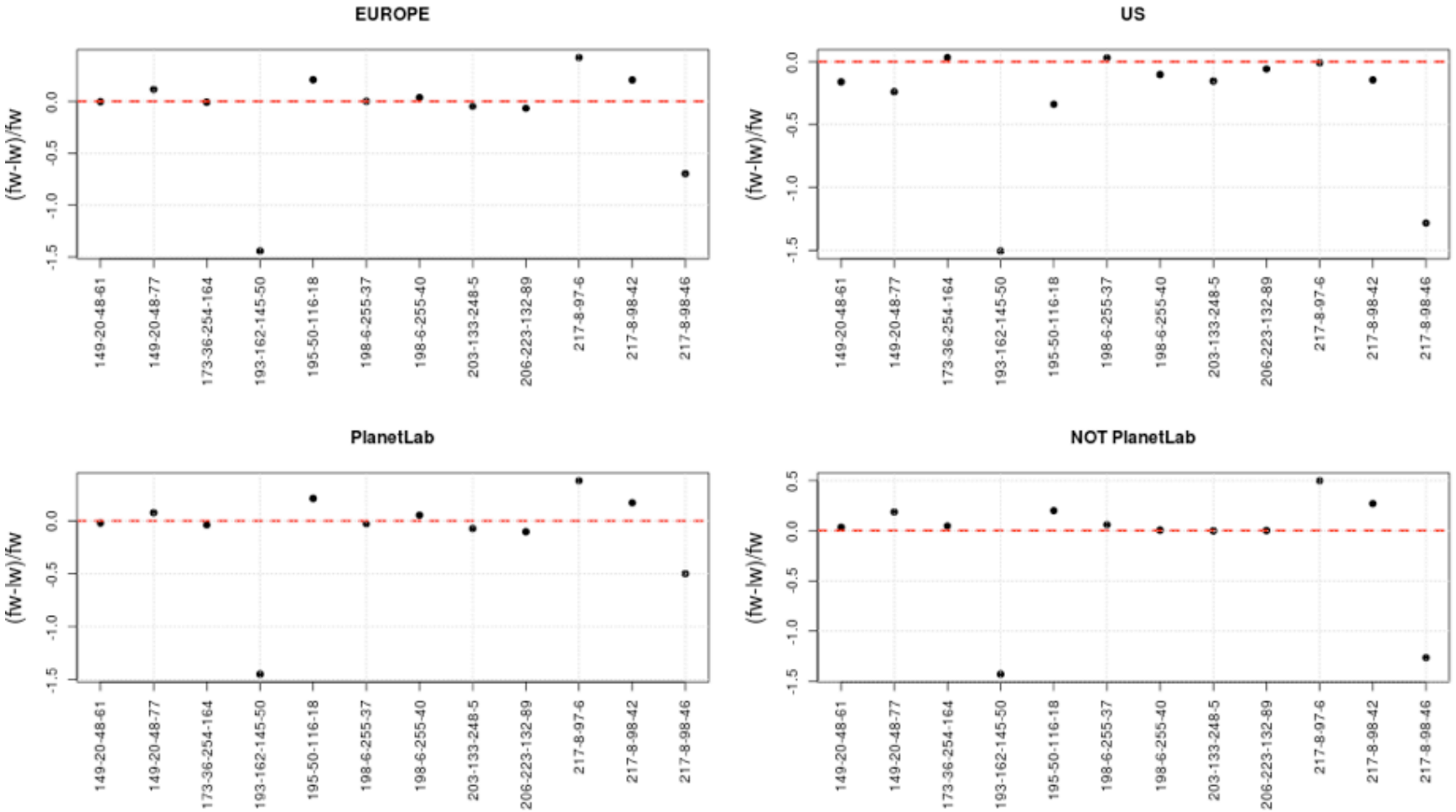
LISP DDT Topology (early 2013)



LISP-DDT Reliability



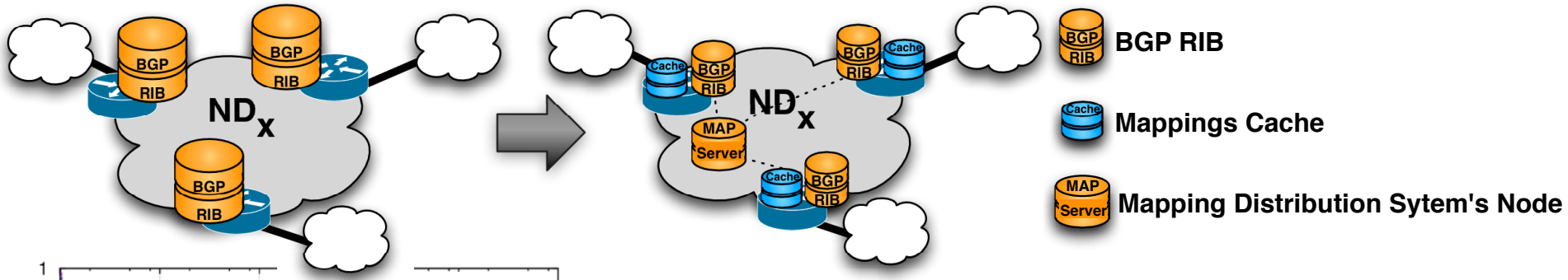
LISP-DDT RTT

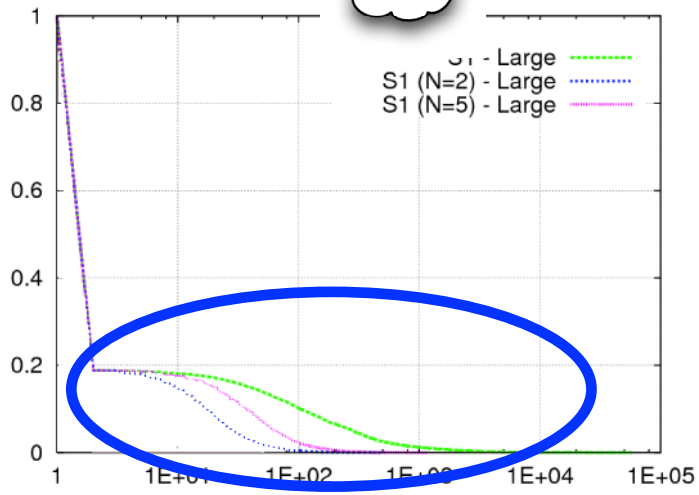

EUROPE
US
PlanetLab
NOT PlanetLab
(fw-lw)/fw
149-20-48-61
149-20-48-77
173-36-254-164
193-162-145-50
195-50-116-18
198-6-255-37
198-6-255-40
203-133-248-5
206-223-132-89
217-8-97-6
217-8-98-42
217-8-98-46

The Big Picture....

Does LISP finally solve (all of) the issues previously mentioned???

What the Internet looks like with LISP



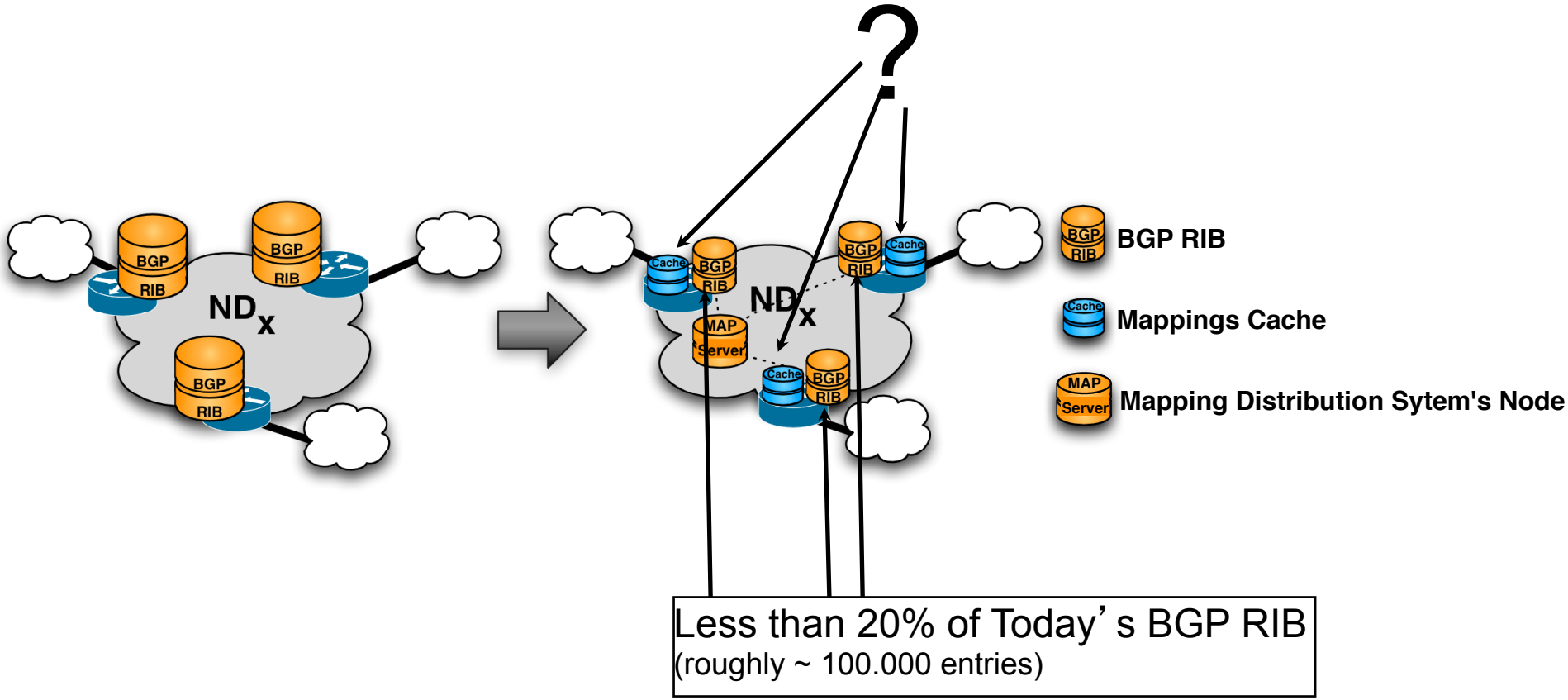


Number of FIB entries (logscale)

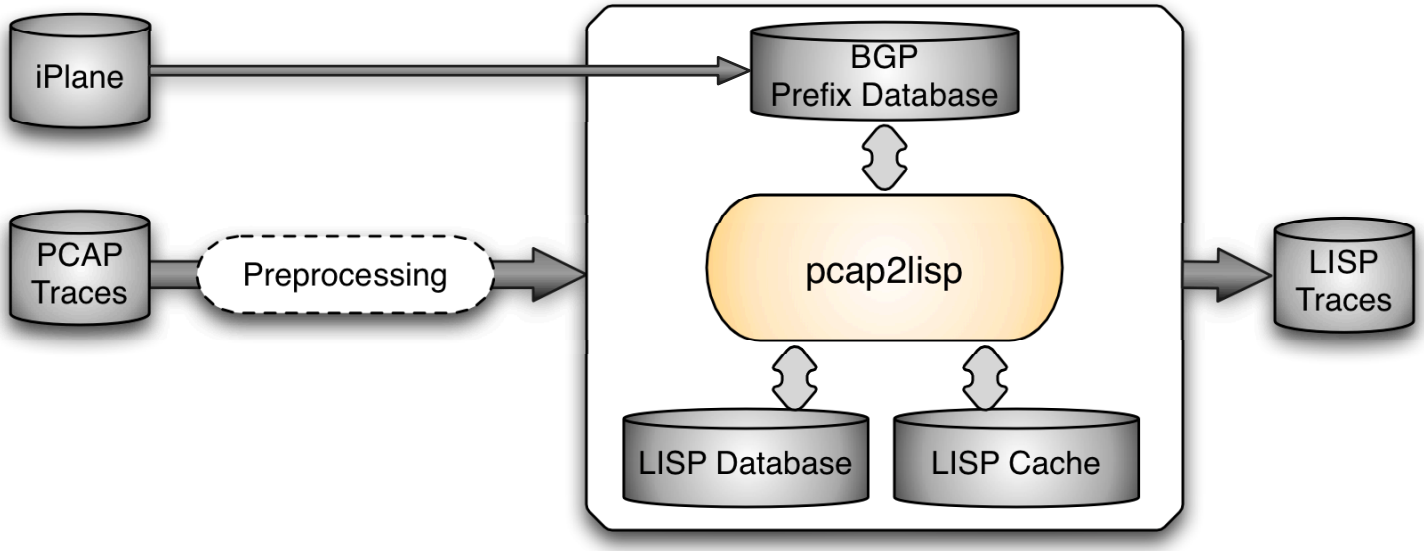
- Simulations
  - Synthetic topologies generated with GHITTLE
  - Hierarchical with business relationship
  - 14965 ASes
  - Gain: 1 order of magnitude

This work has been carried out in collaboration with Prof. B. Quoitin @ UMons

What the Internet looks like with LISP



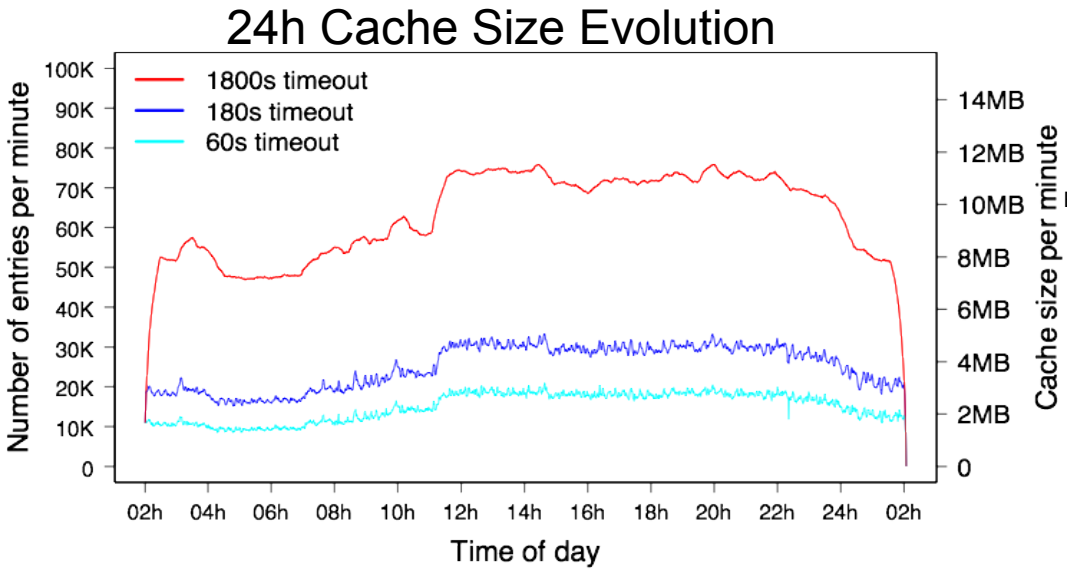
Large Scale LISP Emulation

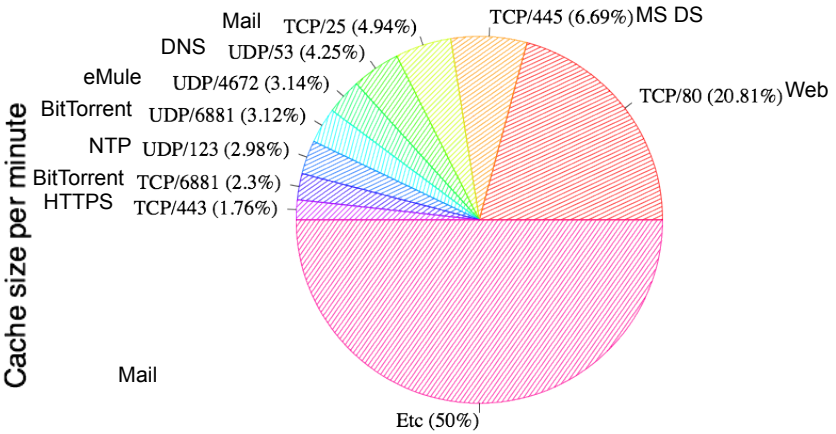


- LISP Emulation
  - Based on PCAP Traces (> 20.000 DSL customers)
  - Used BGP Granularity for mappings

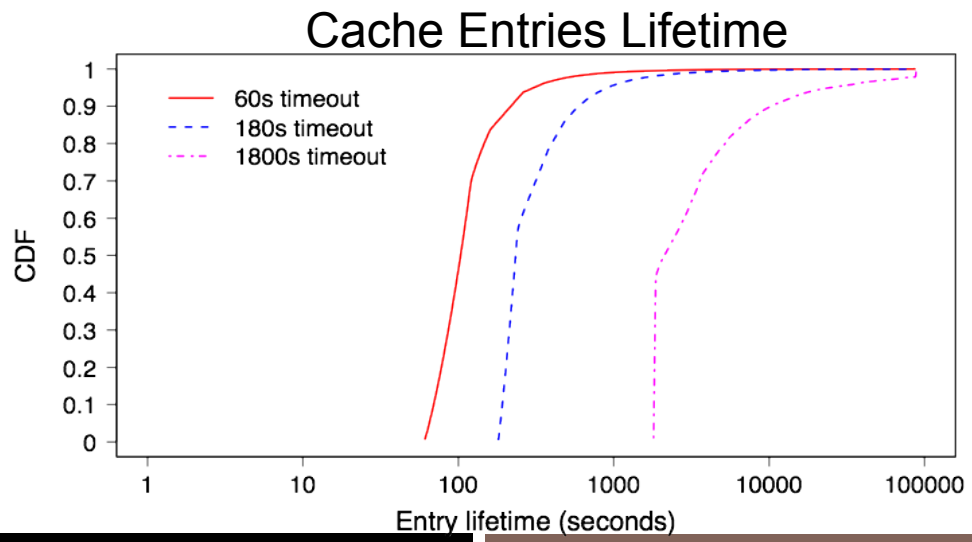
J. Kim, L. Iannone, and A. Feldmann, "A Deep Dive into the LISP Cache and What ISPs Should Know about It," in the 10th IFIP International Conference on Networking (Networking'11), May 2011.

Cache Entries Evolution for Vanilla LISP

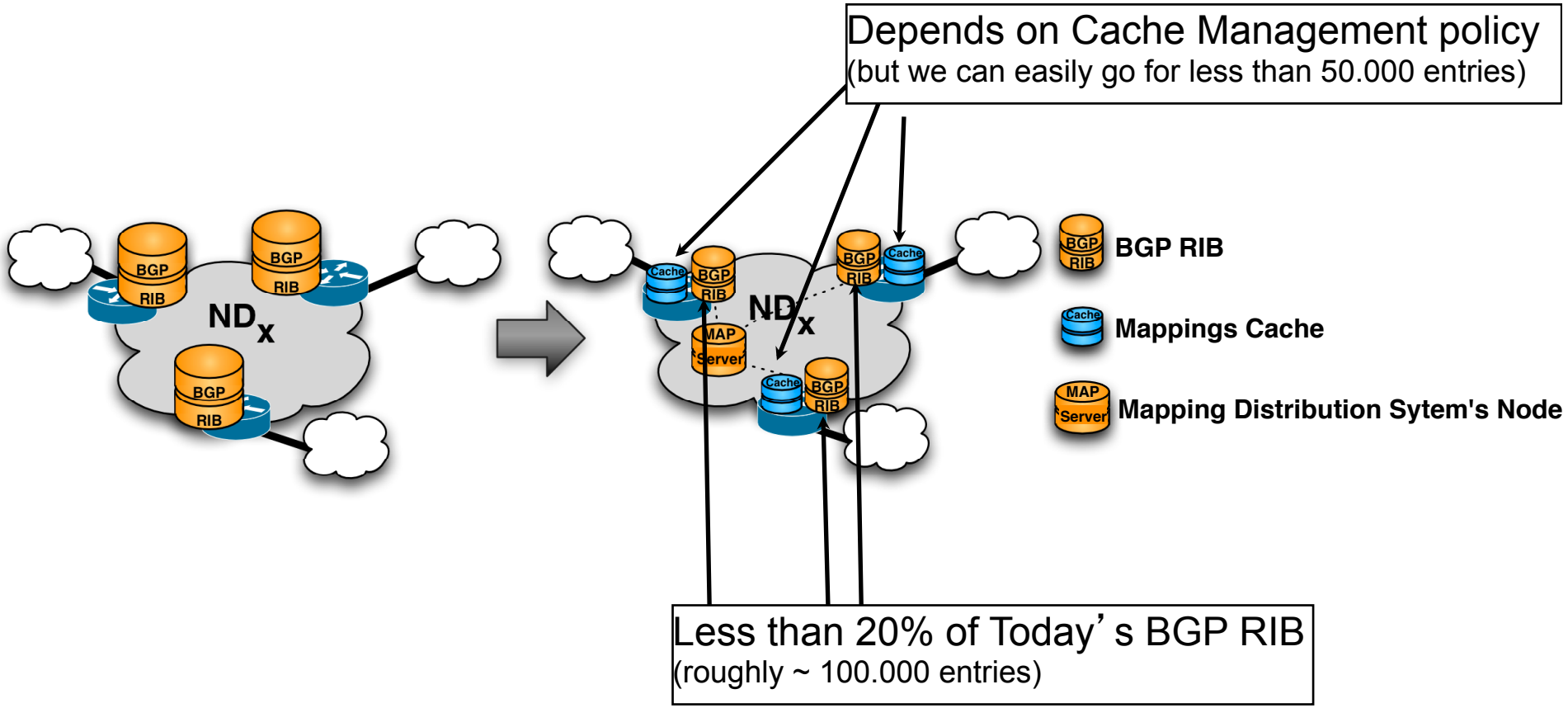




Cache Miss Classification



What the Internet looks like with LISP



Currently lisp4.net has a DFZ potential reduction of 93.8%!

LISP main benefits

- FIB (Forwarding Information Base)
  - shrunk since stub AS do not inject anything in the DFZ (Default Free Zone)
- PI Addresses
  - Just a matter of changing RLOCs
- Multi-Homing
  - Just a list of RLOCs
- Traffic Engineering
  - Just a matter of giving priorities to RLOCs
- Churn
  - Flapping Edge AS are not anymore in the DFZ
- Additional Benefits
  - Path Diversity

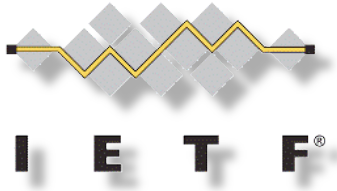
But there is much more

- Mobility in Wireless Mesh Networks
- Smartphones seamless connectivity
- WiFi Offloading
- MaaS: Mobility as a Service
- Cloud Networking
  - VM migration
  - Load Balancing
  - VPN
  - Content Distribution
- Real-Time Traffic Optimization

- ... and more to come....

Thank You!

- datatracker.ietf.org/wg/lisp/



- www.lisp4.net

- www.openlisp.org

- Coming soon...

Lisp-Lab
Building Today the Internet of Tomorrow