



“Micro-mobility in 4G+ Networks”

Connectathon 2002



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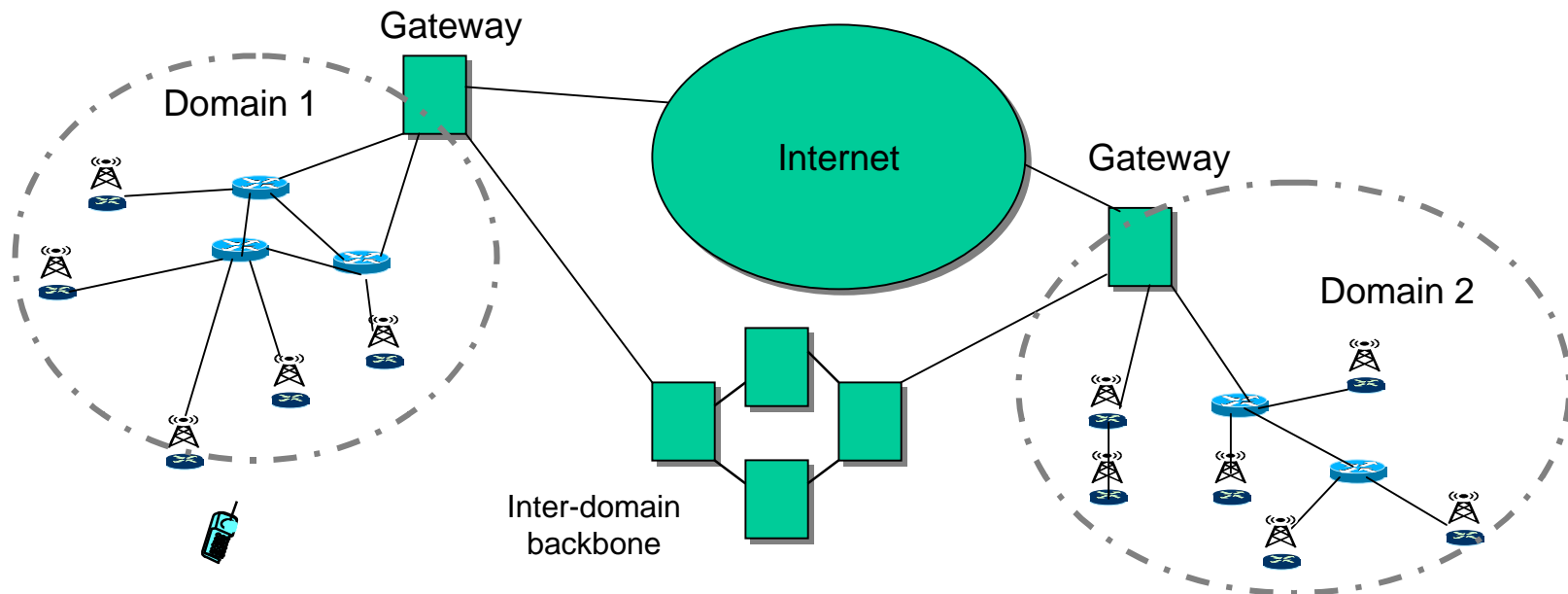
Agenda of the talk

- Problem statement and definition
- Approaches (ext to MIP vs new IP routing protocol)
- LMM Requirements
- Micromobility Taxonomy
- Project status and collaboration

Macro-mobility Micro-mobility Architecture

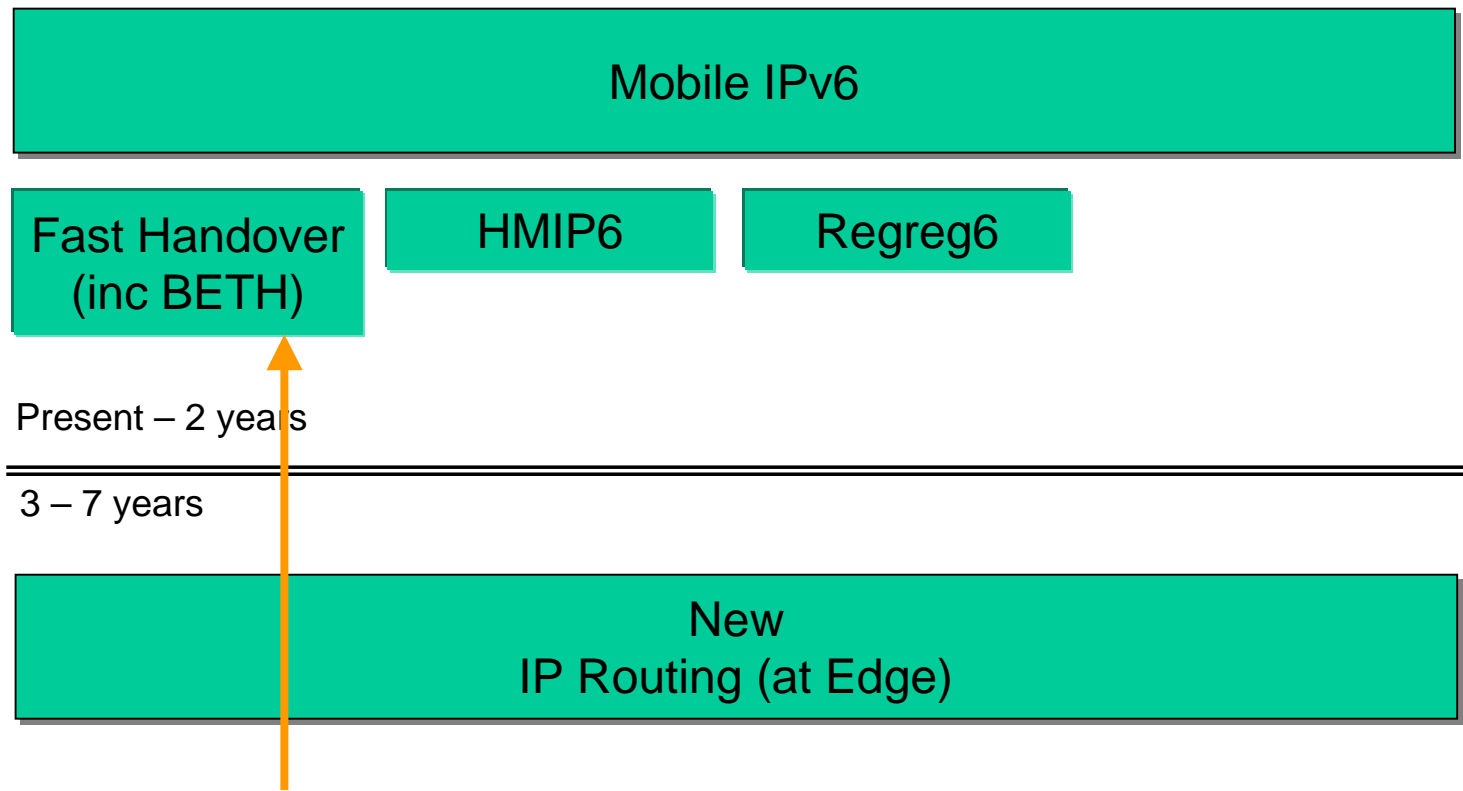
What is Micro-mobility?

- One definition of micro-mobility is **the opposite of macro-mobility**: micro-mobility is mobility where the access address does not change.
- Ability to **perform signaling locally** to a domain as compared to global signaling in the macro-mobility case.



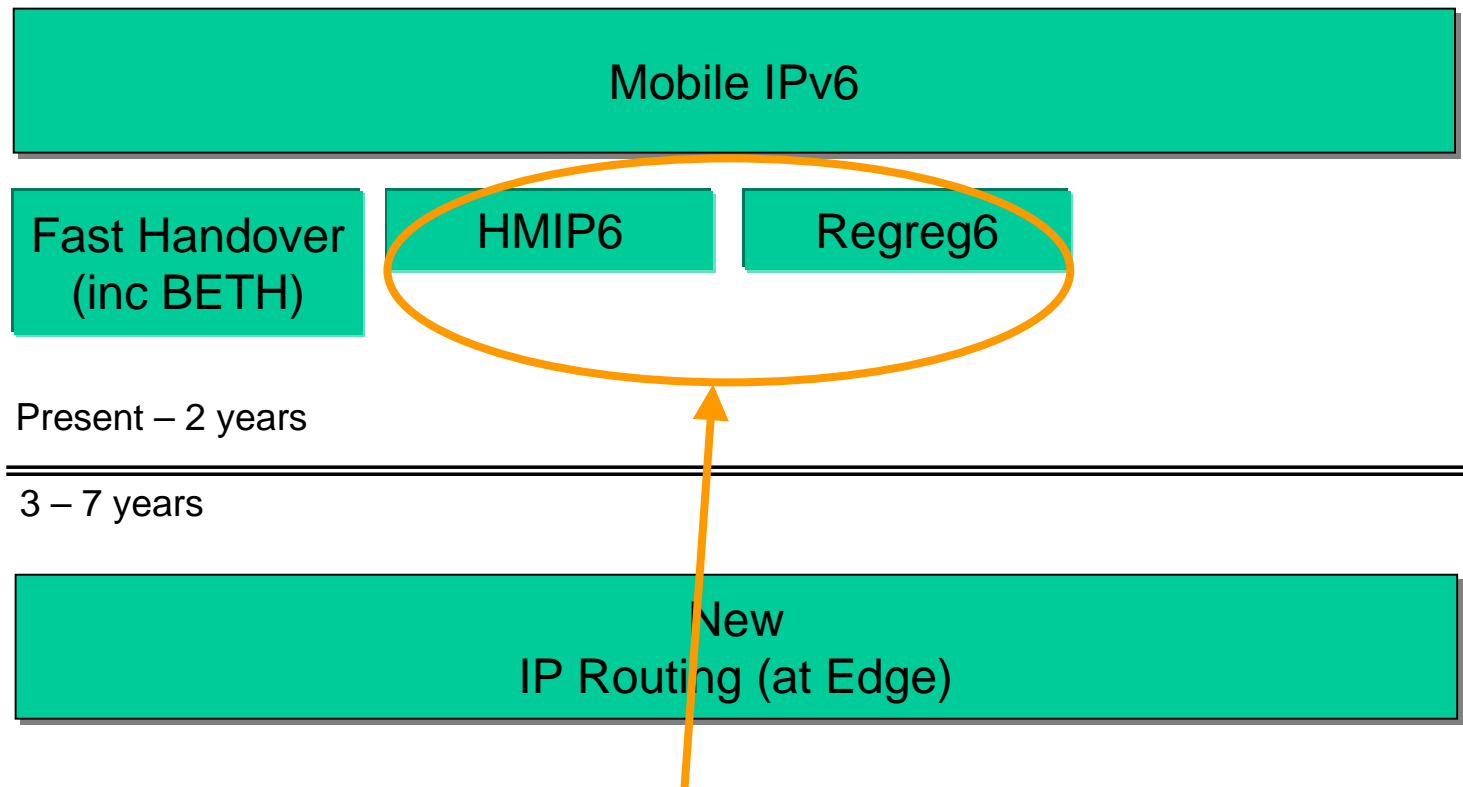
Expected Mobility Landscape Model

Approaches



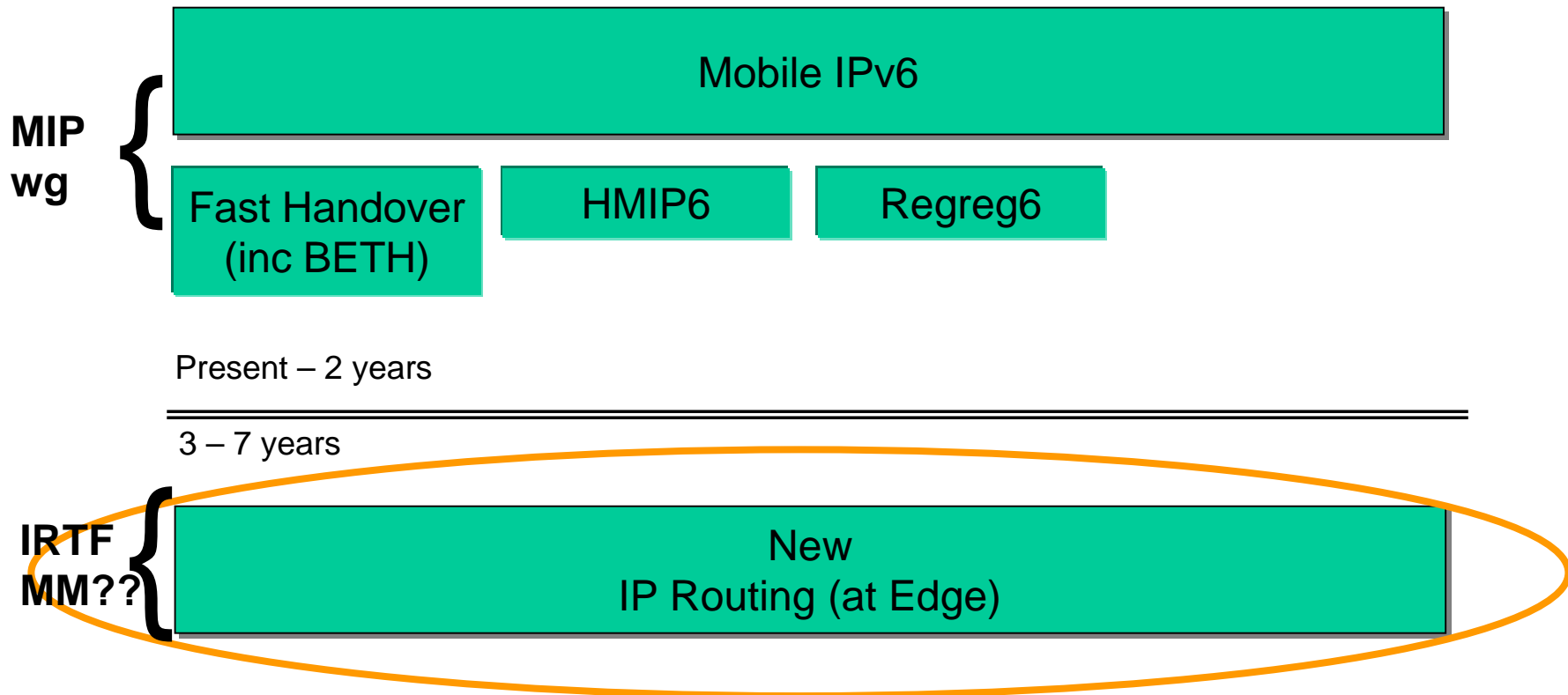
Extending Mobile IP with intrinsic micro-mobility capabilities to act local to a set of access routers

Approaches



Explicitly extend Mobile IP with intrinsic micro-mobility capabilities to act local to a visited domain

Approaches

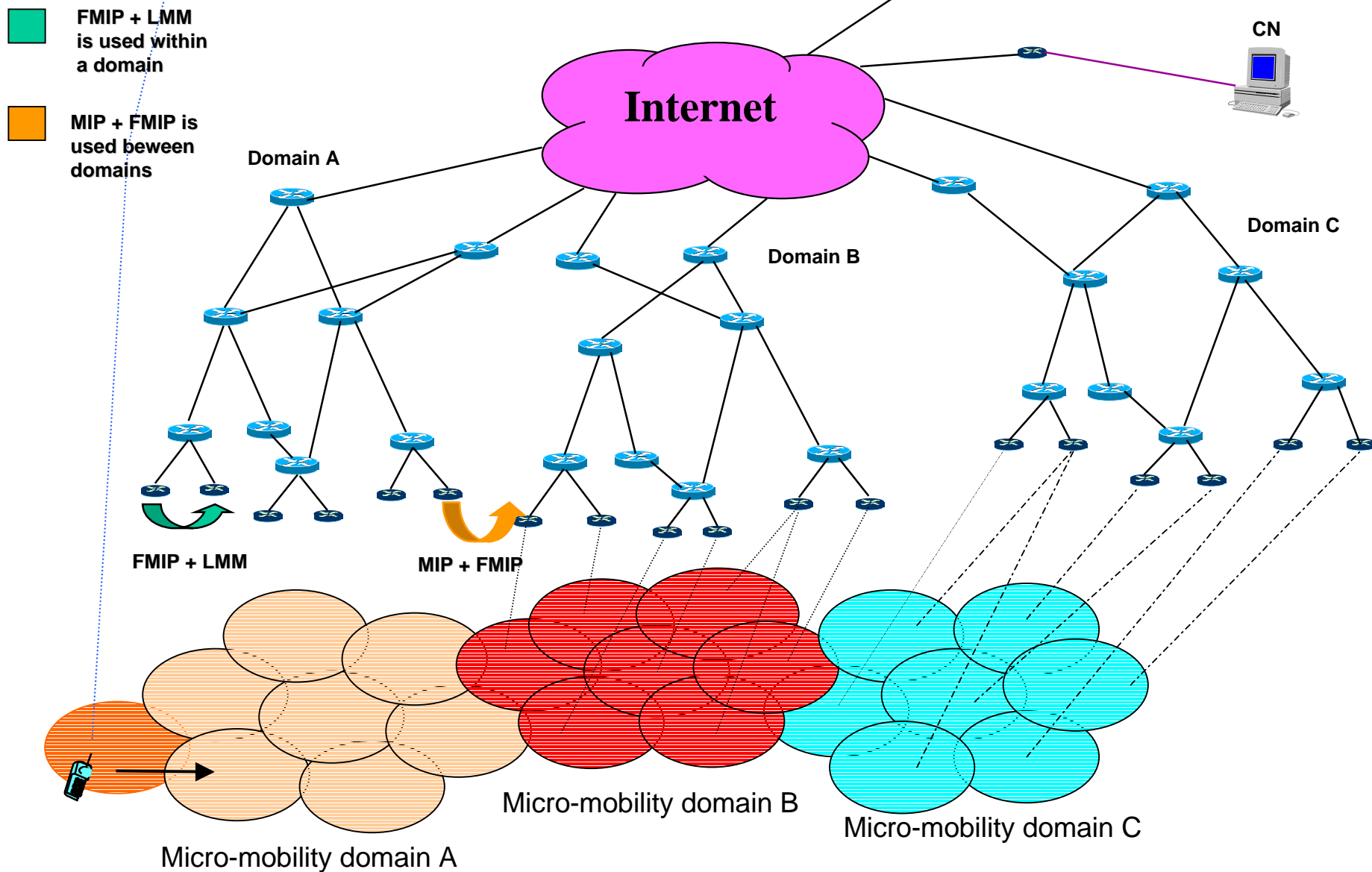


Keep Mobile IPv6 in its original form and use specific micro-mobility protocol at the routing exterior.

Micro-mobility Work in the IETF Mobile IP group

- FMIPv6/BETH (access routers)
Reduce handover latency and packet loss during handover by reducing the period (gap) between moving from one access router to another.
- LMM (HMIPv6/RegReg6) (visited domain)
Addresses latencies and packet loss as a result of mobility management signaling. This is done by restricting the signaling area, thereby reducing the signaling load bandwidth consumed on the Internet and local network.

Mobile IPv6 Micro-mobility



IRTF MM Investigation

Problem Statement:

- Currently, Mobile IP **hides** the end system mobility from the **infrastructure routing protocols**.
- IRTF will investigate a **routing protocol at the exterior** whose purpose is to allow a mobile node to retain connectivity via its current IP subnet while it moves within the **scope of the micro-mobility domain**.
- IRTF will investigate the limits and issues with using (a) new protocol(s) to implement **per node routes** to facilitate better the **movement of nodes** and **recovery of the network** in presence of failed links or routers.

Why a new Protocol?

- Mobile devices will become a significant portion of all Internet end nodes; thus, **investigation of alternative designs merit consideration**.
- Many investigators converged on solutions that propose the use of **local subnet mobility routing** to support micro-mobility; this approach **exposes mobility of the end systems to the routers**.

IRTF MM Investigation

Why the IRTF and not the IETF:

- The **area directors** overseeing the activities of the Seamoby working group and the Mobile-IP working group **have raised questions about the scale of local subnet mobility routing and the potential need to introduce both another routing protocol and another mobility protocol.**
- A comparison with existing mobility management and routing protocols are involved in making such an **assessment both in terms of relative scalability, performance and complexity.** The IRTF is the right home for such research activities.

DoCoMo IRTF efforts

IRTF Micro-mobility Working Group

John Loughney (Nokia), Co-chair

Carl Williams, (DoCoMo USA Labs), Co-chair

IRTF Micro-mobility Design Team

Carl Williams, DoCoMo USA Labs

Ichiro Okajima, NTT DoCoMo Wireless Labs

Alper E. Yegin, DoCoMo USA Labs

* Also includes members from Cisco, Nokia, Ericsson, BT, Flarion, etc....

Micro-mobility current research

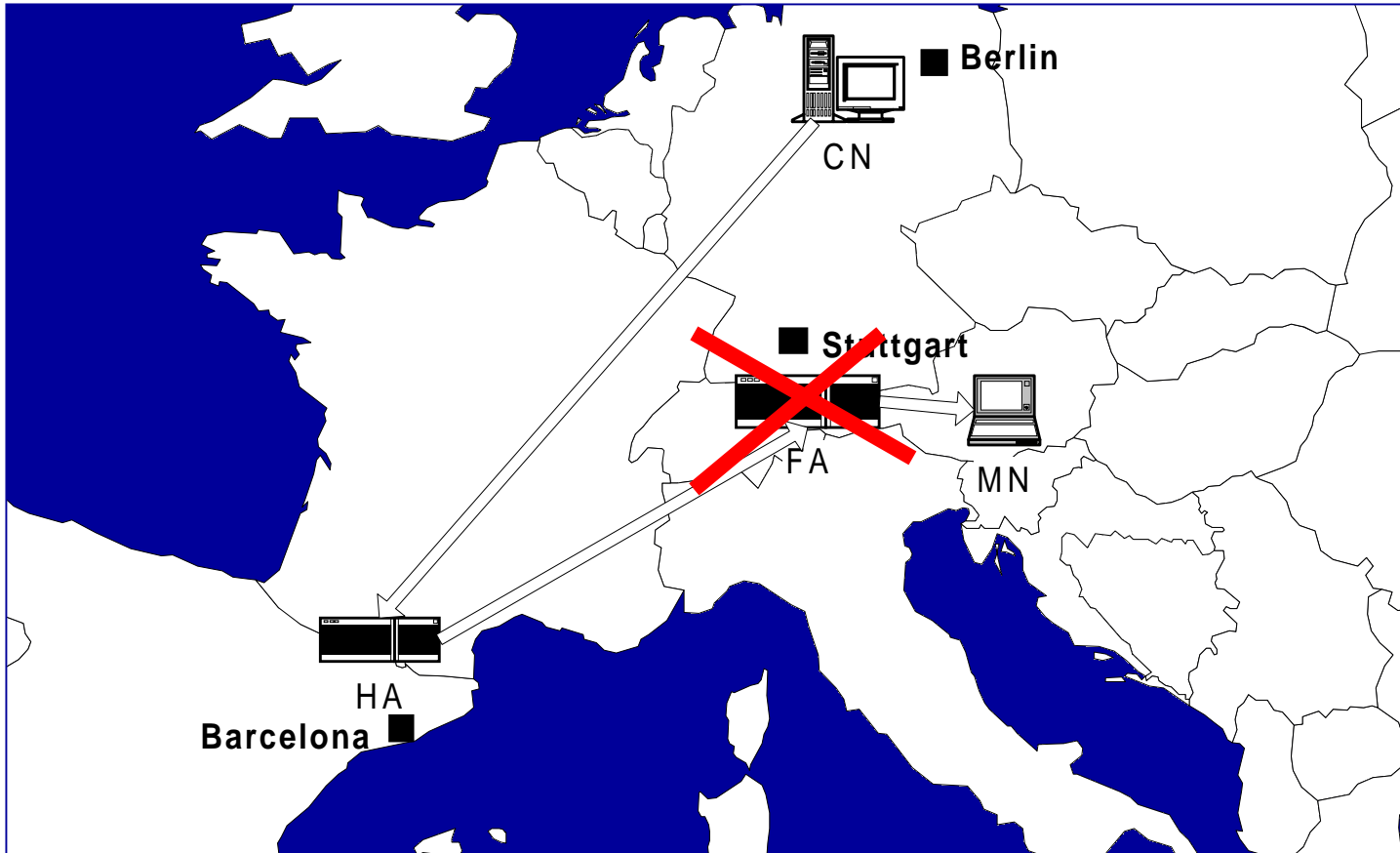
- Jari T. Malinen, *Carl Williams*, *Alper E. Yegin*: Micromobility Taxonomy, [draft-irtf-mm-taxonomy-00.txt](#)
- *Carl Williams*, Editor : Localized Mobility Management Requirements for IPv6, [draft-ietf-mobileip-lmm-requirements-01](#).
- Karim El Malki (Editor), Pat R. Calhoun , Tom Hiller , James Kempf, Peter J. McCann , Ajoy Singh , Hesham Soliman , Sebastian Thalanany: Low Latency Handoffs in Mobile IPv4, [draft-ietf-mobileip-lowlatency-handoffs-v4-03.txt](#)
- G. Dommety, *A. Yegin*, C. Perkins, G. Tsirtsis, K. El-Malki, M. Khalil Fast Handovers for Mobile IPv6, [draft-ietf-mobileip-fast-mipv6-04.txt](#)
- *J. Kempf* and J. Wood, "Analysis and Comparison of Handoff Algorithms for Mobile IPv4" (coming soon)

Analysis of Achieving Micro-mobility functionality with Mobile IPv6

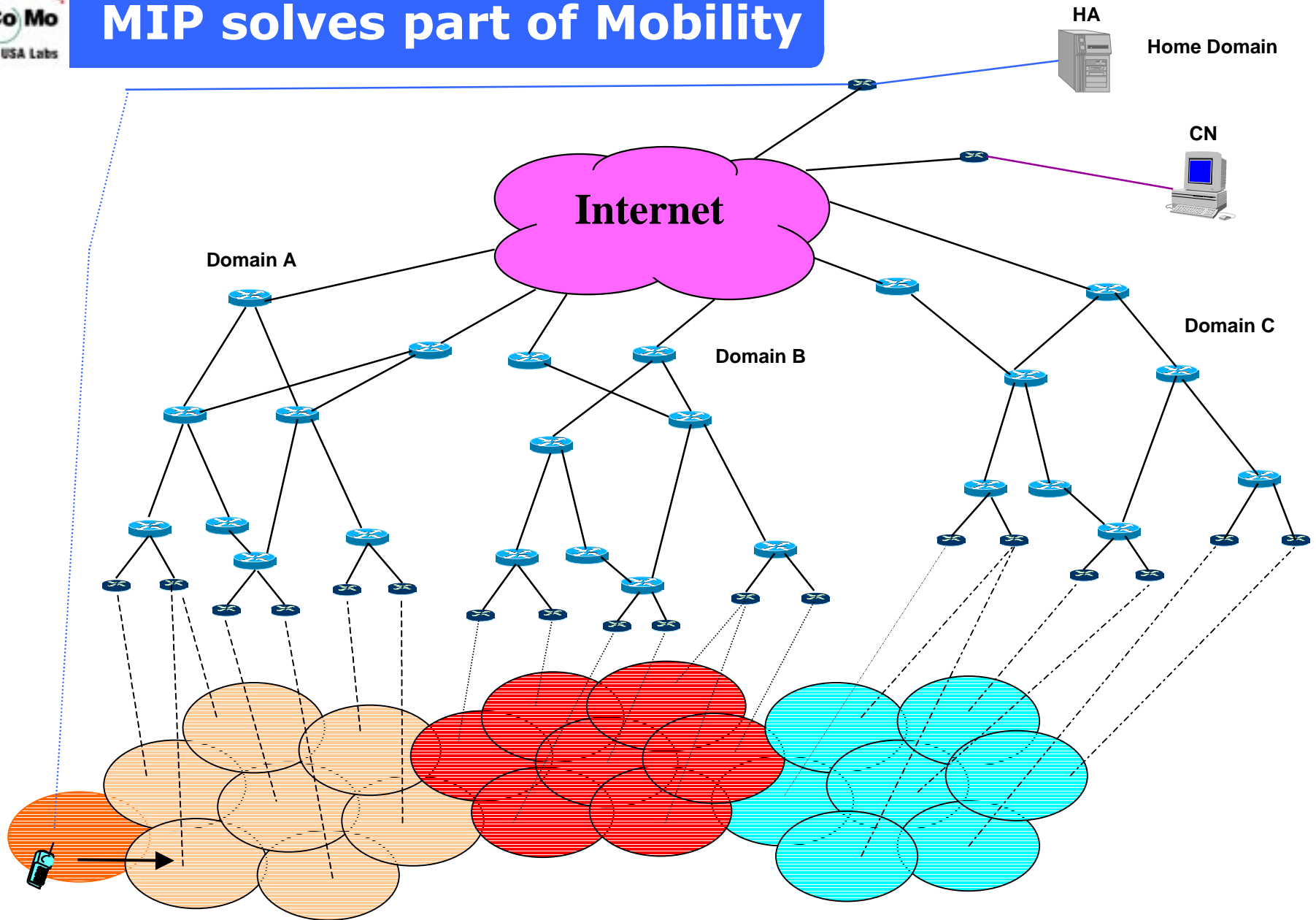
A look at MIPv6 shortcomings

MIP solves part of Mobility

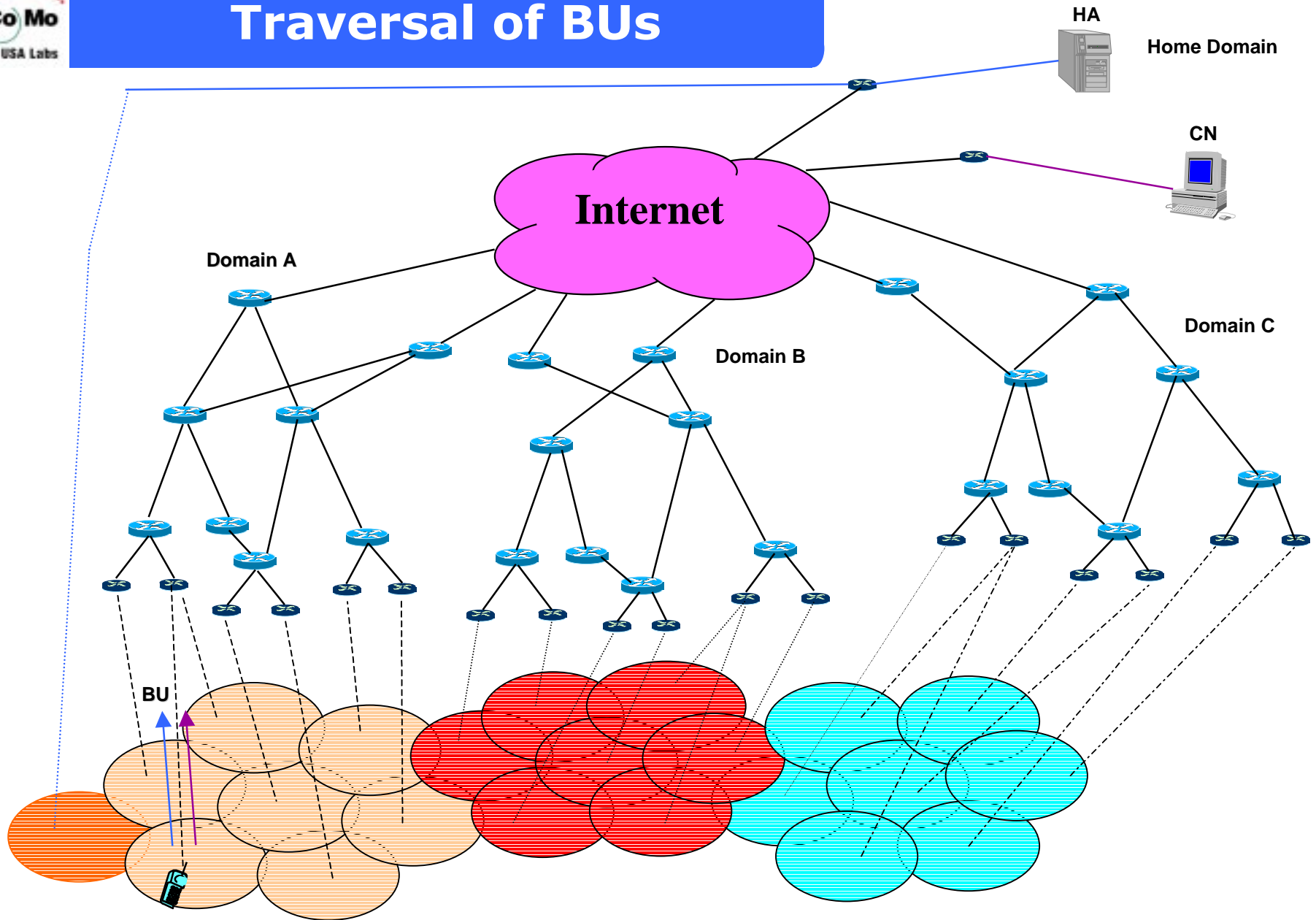
Mobile IPv6 gives us route optimization as default to the protocol



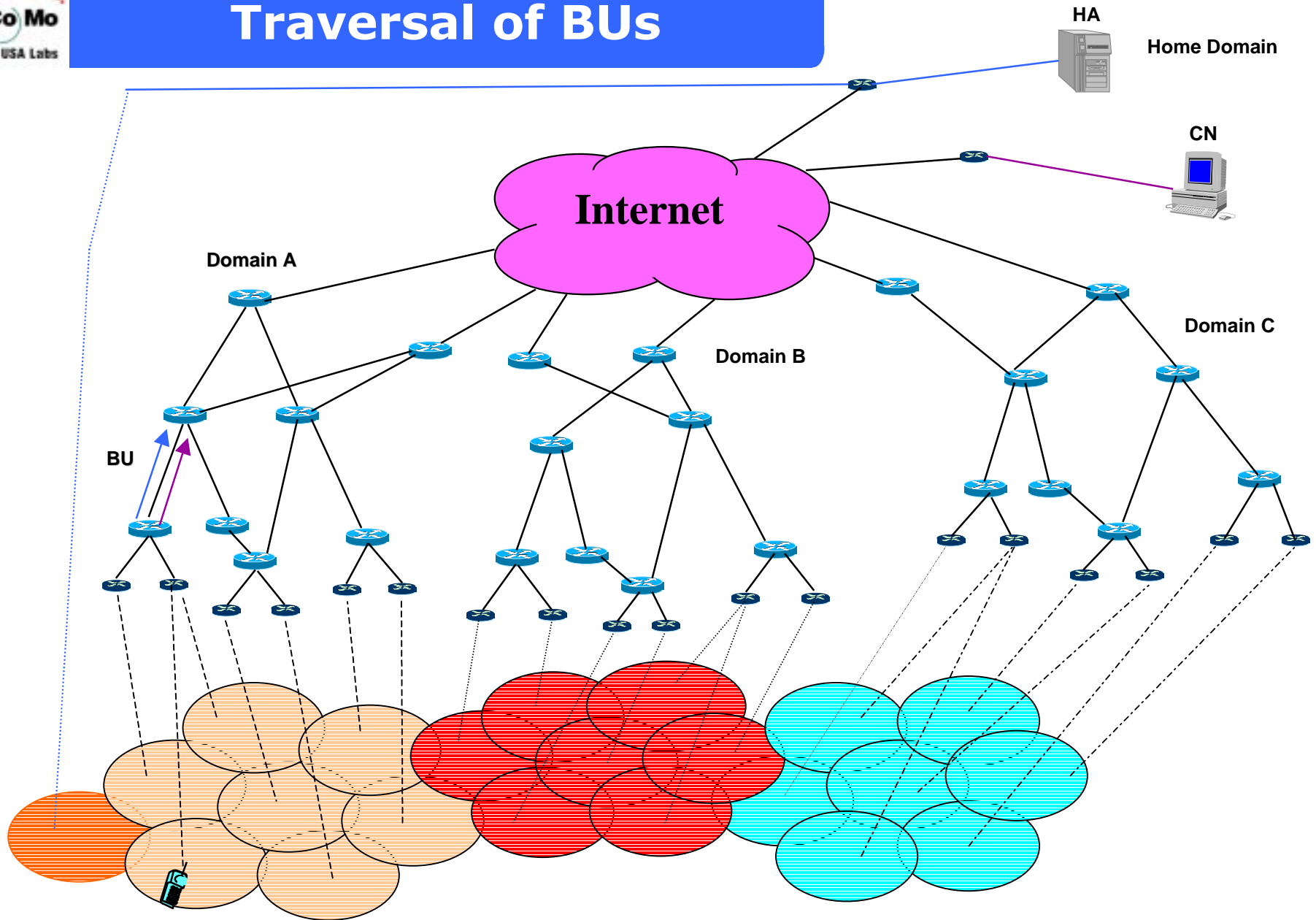
MIP solves part of Mobility



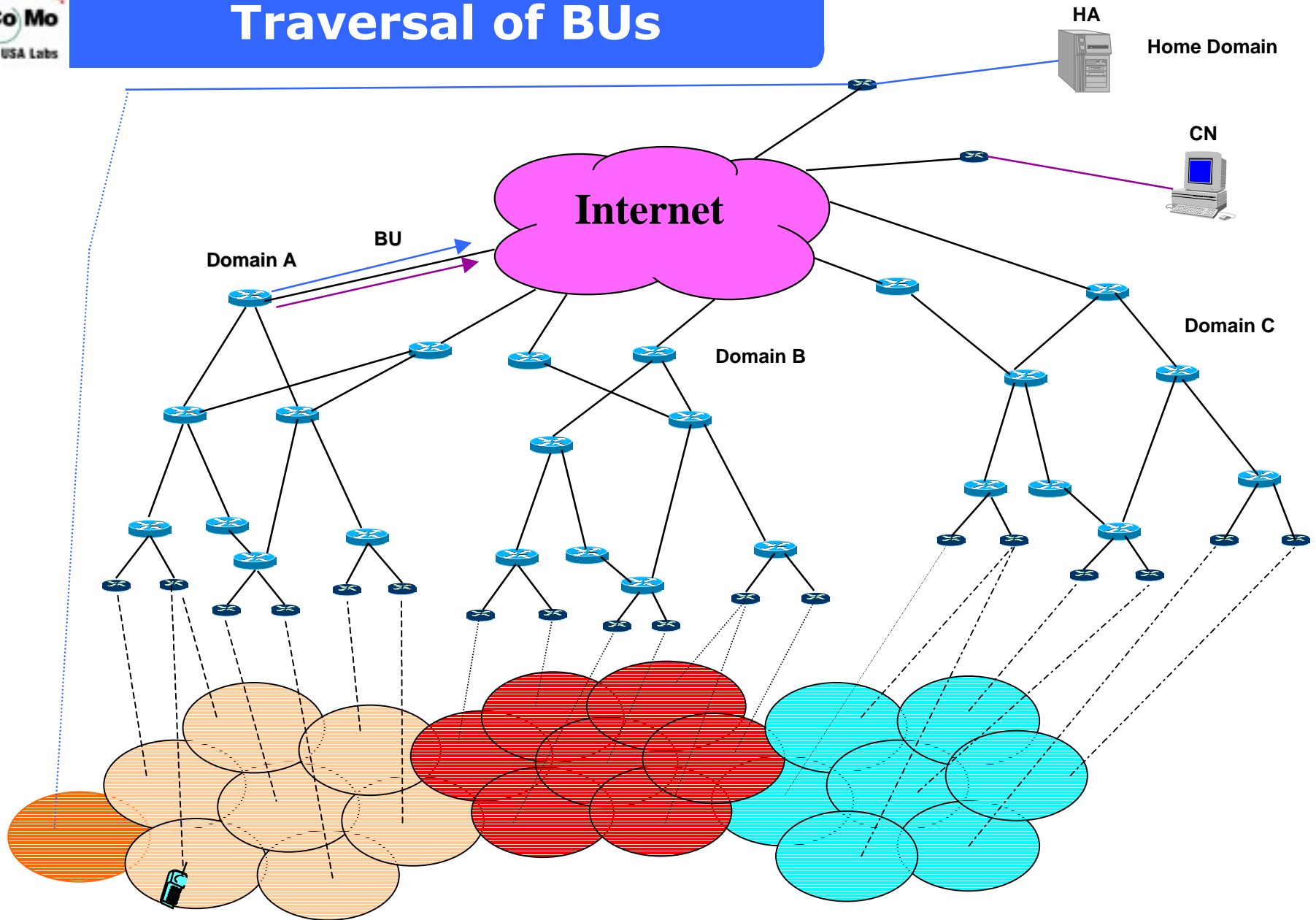
Traversal of BUs



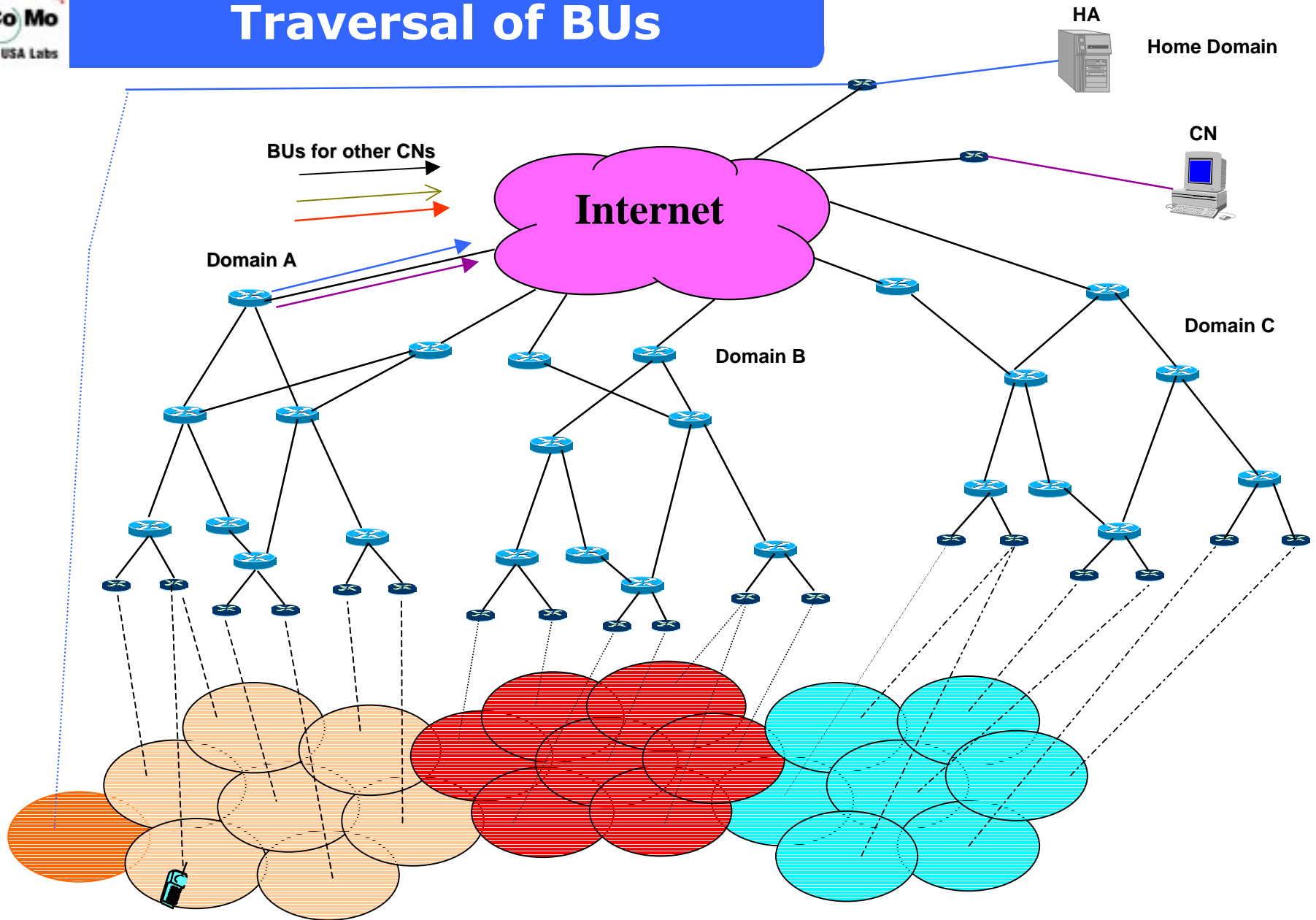
Traversal of BUs



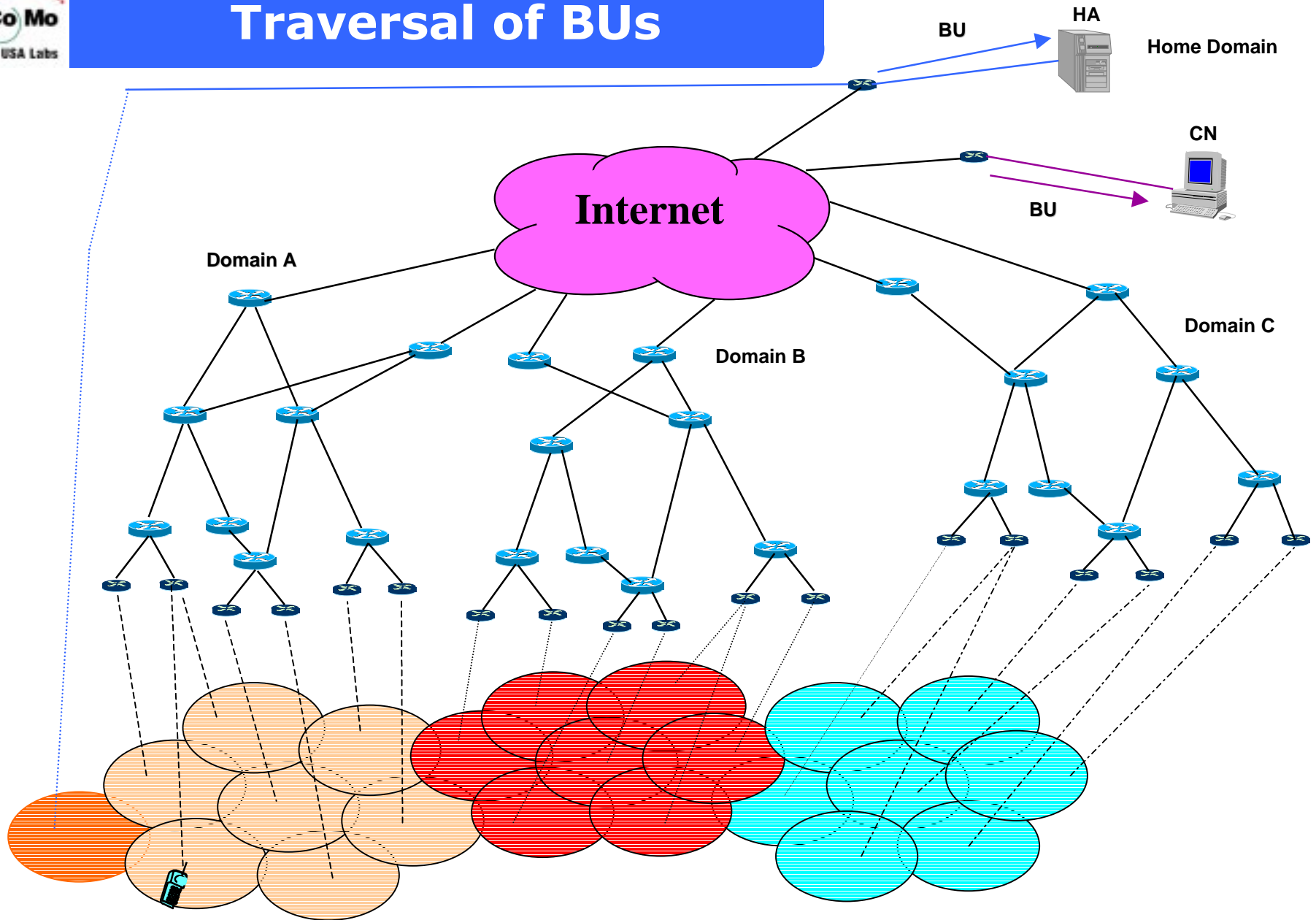
Traversal of BUs



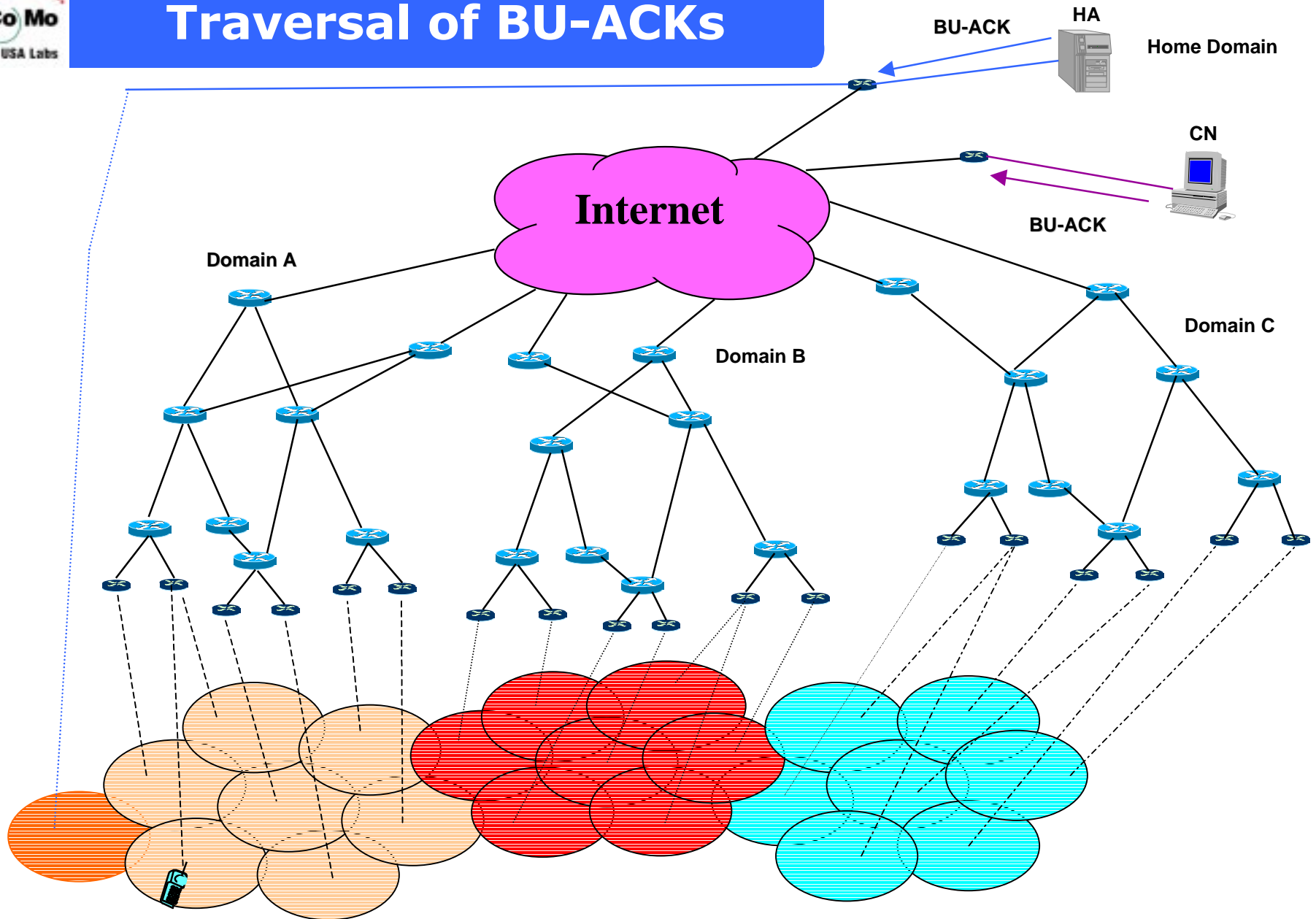
Traversal of BUs



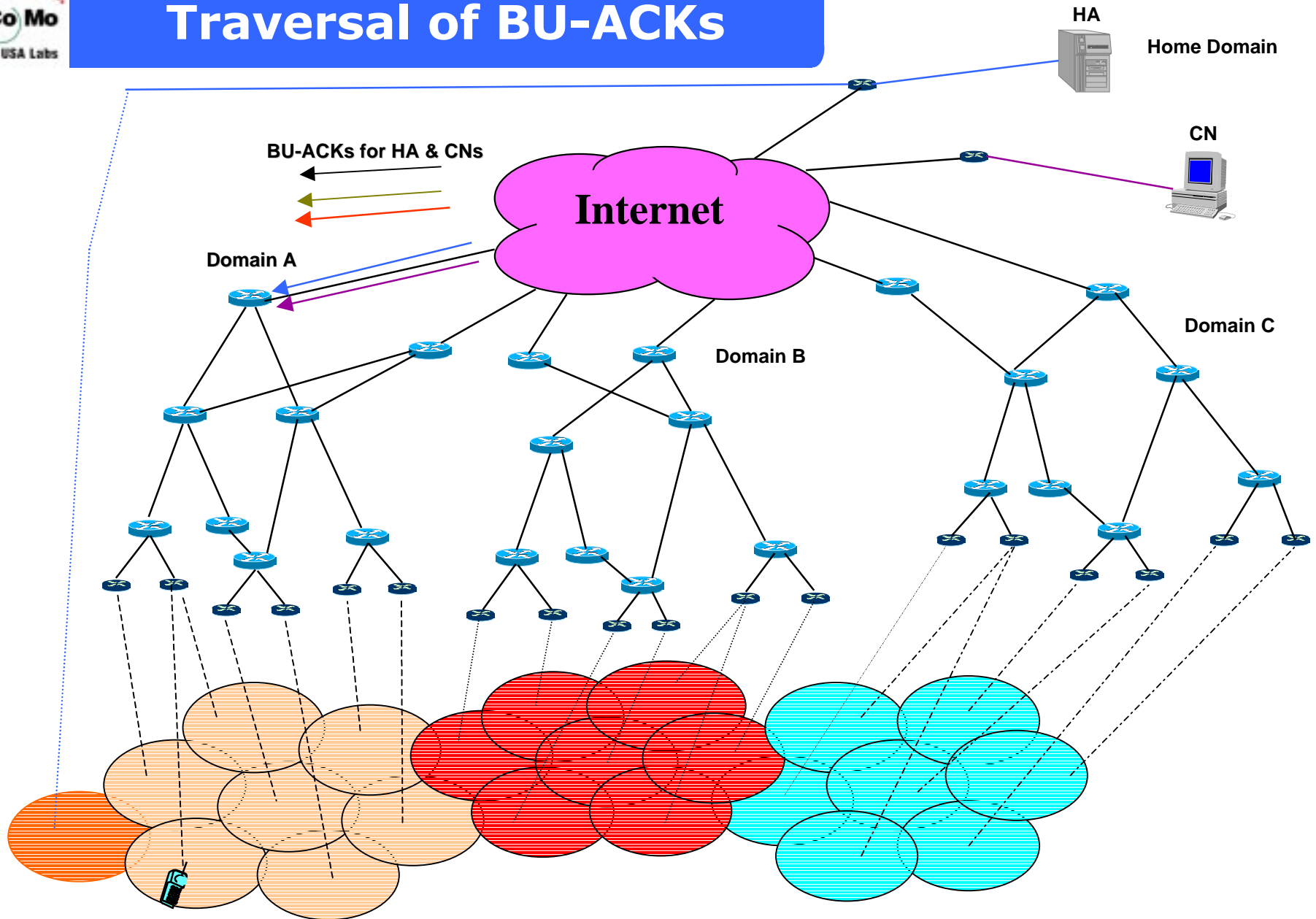
Traversal of BUs



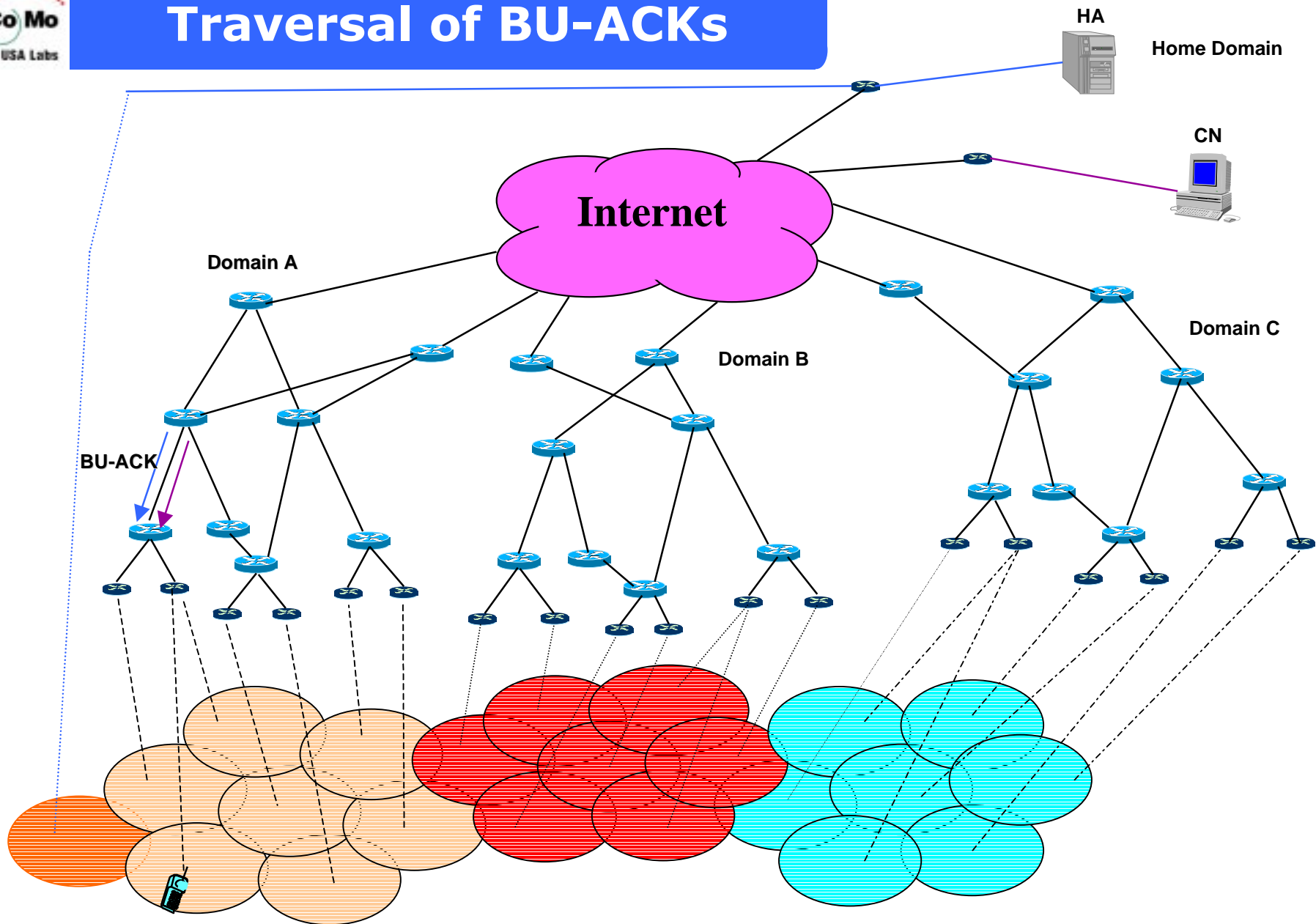
Traversal of BU-ACKs



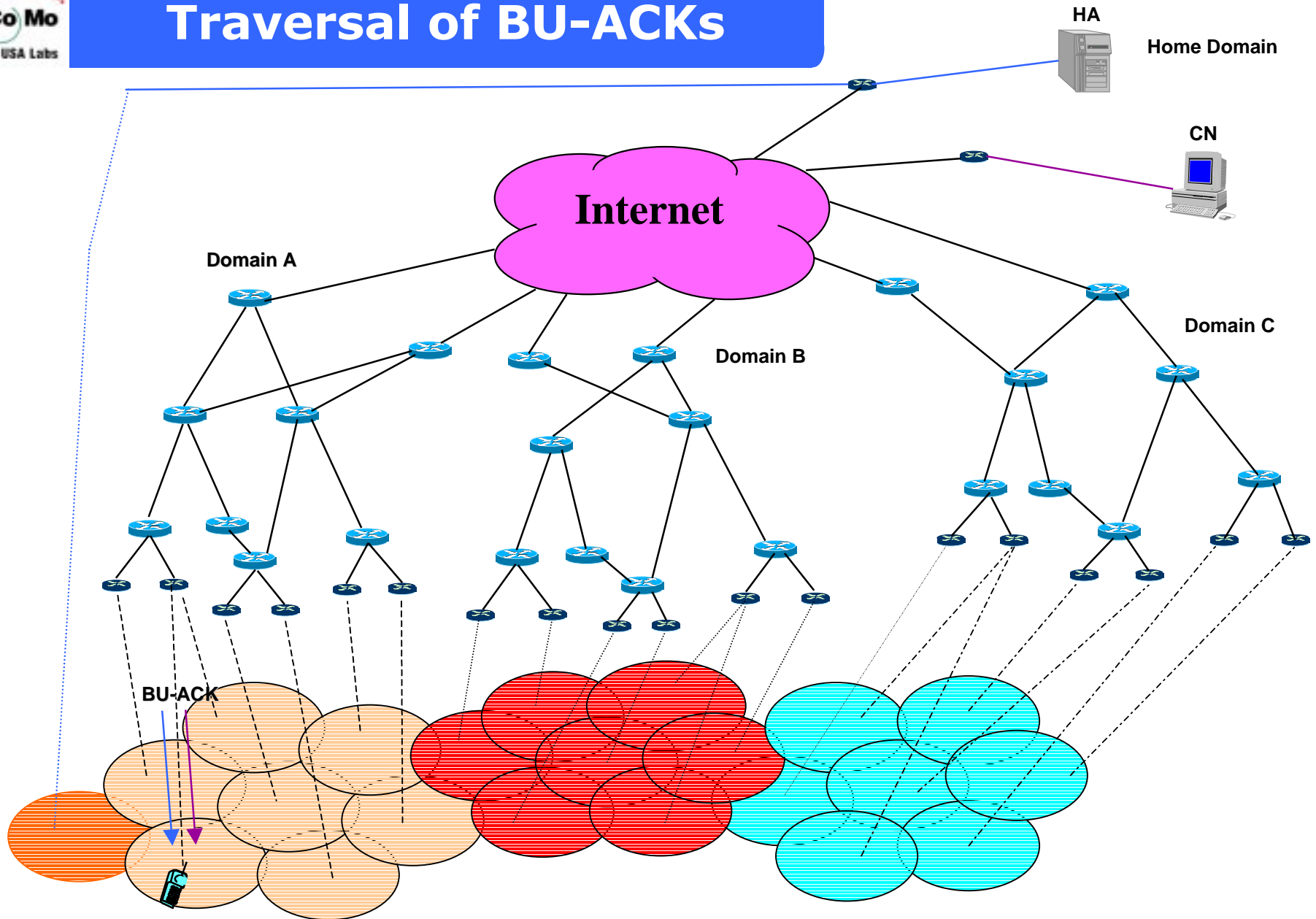
Traversal of BU-ACKs



Traversal of BU-ACKs



Traversal of BU-ACKs



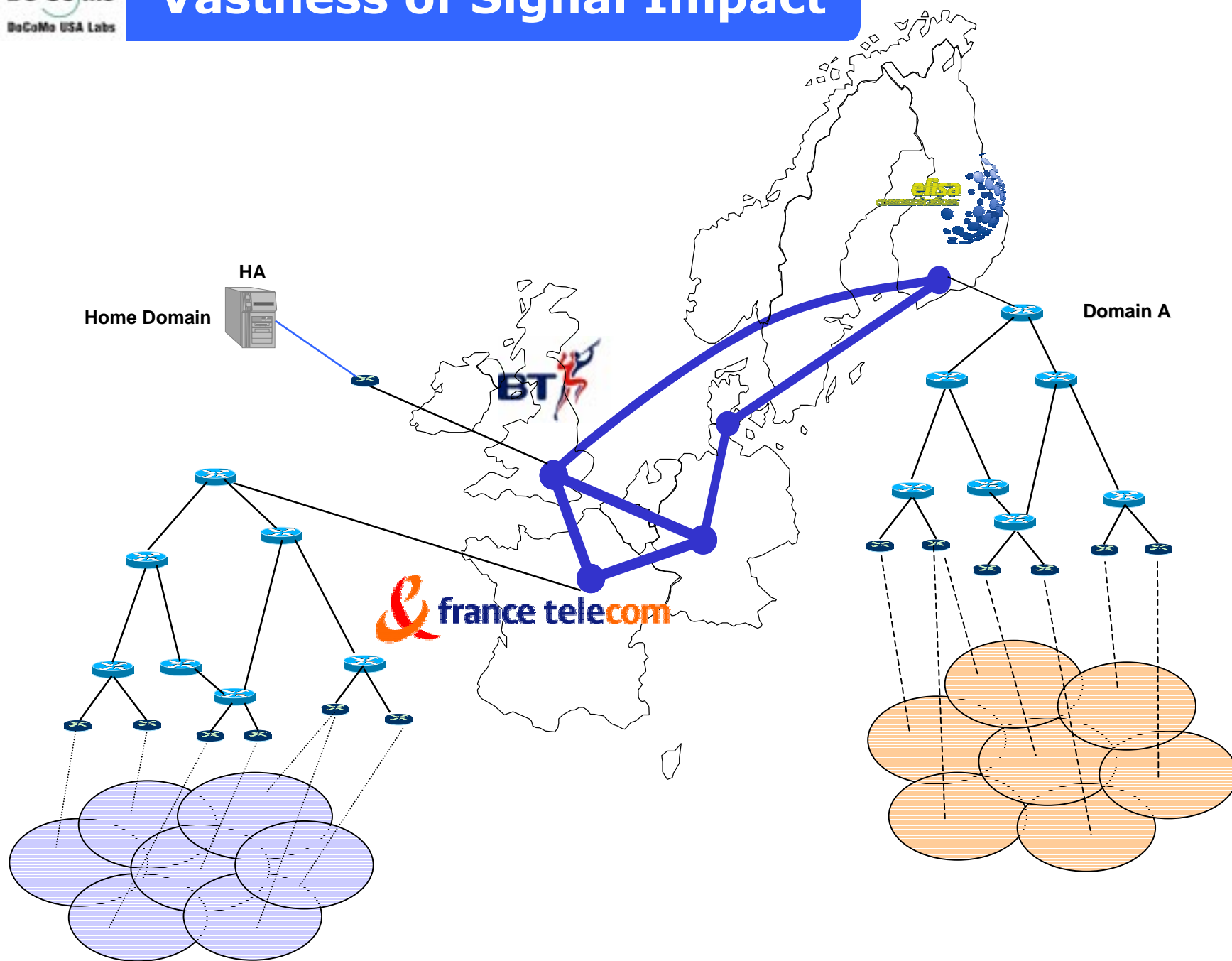
Why Micro-mobility

- “FULL-IP”: The “FULL-IP” architecture actually promises to be the holy grail for operators looking for a cheaper and more flexible infrastructure.
- Mobile IPv6 reaches its limits inside cellular systems: it is not sufficient to handle efficiently seamless handovers, in particular for time-stringent applications such as VoIP.
- Micro-mobility protocols aim to address a number of technical challenges for Mobile IPv6 in terms of performance and scalability.
- Micro-mobility protocols will be used in the access network while Mobile IPv6 will be the common mobility protocol between different access networks. As such in order for NTT DoCoMo to fully realize a “FULL-IP” architecture (e.g., IP²), micro-mobility will be fundamental to meet real-time requirements.

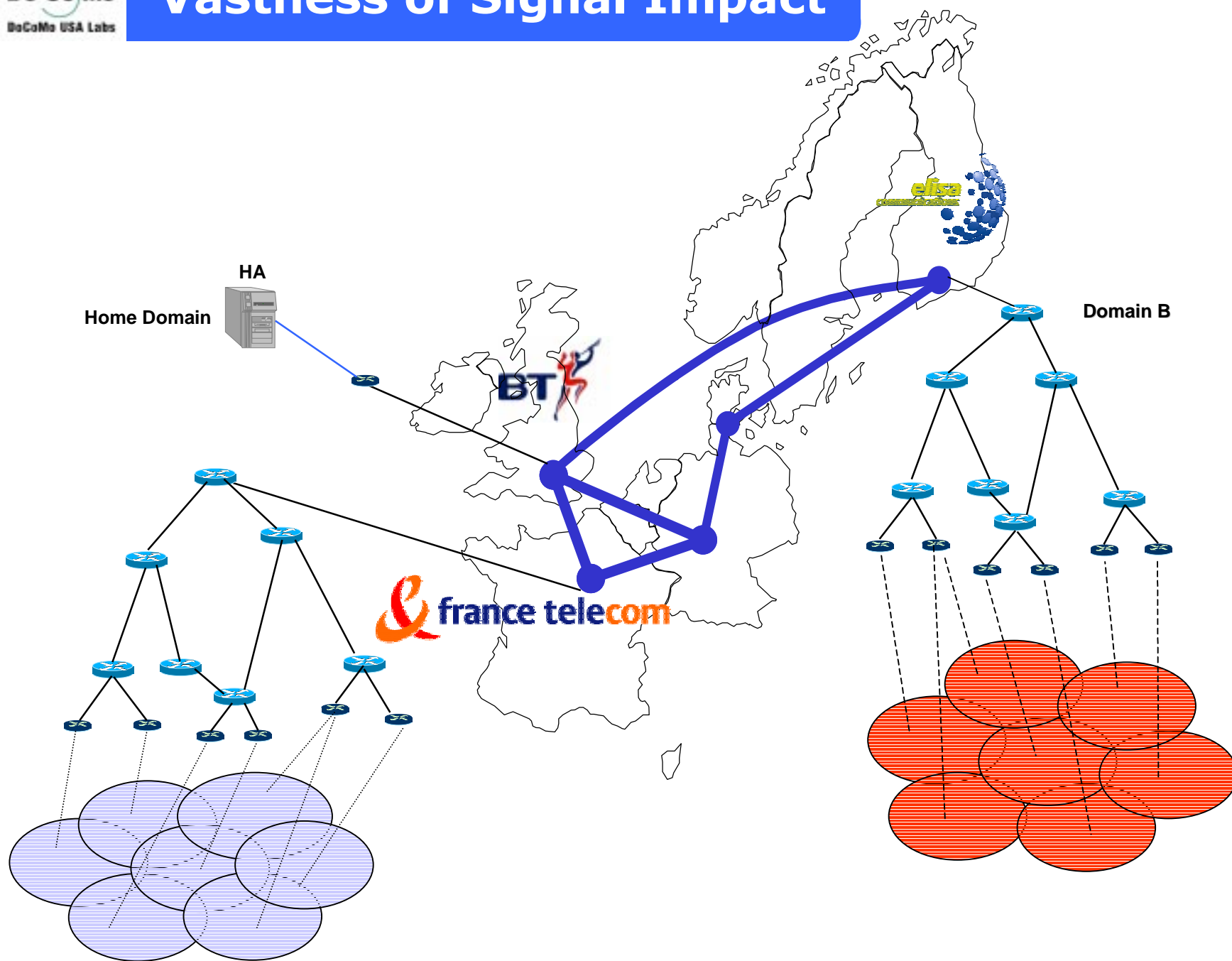
LMM Requirements

- Analysis of problem space for identification and enumeration of LMM requirements.
- LMM requirements will be used to guide the design of LMM framework and protocol
- LMM is Mobile IP working group's way of realizing micro-mobility functionality by way of extending Mobile IPv6 protocol.

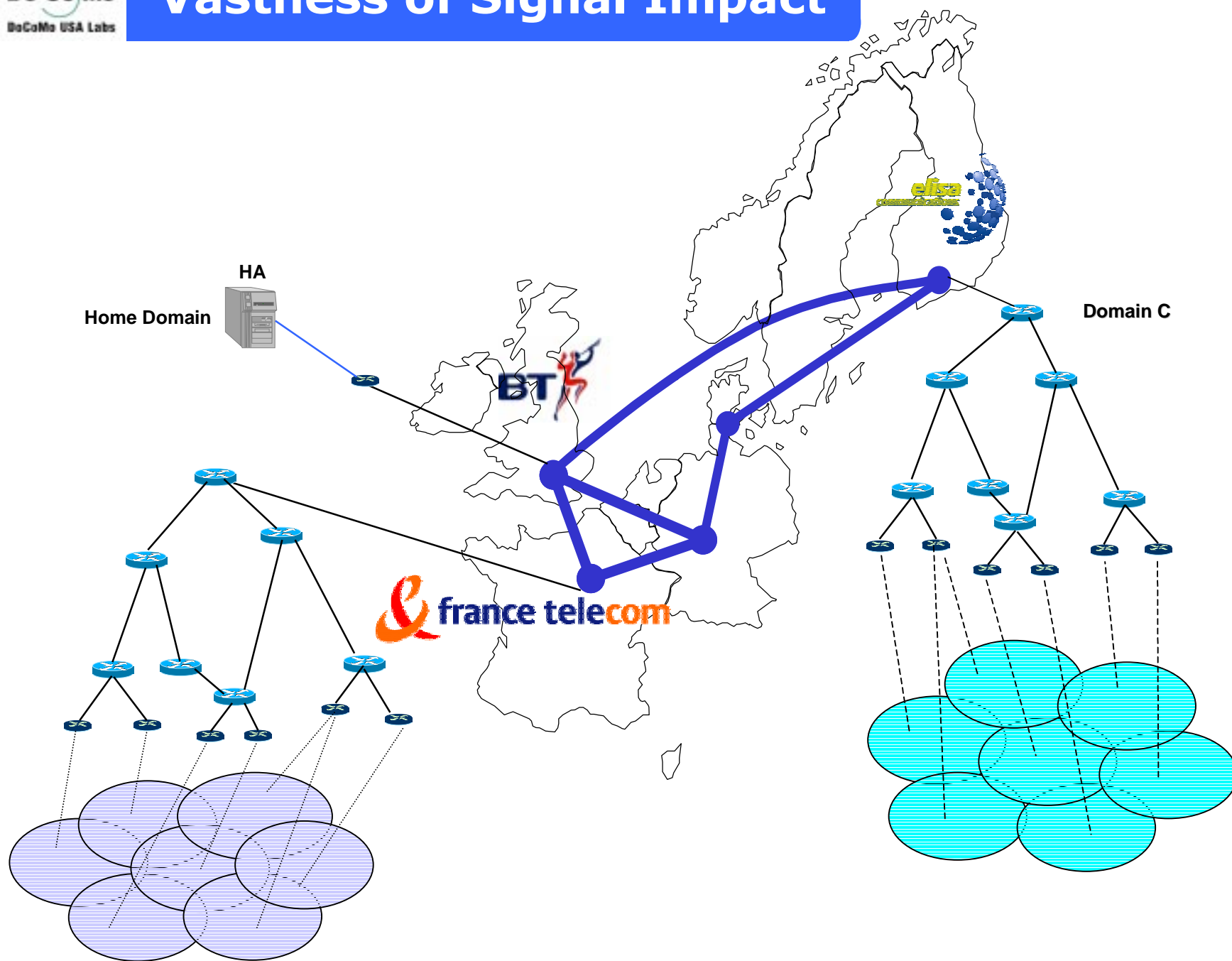
Vastness of Signal Impact



Vastness of Signal Impact

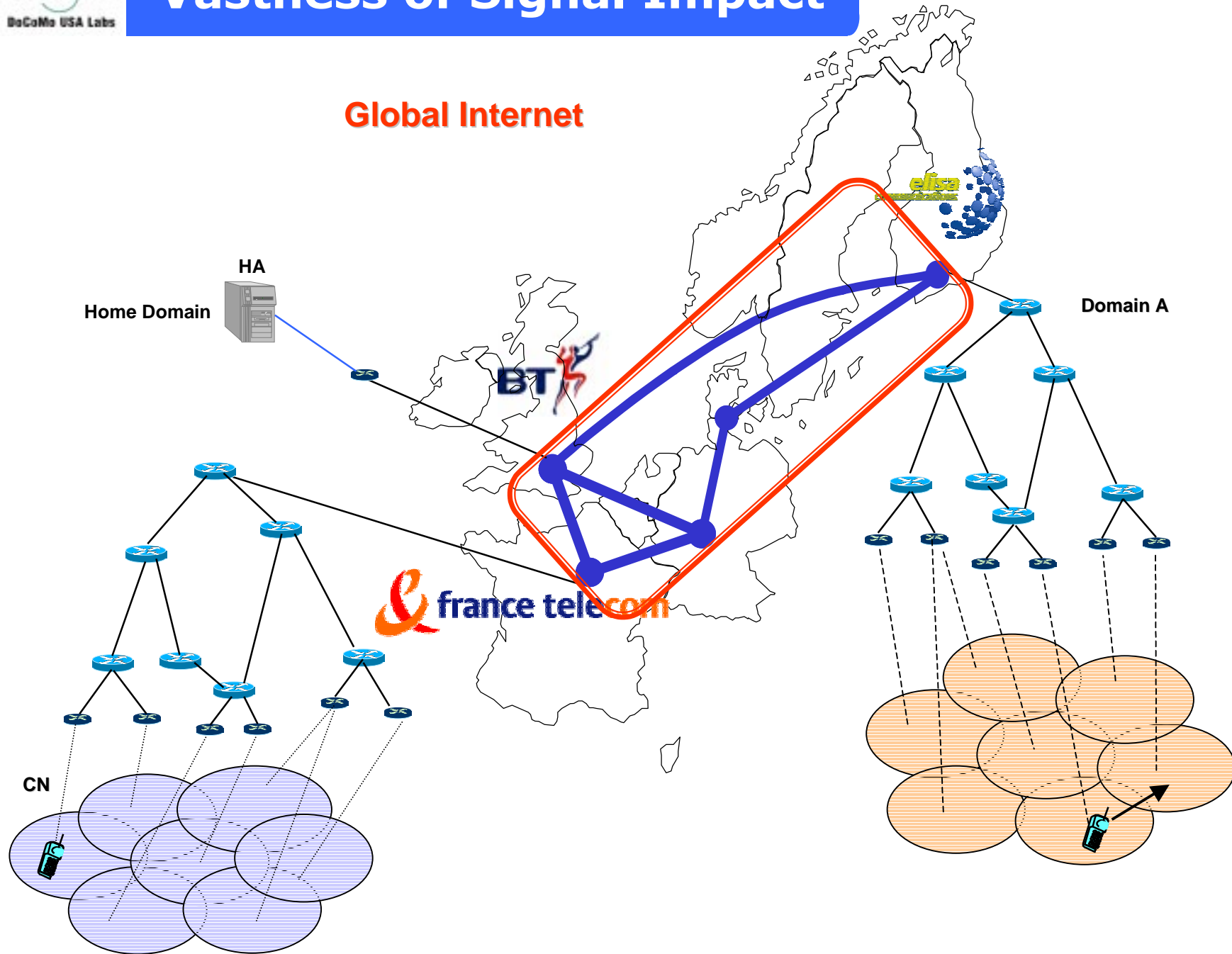


Vastness of Signal Impact

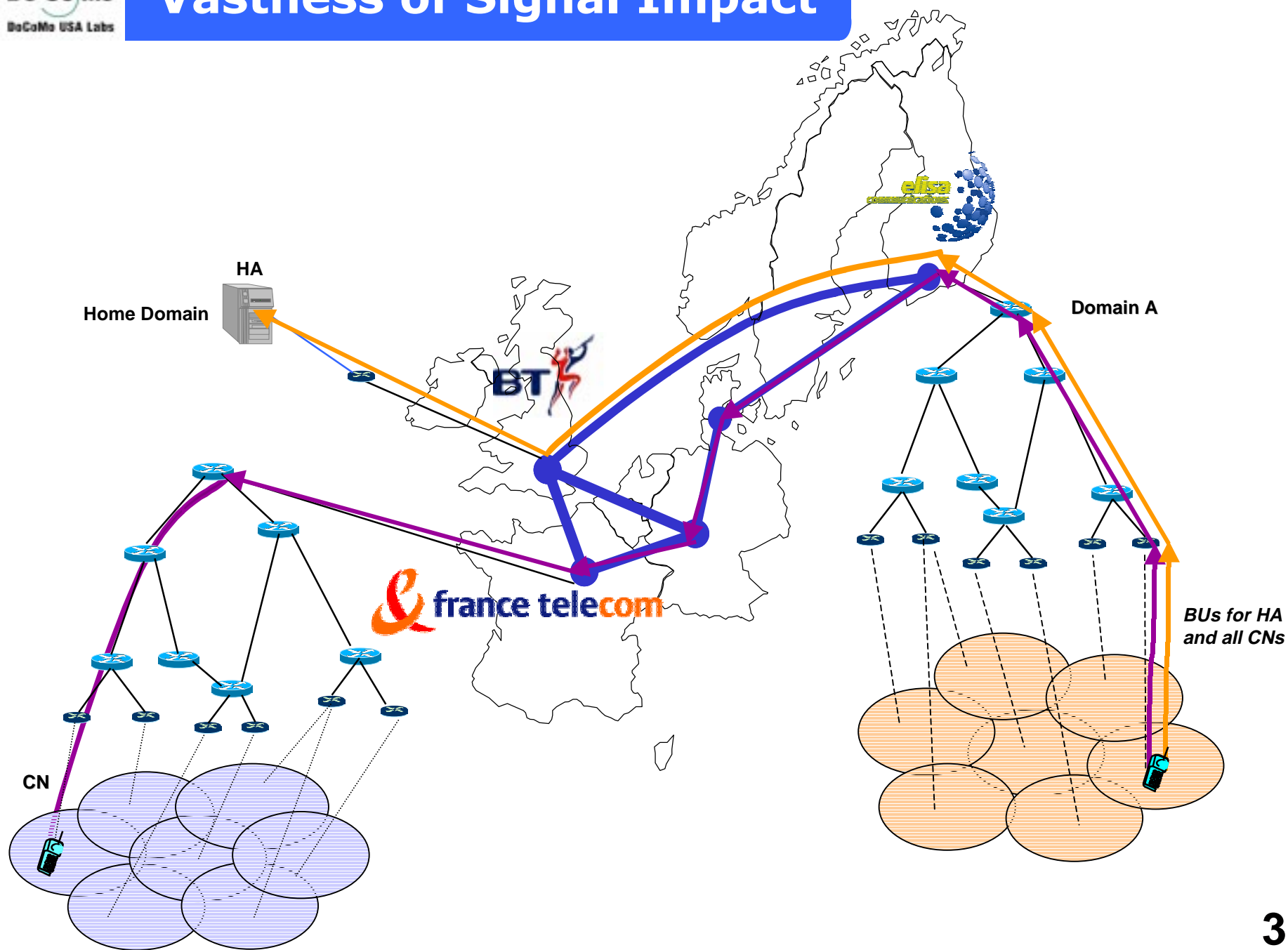


Vastness of Signal Impact

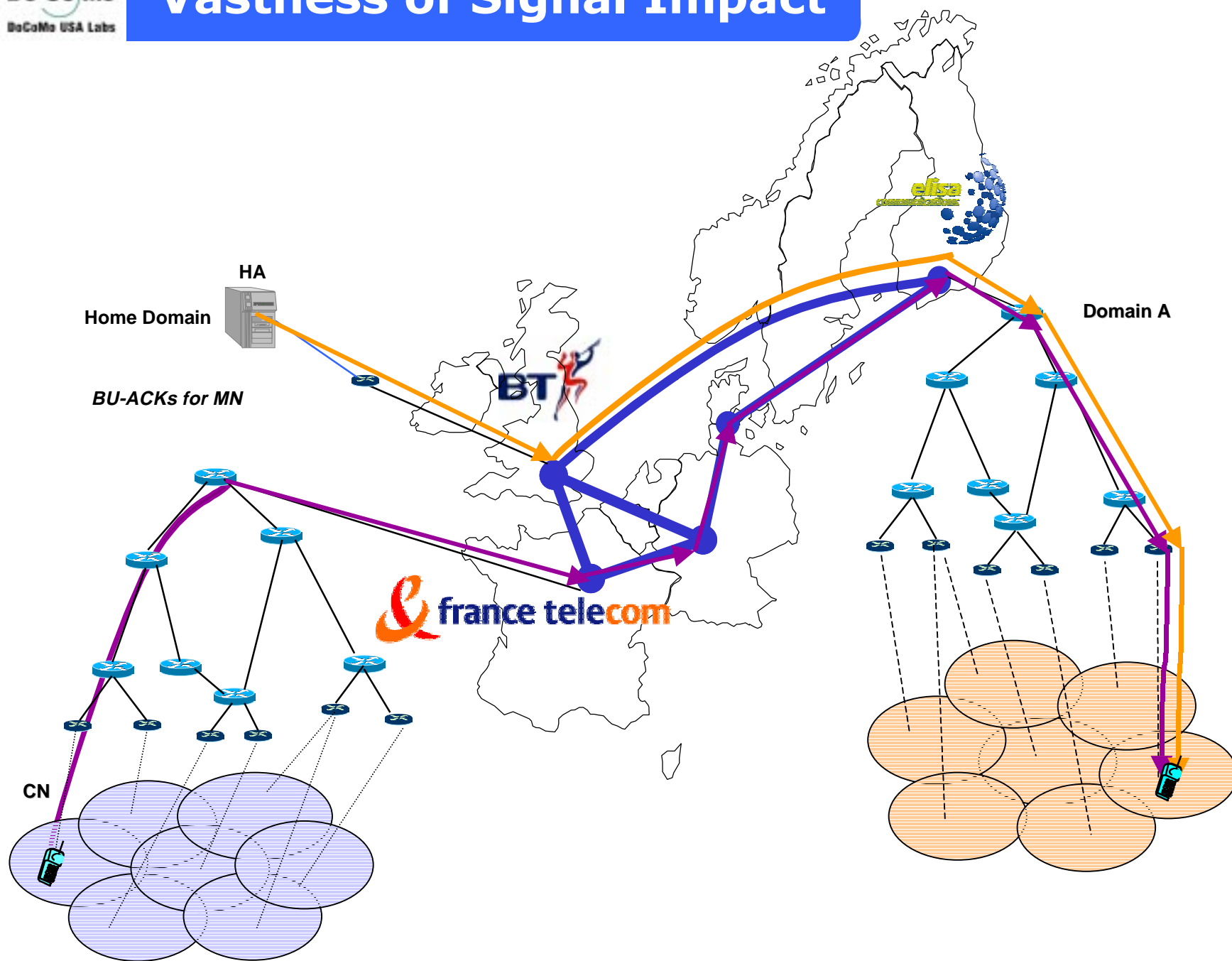
Global Internet



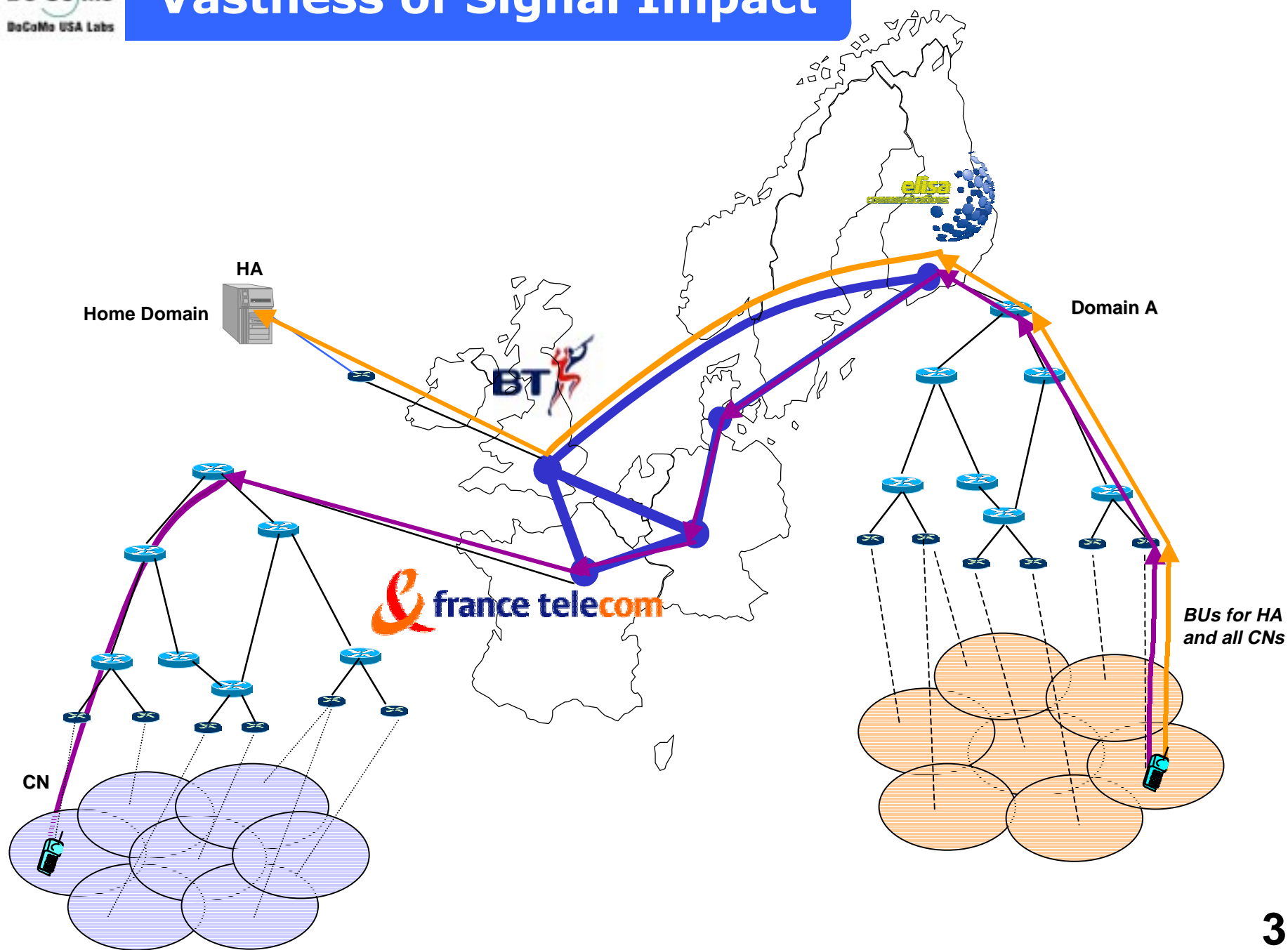
Vastness of Signal Impact



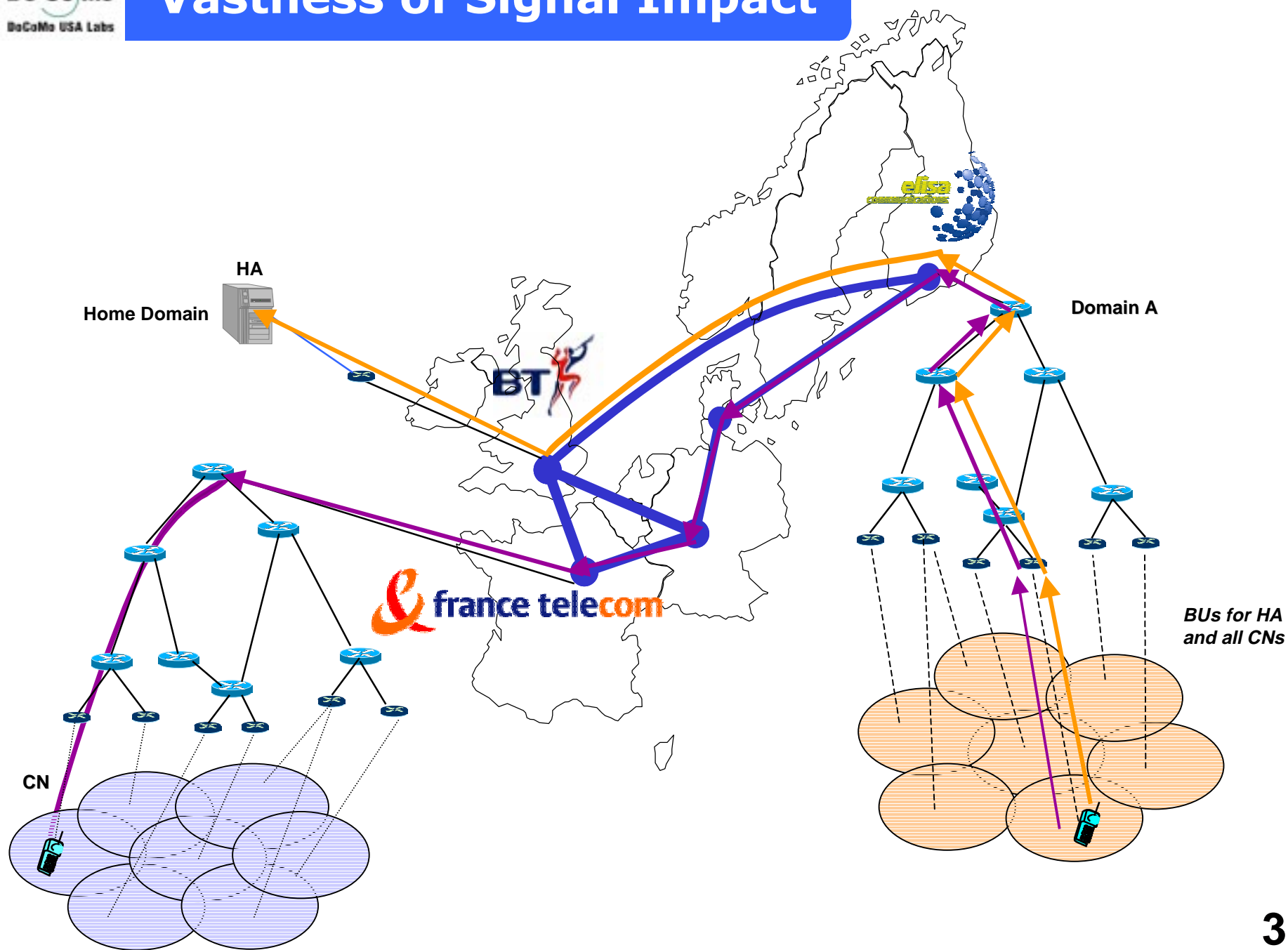
Vastness of Signal Impact



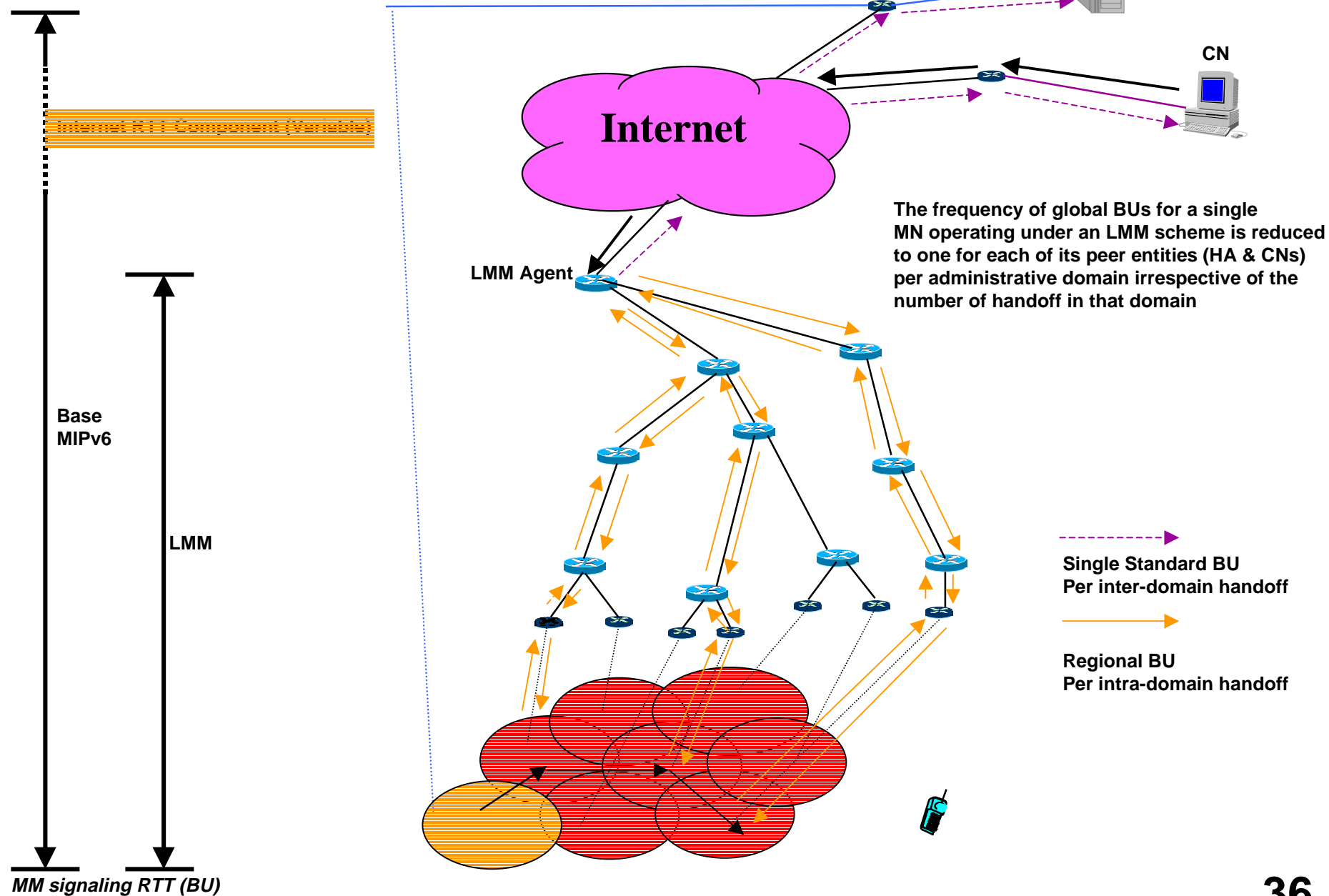
Vastness of Signal Impact



Vastness of Signal Impact



Local Mobility Management



LMM

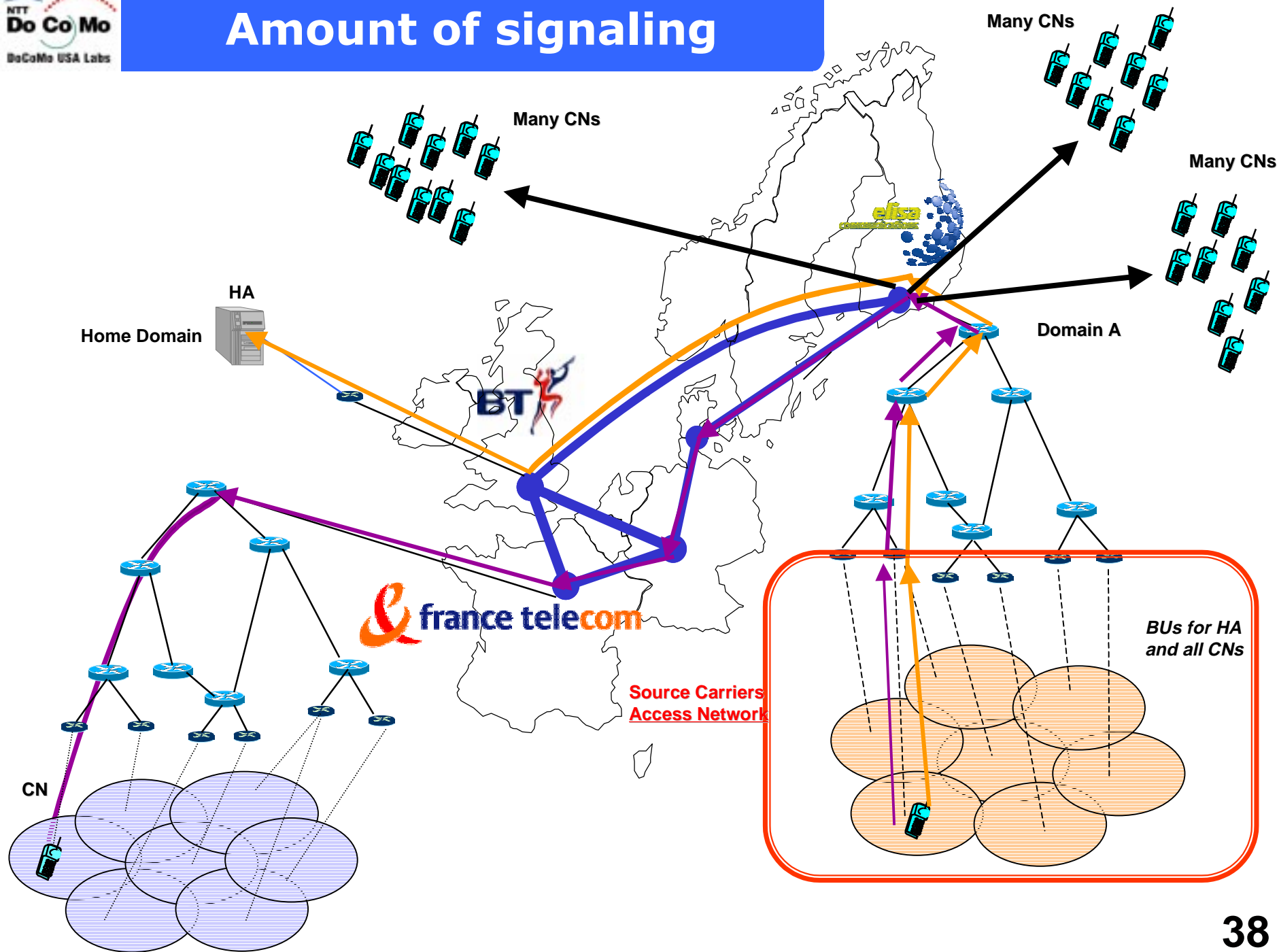
Signaling Width (length)

- Addresses latencies caused by mobility management (MM) signaling. For large round-trip times (RTT) between the MN and its HA or CNs (in order of 300-500 ms), the MM signaling is bound to introduce delays as well as potential packet loss in the forwarding of traffic through HA tunnel or between the MN and the CN.
- Reduces packet loss as a result of the latency of MM signaling.

Amount of Signaling

- Reduce the usage of precious radio resources.
- Reduce the amount of signaling over the global Internet (and that portion of carriers core networks). Important as NTT DoCoMo charges on a per packet basis.

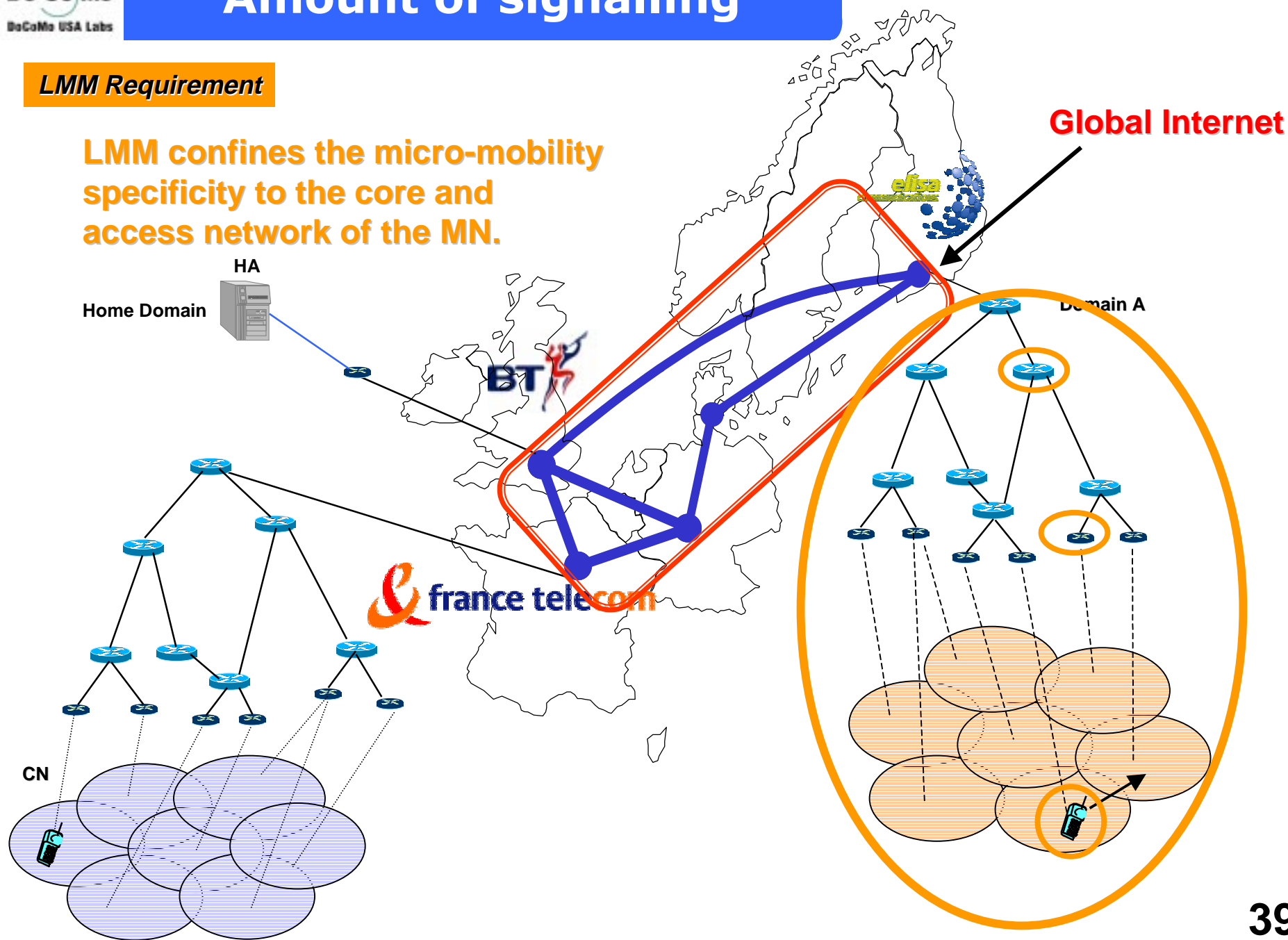
Amount of signaling



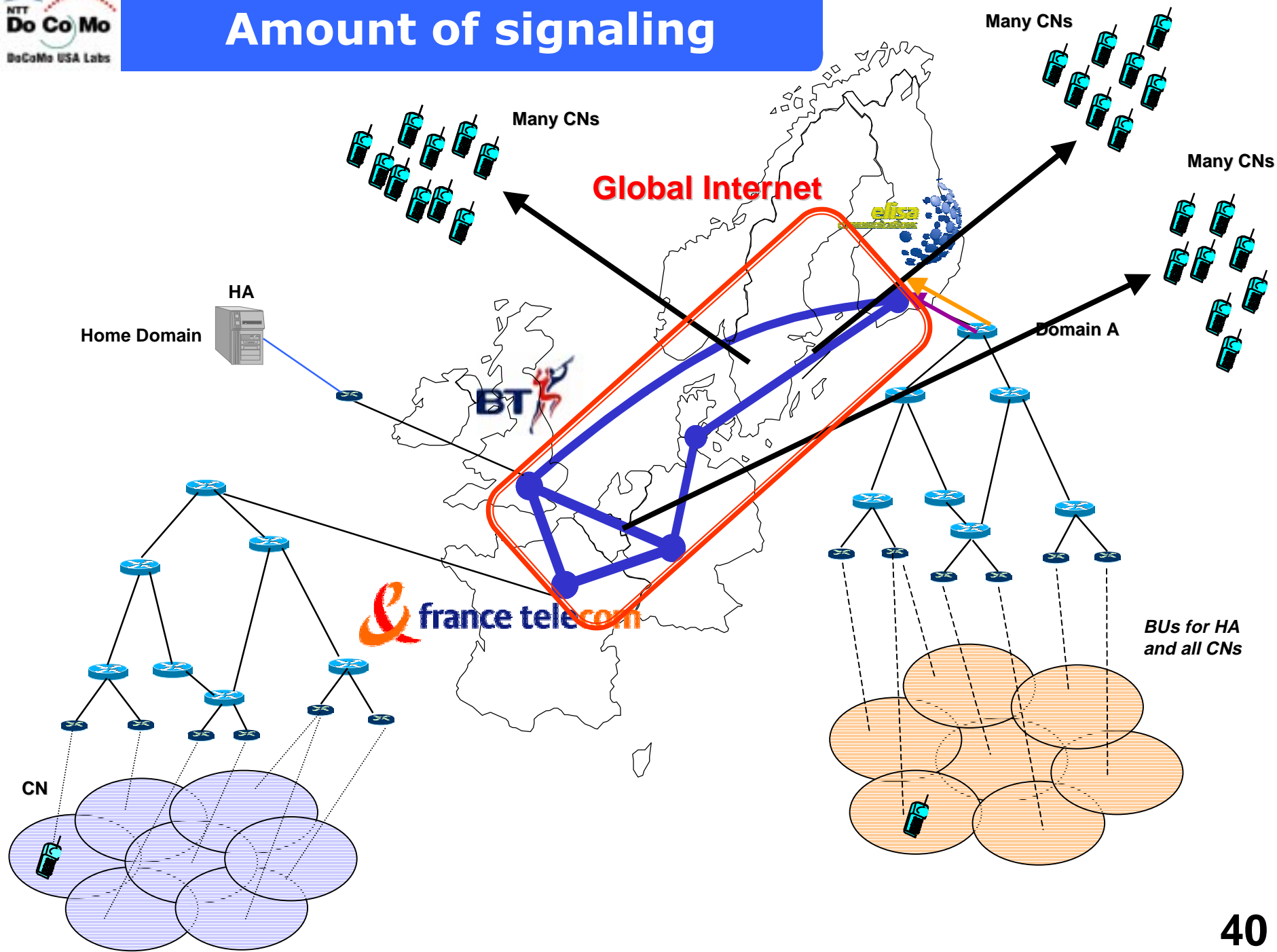
Amount of signalling

LMM Requirement

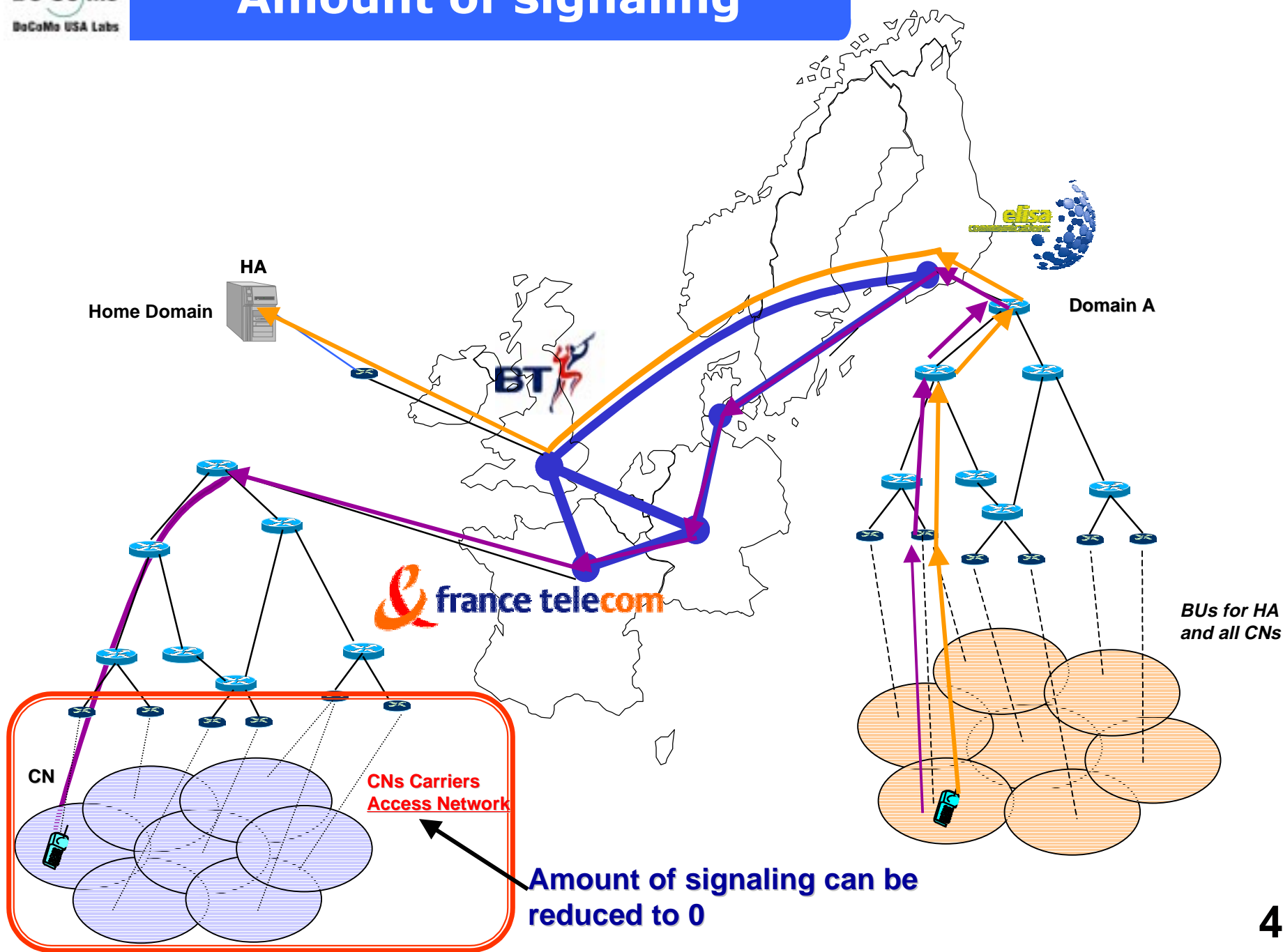
LMM confines the micro-mobility specificity to the core and access network of the MN.



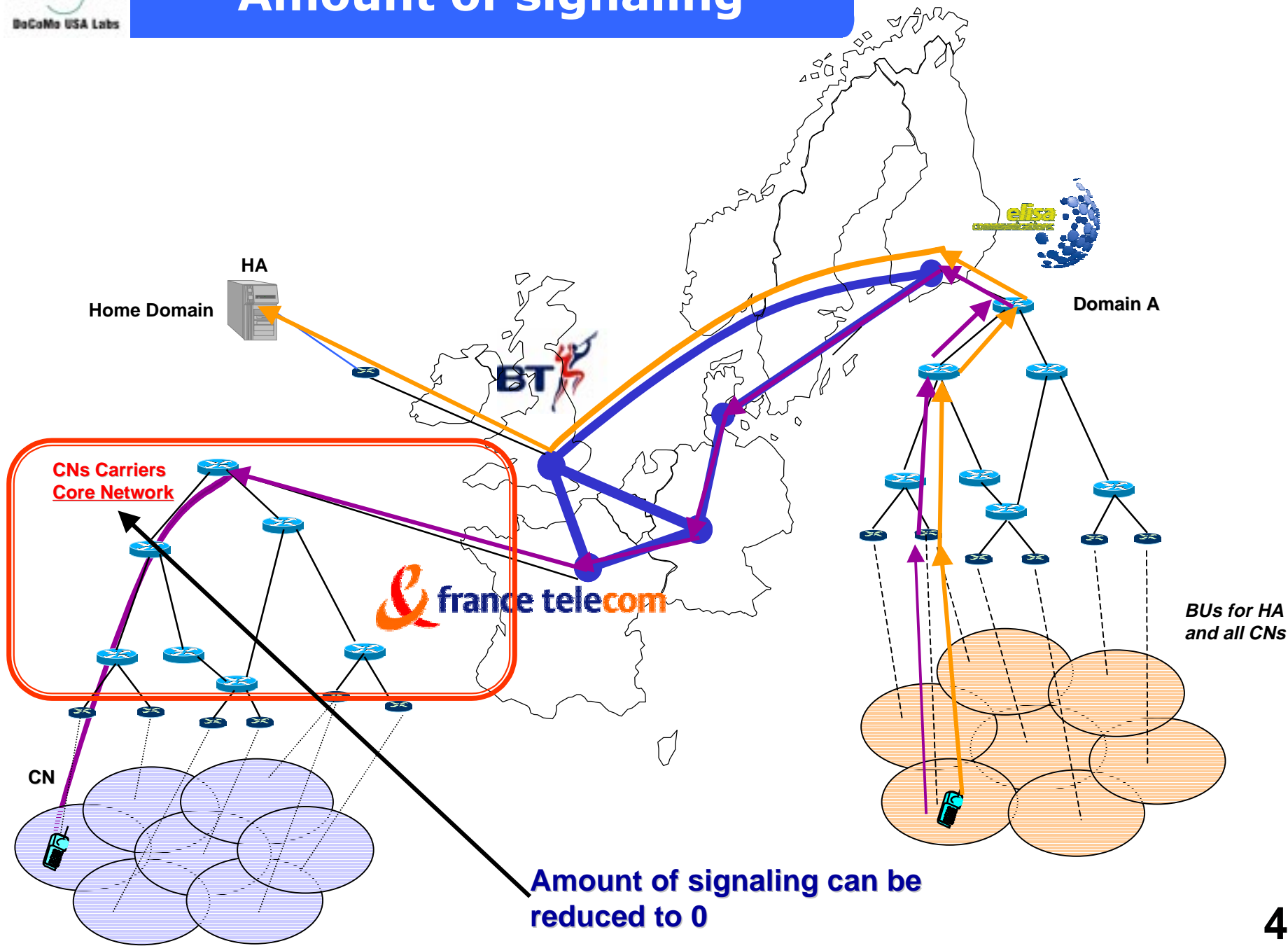
Amount of signaling



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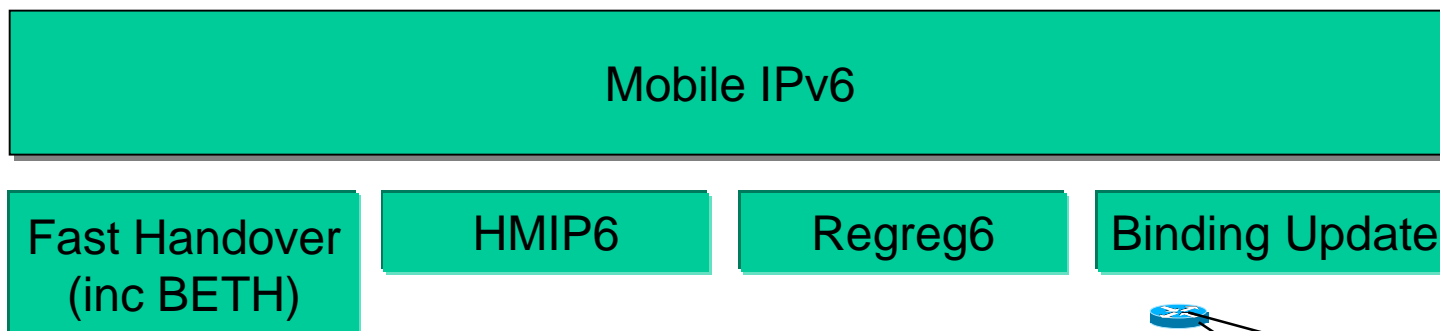


Amount of signaling



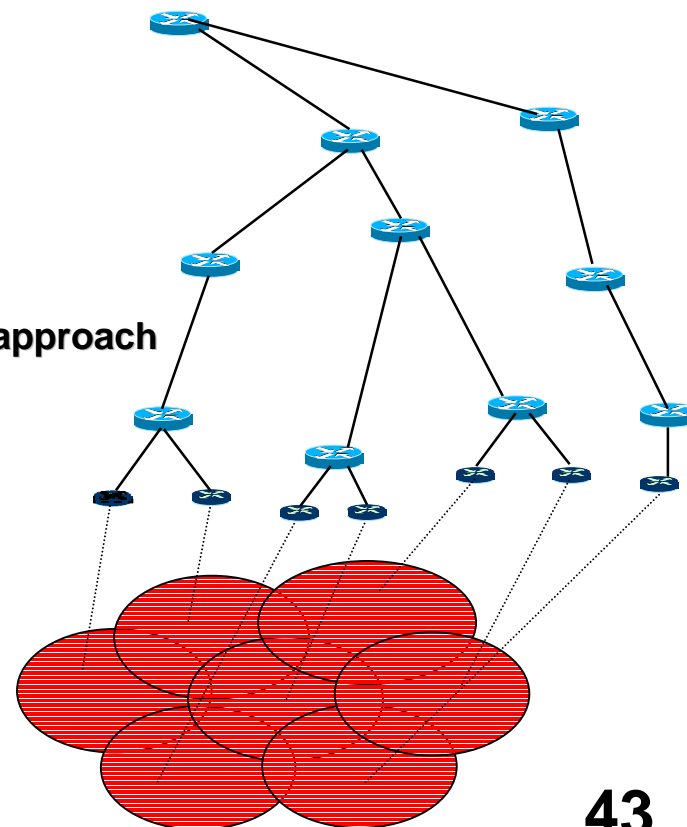
Optimized handover vs LMM

LMM Requirement LMM should be compatible with any handover scheme.

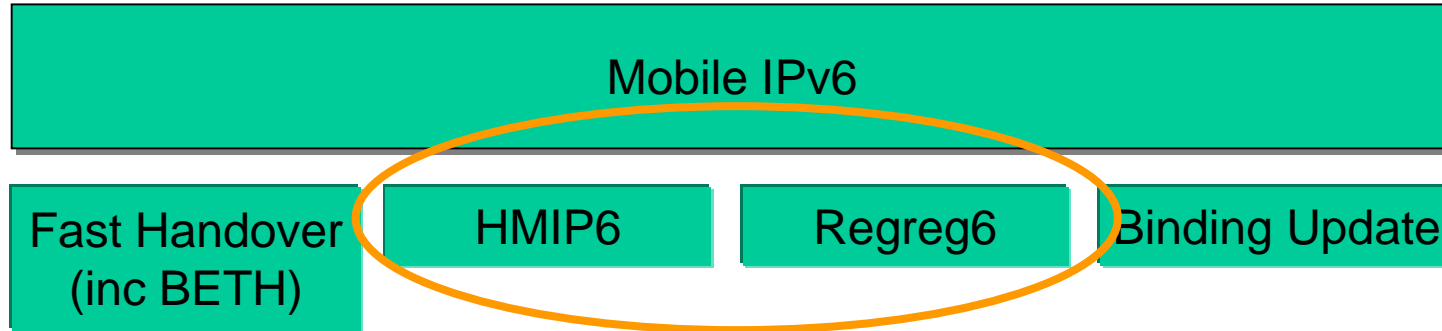


Enabling the MN to “freely” move in the domain visited in which the mobility bindings effected globally are those of the domain the MN resides and not the precise link.

Comparing FMIPv6 based approach with HMIPv6-Regreg6 based approach



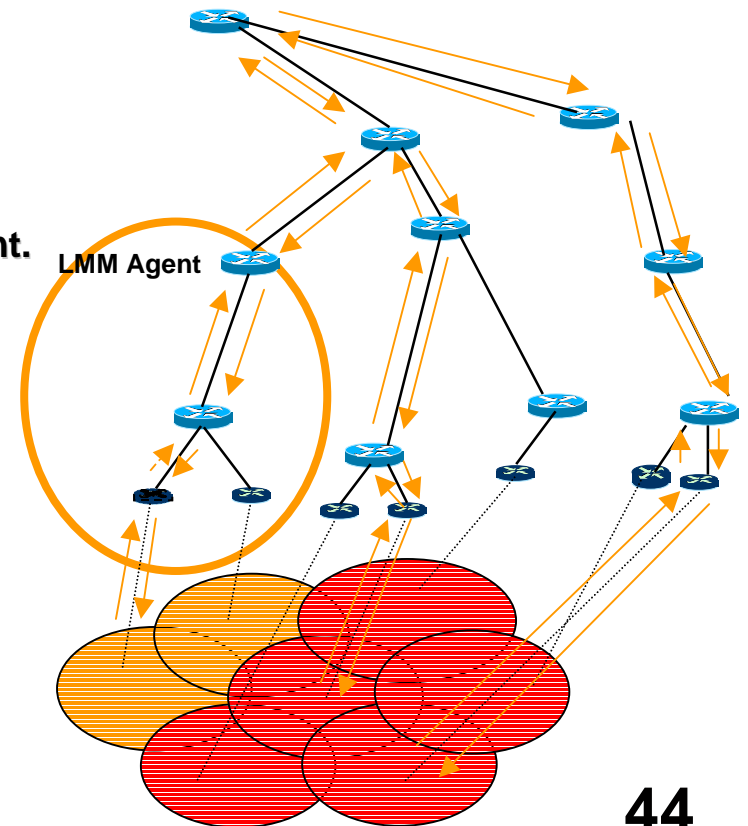
Optimized handover vs LMM



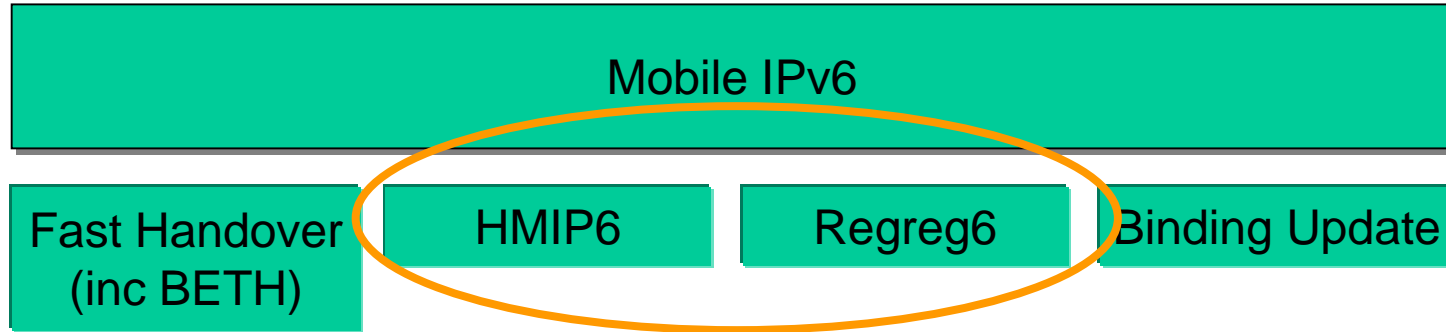
HMIP6/Regreg6 approach

Defines the domain vertically upward into the core network.
Signaling is executed upward to at most the top level LMM agent.

Only when moving into another domain will global signaling
be done to HA and CNs

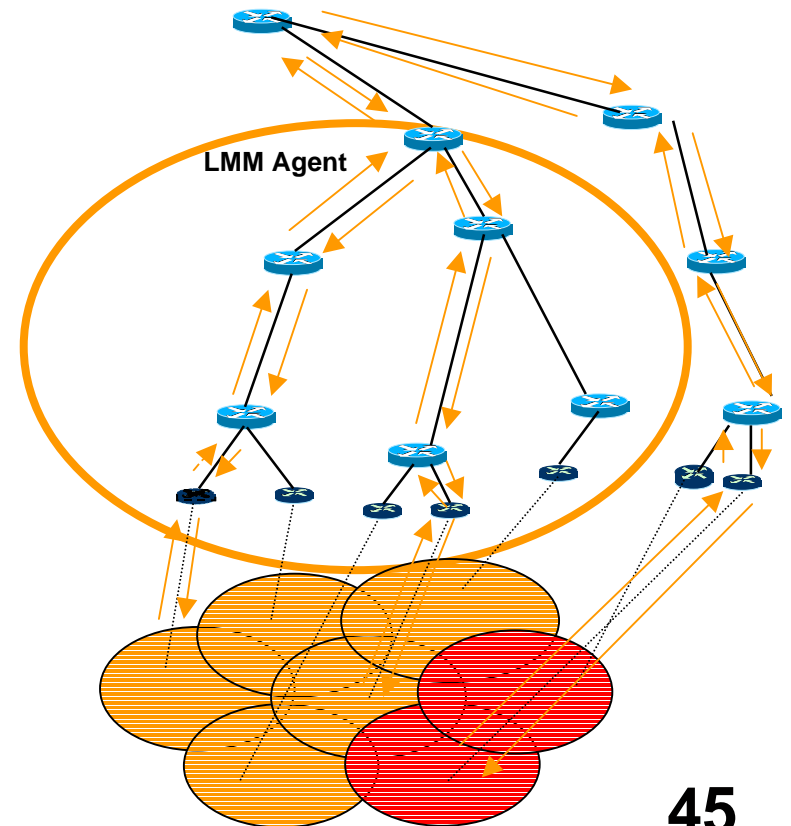


Optimized handover vs LMM

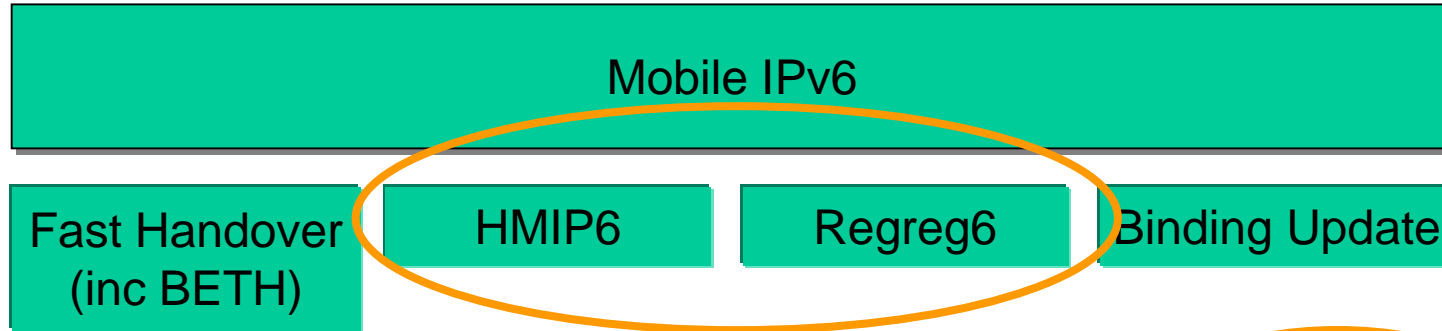


HMIP6/Regreg6 approach

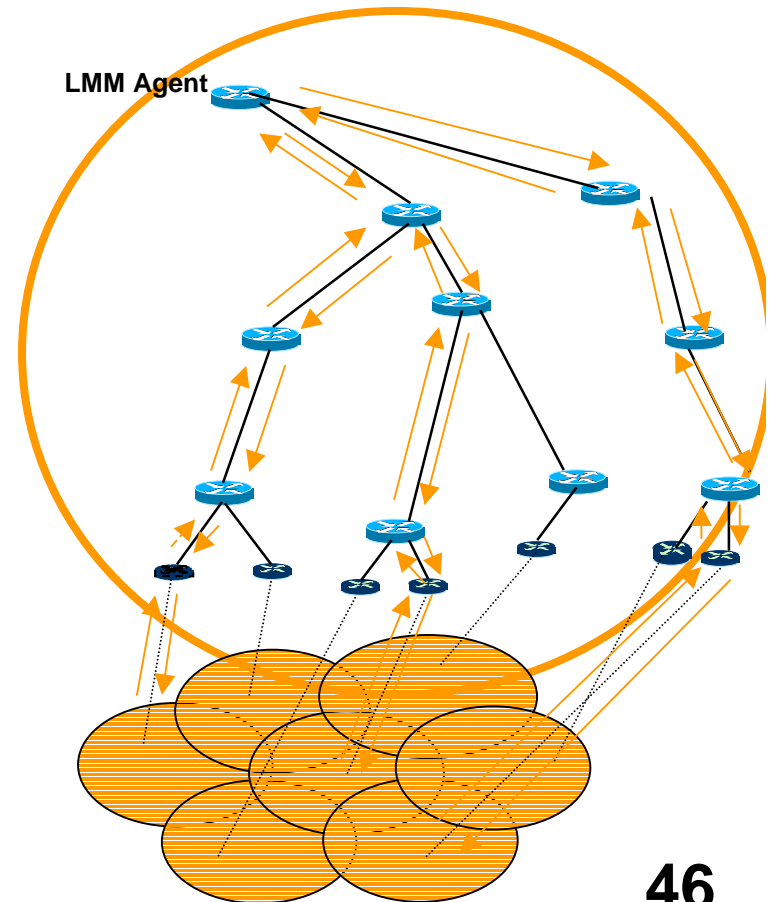
Region grows as you move the top-level router higher in core network.



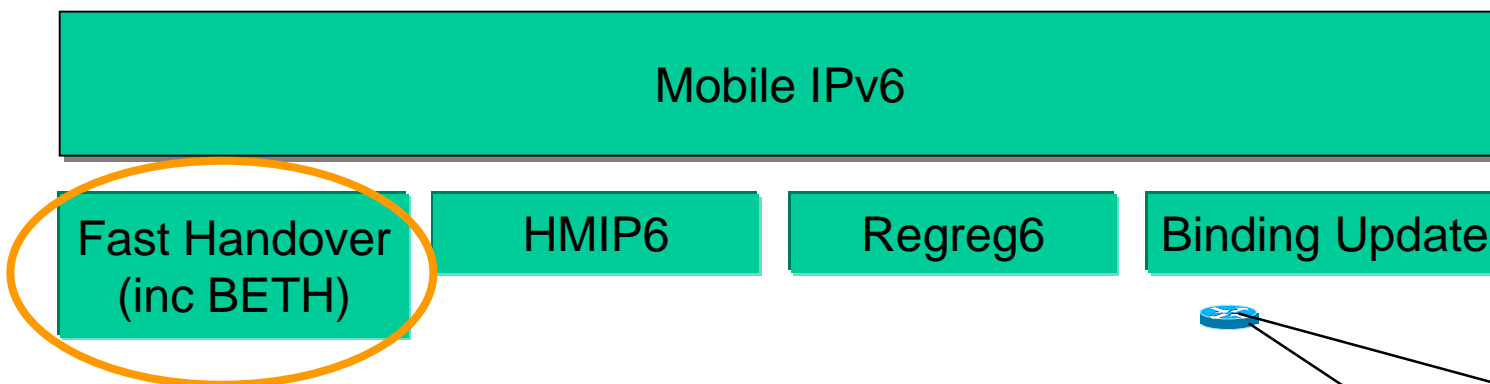
Optimized handover vs LMM



HMIP6/Regreg6 approach



Optimized handover vs LMM



FMIPv6 based approach

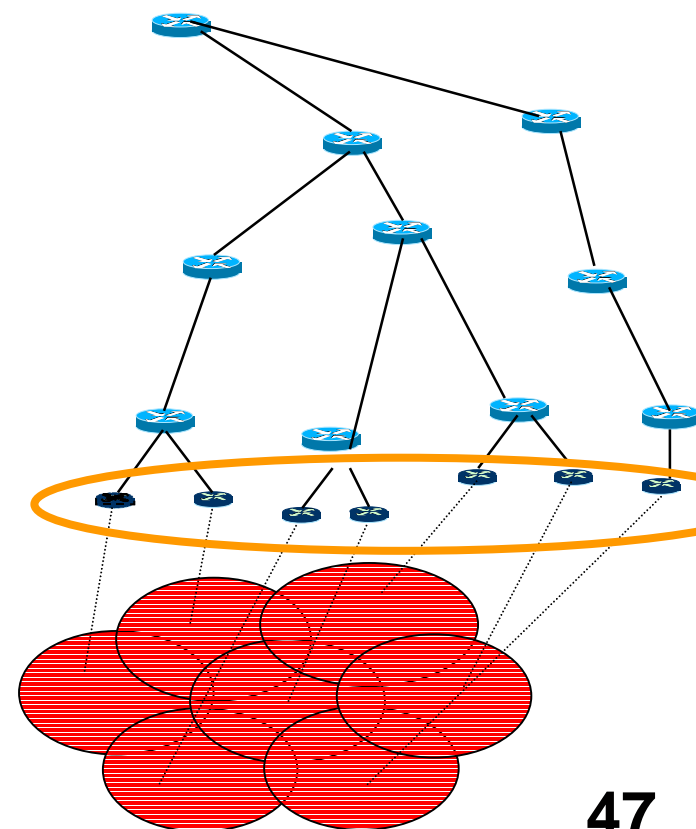
Uses tunnels to reduce length of signaling.

FMIPv6 domain is defined as a set of Access routers.

Simple case: OldAr and NewAr.

BETH feature allows tunneling through more than 2 ARs.

Horizontal perspective of reducing global signaling.



LMM-FMIPv6 research analysis

FMIPv6 as an LMM scheme

- Performance and feasibility of FMIPv6 vs LMM (e.g., HMIPv6)
Compare performance results of two approaches. Study the feasibility of FMIPv6 tunnel based approach from various perspective including the amount of global signaling.

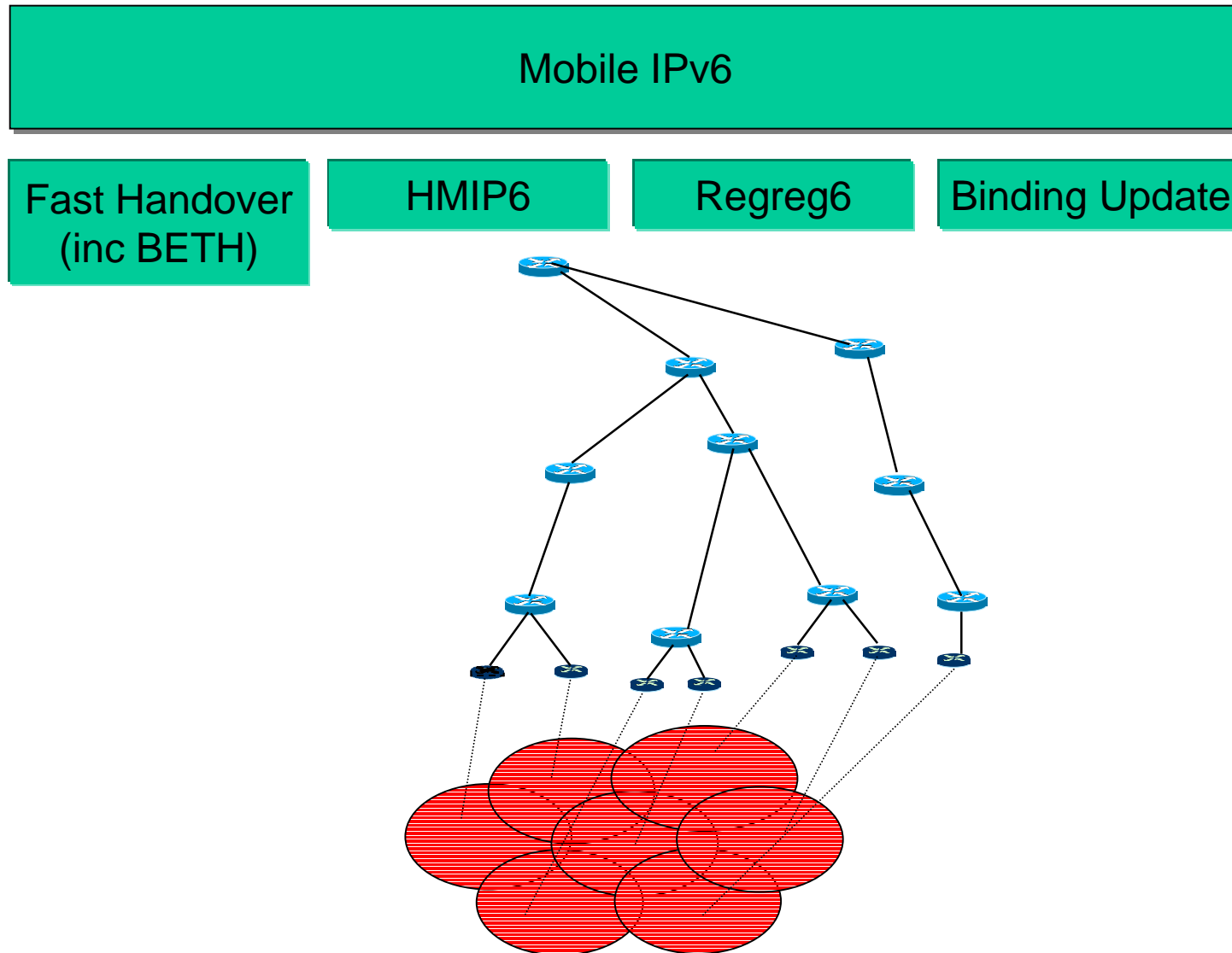
LMM (e.g., HMIPv6) interworking with FMIPv6

- Determine feasibility of co-existing FMIPv6 with LMM (HMIPv6)
- What performance gains (if any) from using both approaches.

LMM Requirement Analysis

LMM Requirement

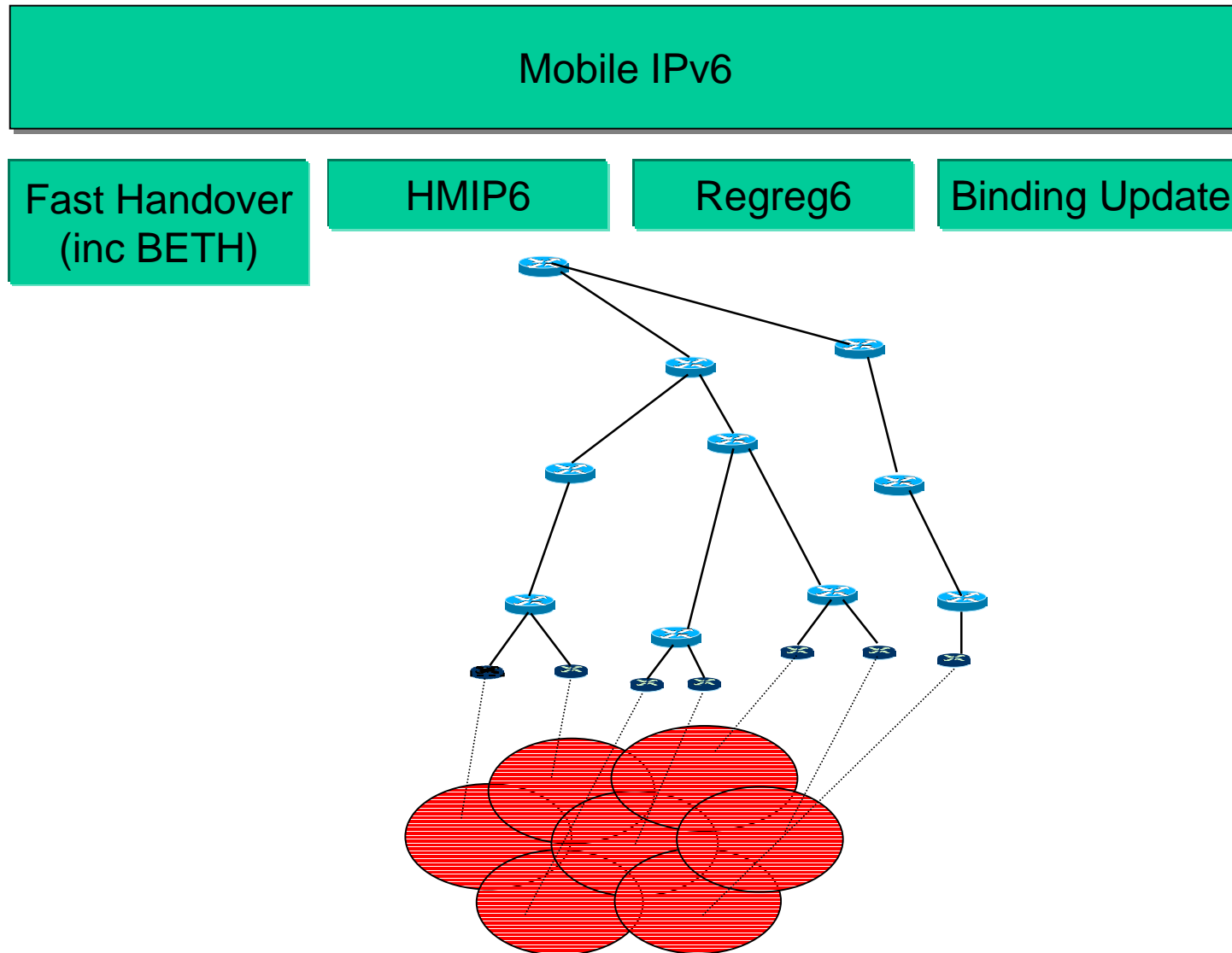
LMM scheme **MUST** be able to deal with topological changes in the core network.



LMM Requirement Analysis

LMM Requirement

LMM scheme MUST not introduce a single point of failure



LMM Requirement Analysis

LMM Requirement

Security related requirements...

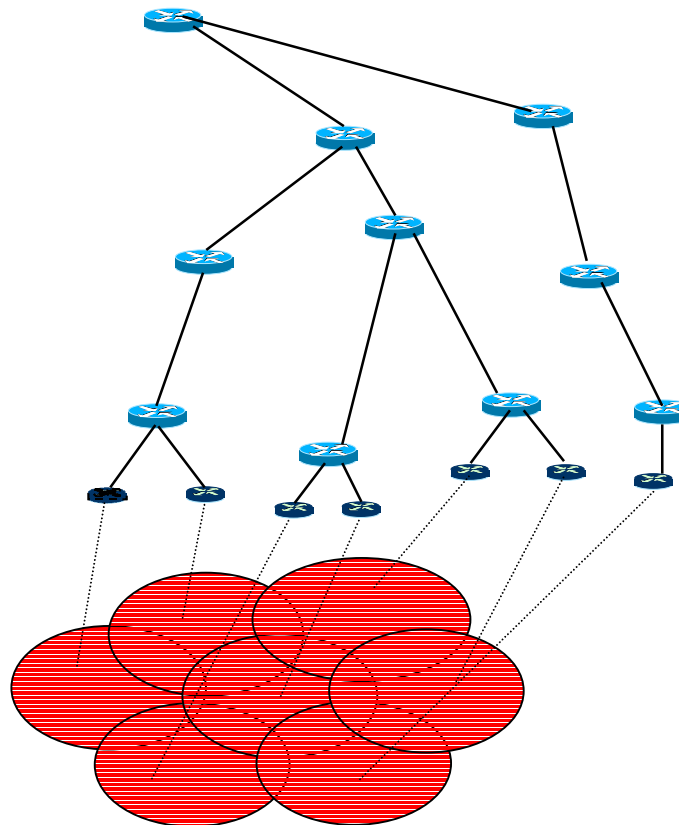
Mobile IPv6

Fast Handover
(inc BETH)

HMIP6

Regreg6

Binding Update







Giving Wings to the Internet