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IPv6 in a Mobile World

An IPv6 Forum Presentation, Spain
March 15, 2002

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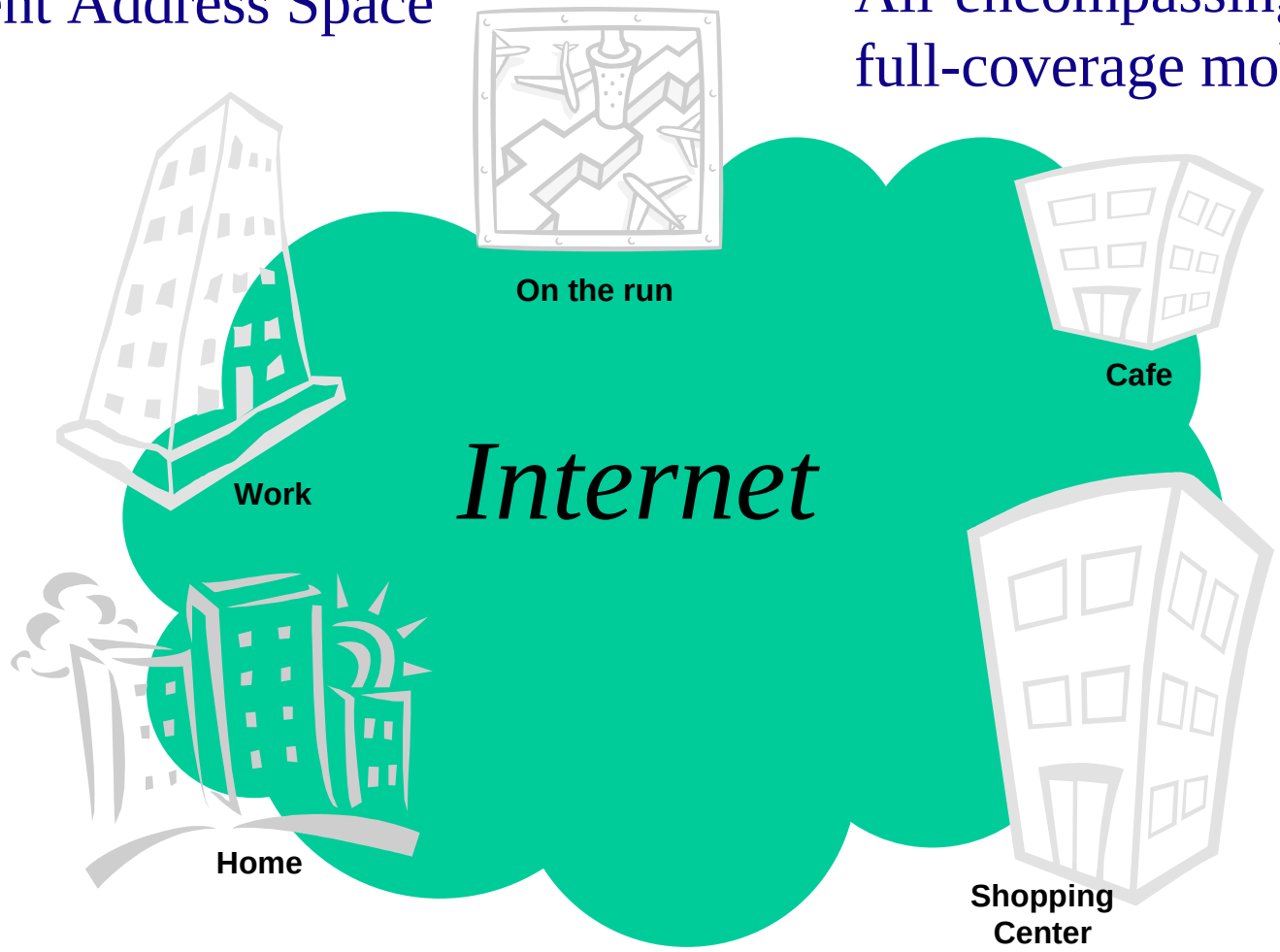
IPv6 –The Foundation

Everybody
Sufficient Address Space

Everywhere
All-encompassing and full-coverage mobile network



Always ON

IPv6 and Mobile IPv6 Integration

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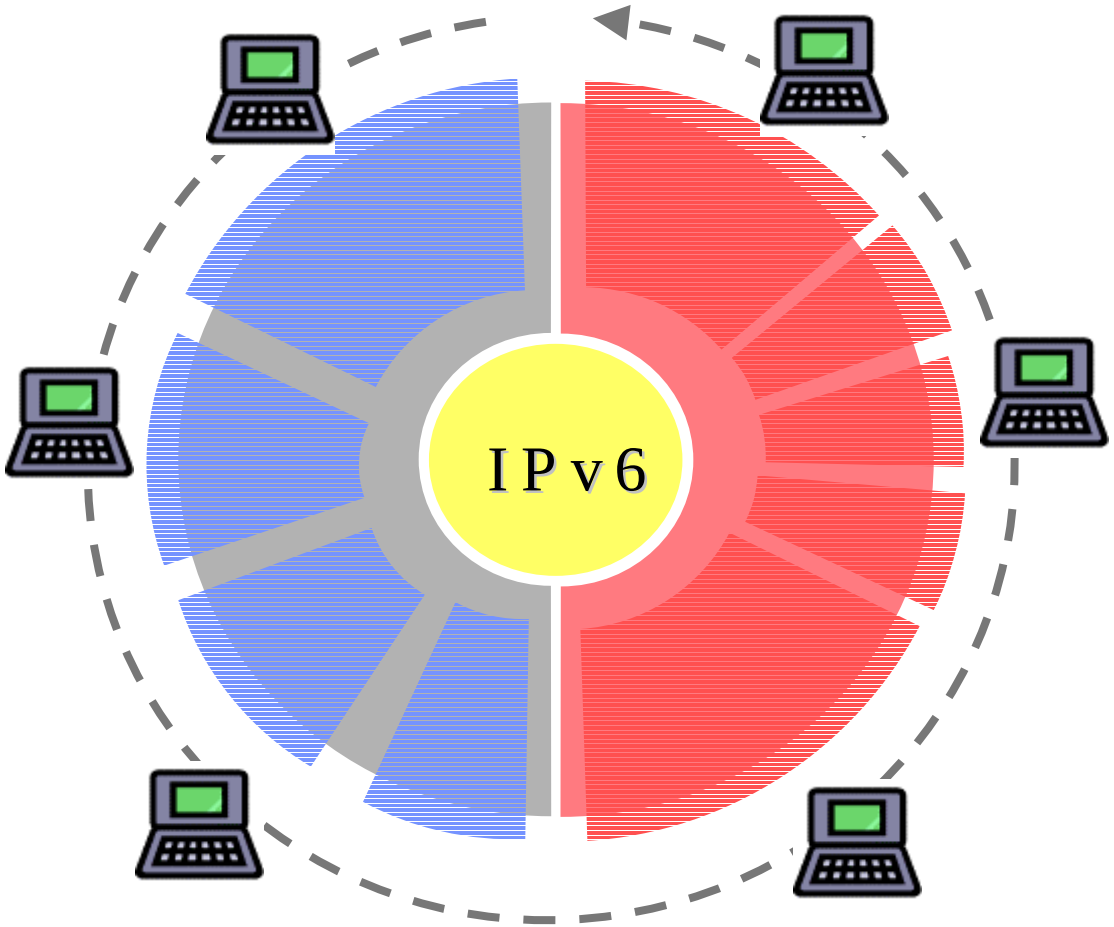

IPv6 and Mobile IPv6 Integration

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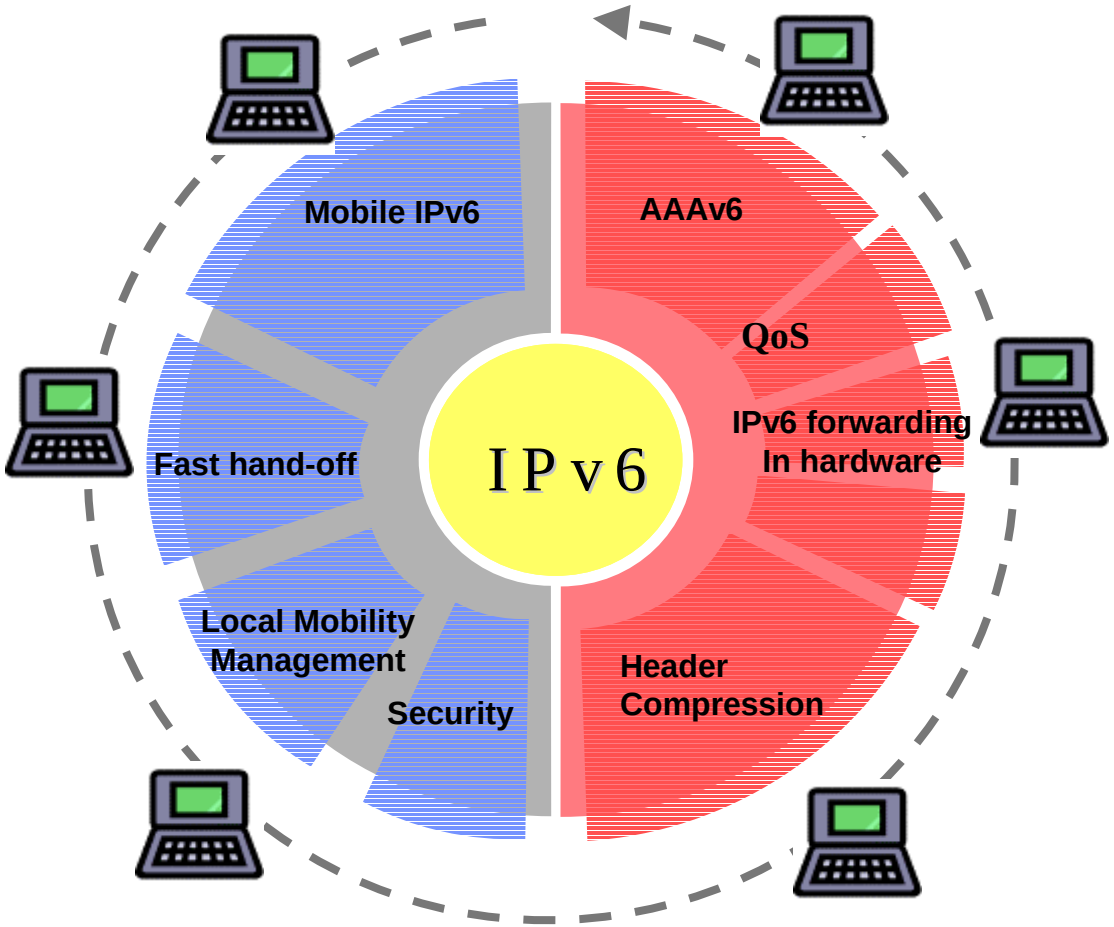

Link layer mobility vs. IP layer mobility

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- With link layer (L2) mobility routing can be ineffcient.
  - Roaming in a domain that is located far away from the home network and local services are being used.
- With L2 mobility a multi-mode mobile device is given a new IP address when roaming between different access networks.
  - Existing application connections are lost.
- IP layered (L3) mobility allows packets sent to the home address to be delivered to the mobile node.
  - L3 mobility hides any address change from the transport and application layers.
  - L3 mobility enables the mobile device to roam seamlessly between different (or same) access networks.

Link layer mobility vs. IP layer mobility

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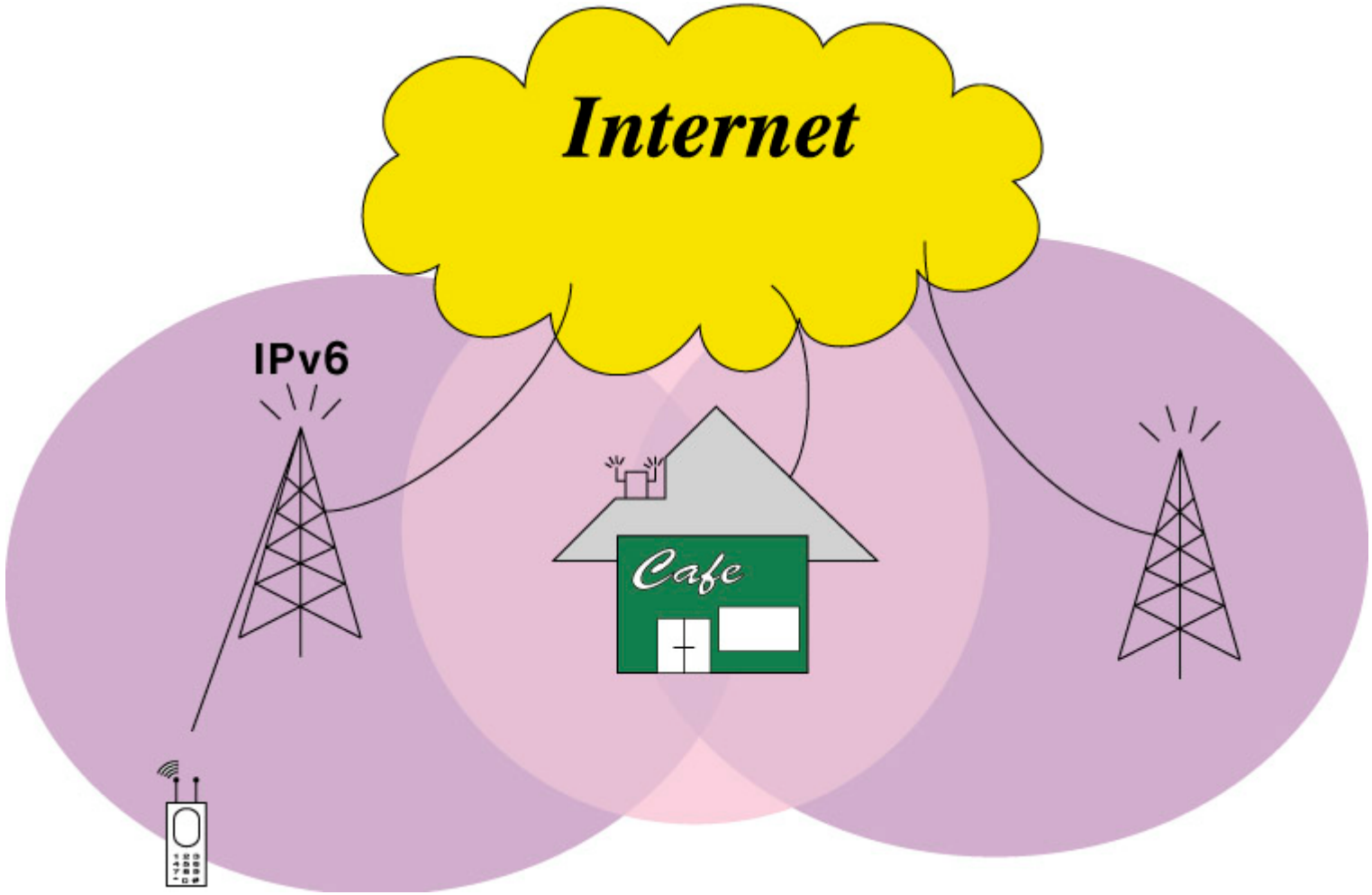

Independent of access technologies

Link layer mobility vs. IP layer mobility

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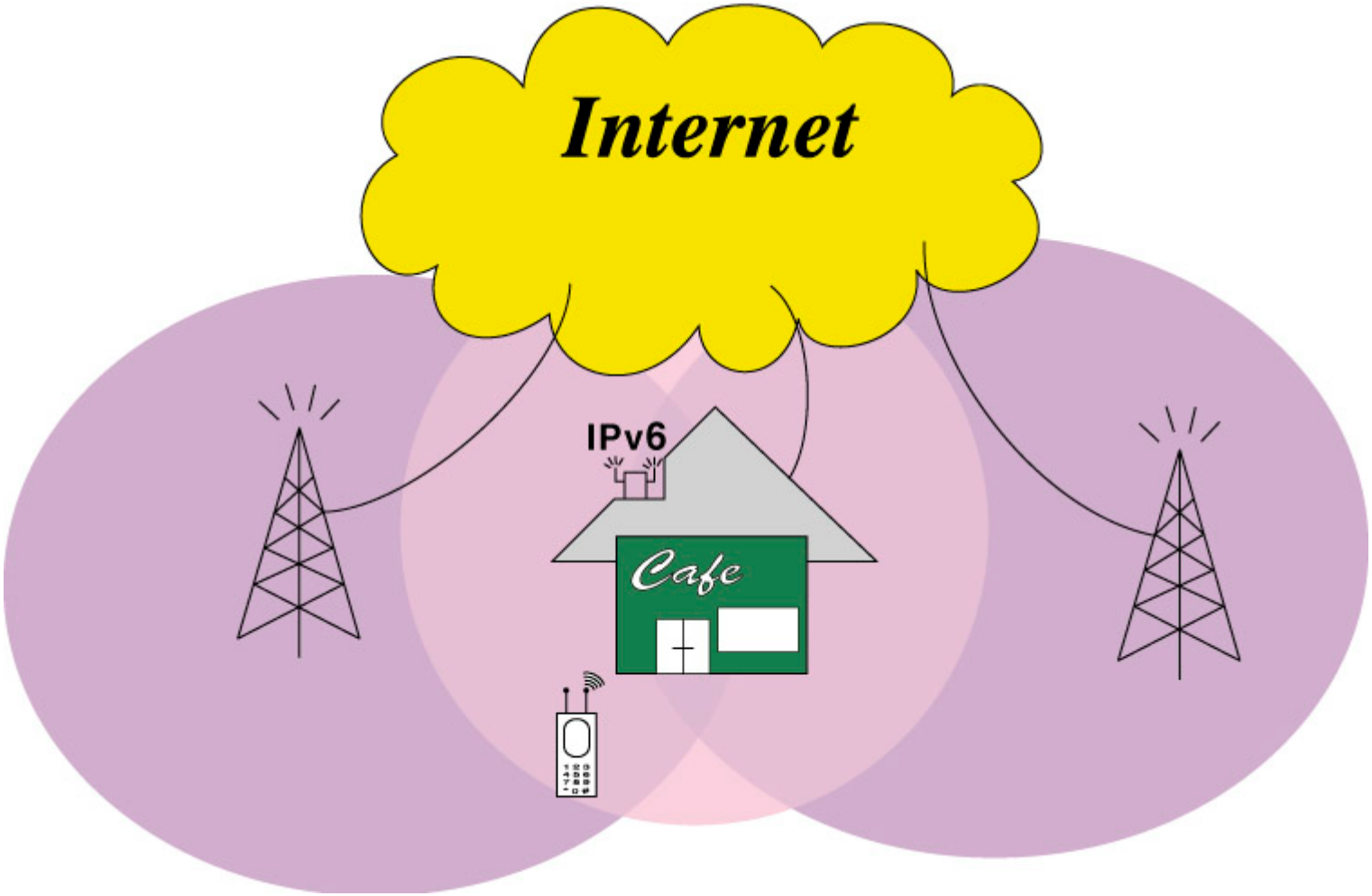

Independent of access technologies

Link layer mobility vs. IP layer mobility

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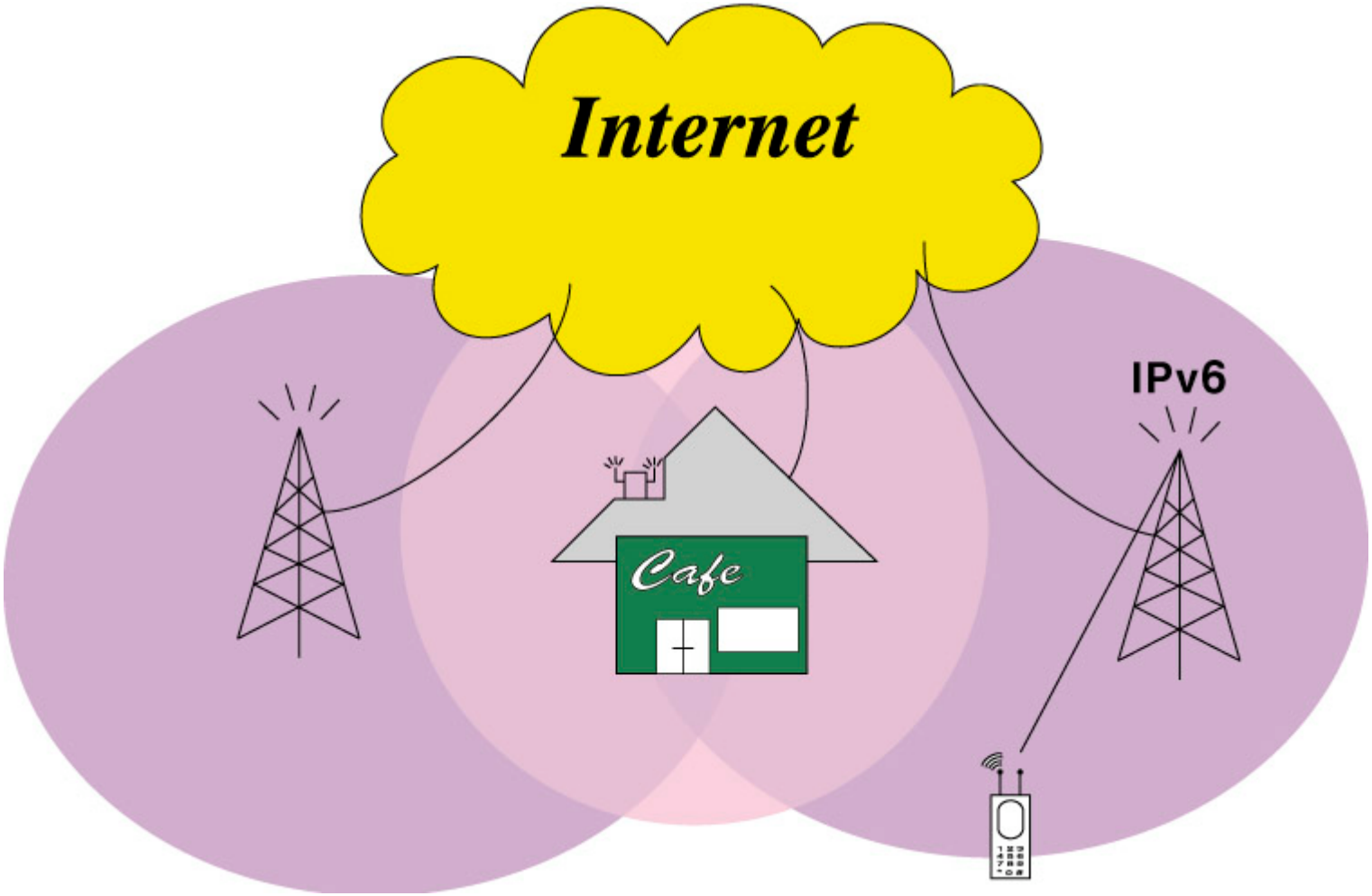

Independent of access technologies

Mobile Device Receiving a Connection

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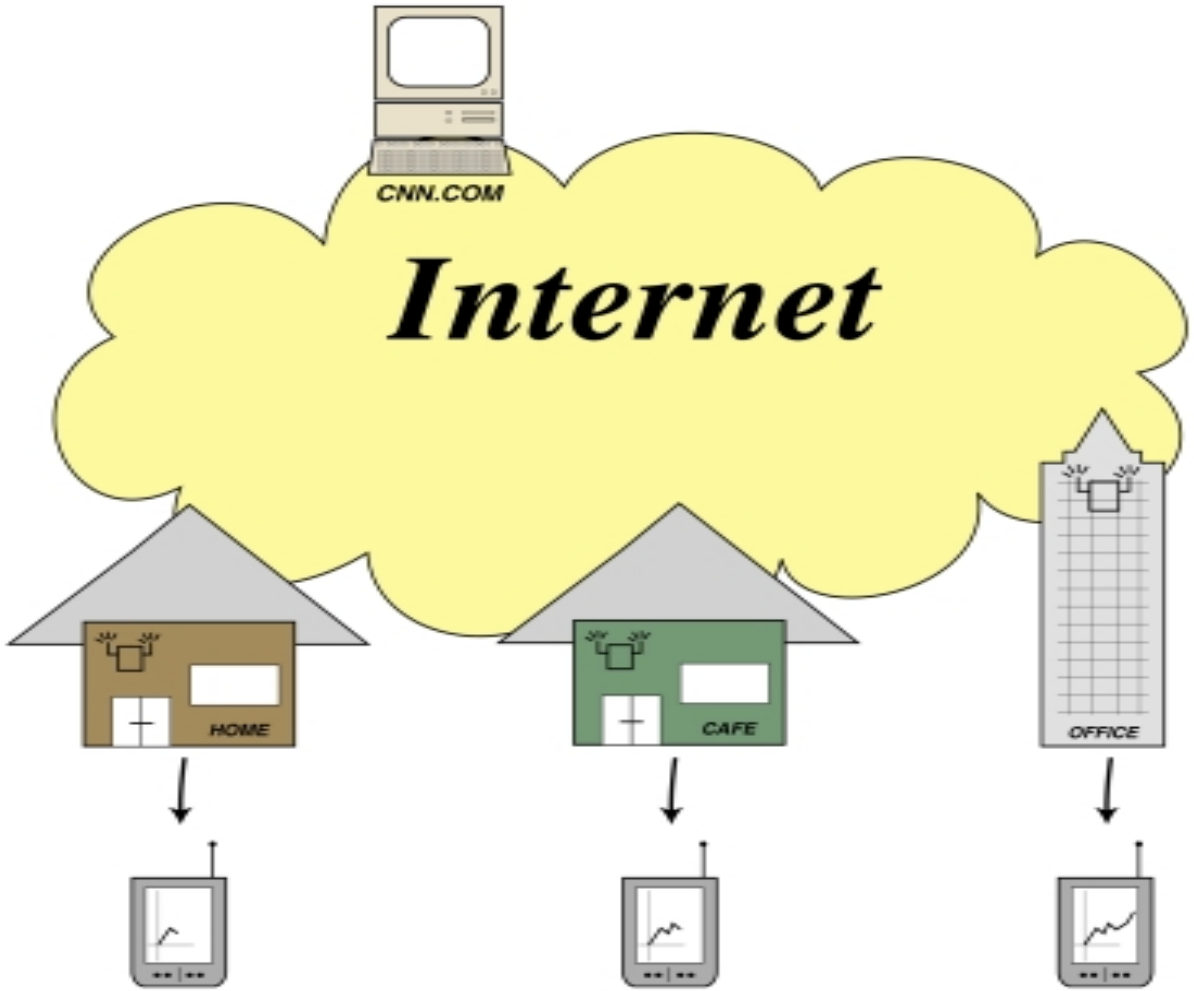
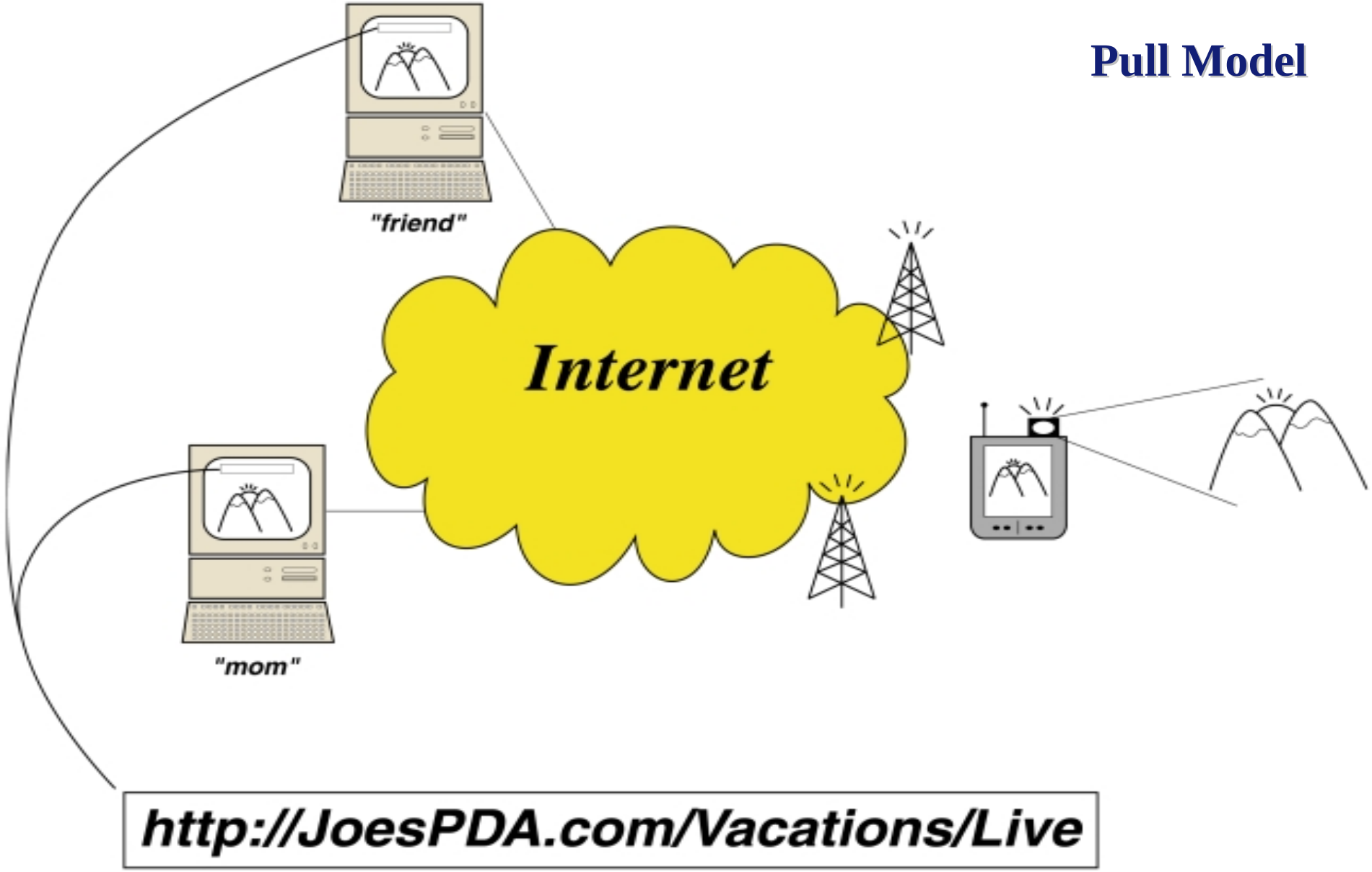


Push Model

Mobile Device as a Server



Wireless LANs in the city

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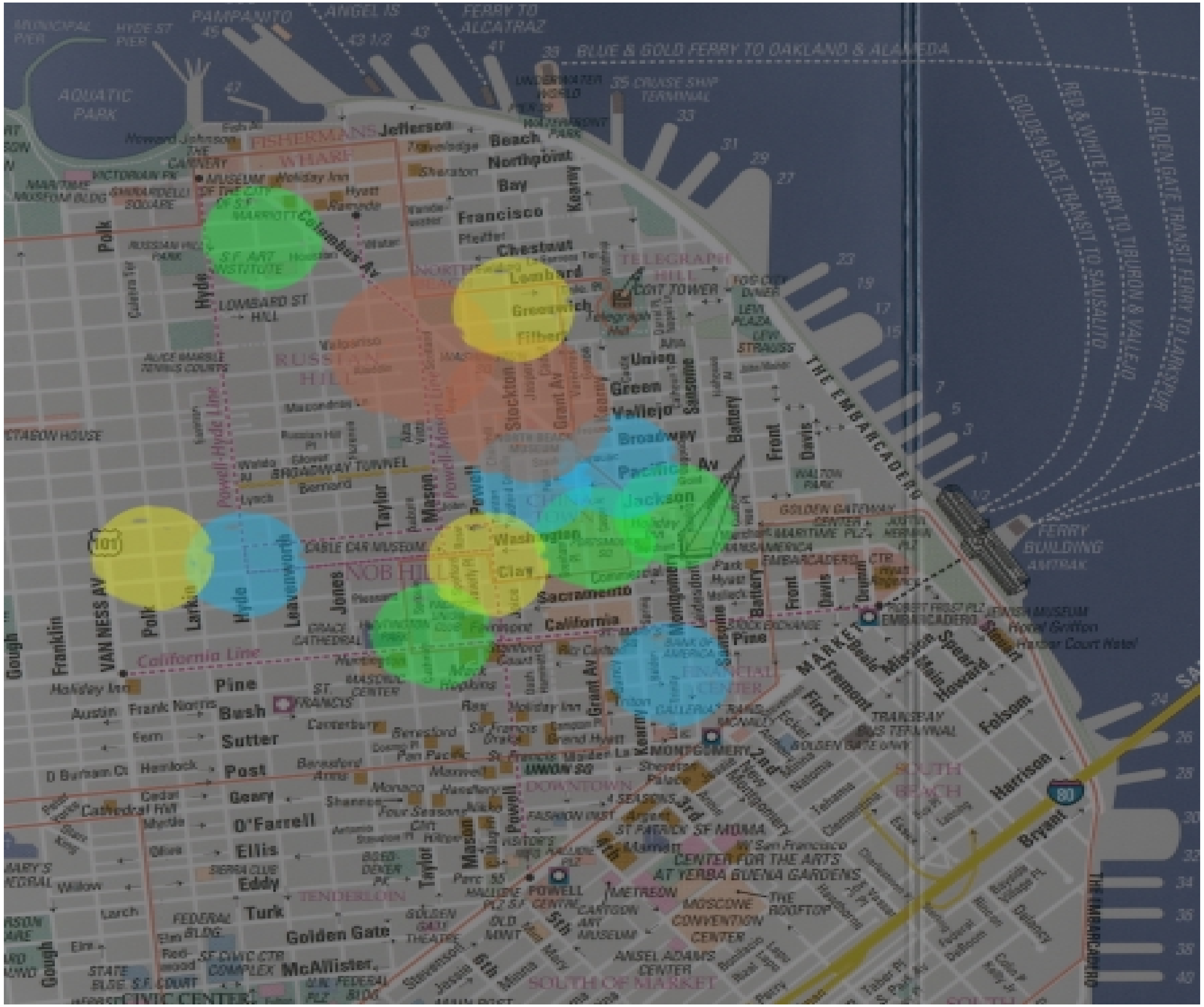

Same L2 Media, Different Administration

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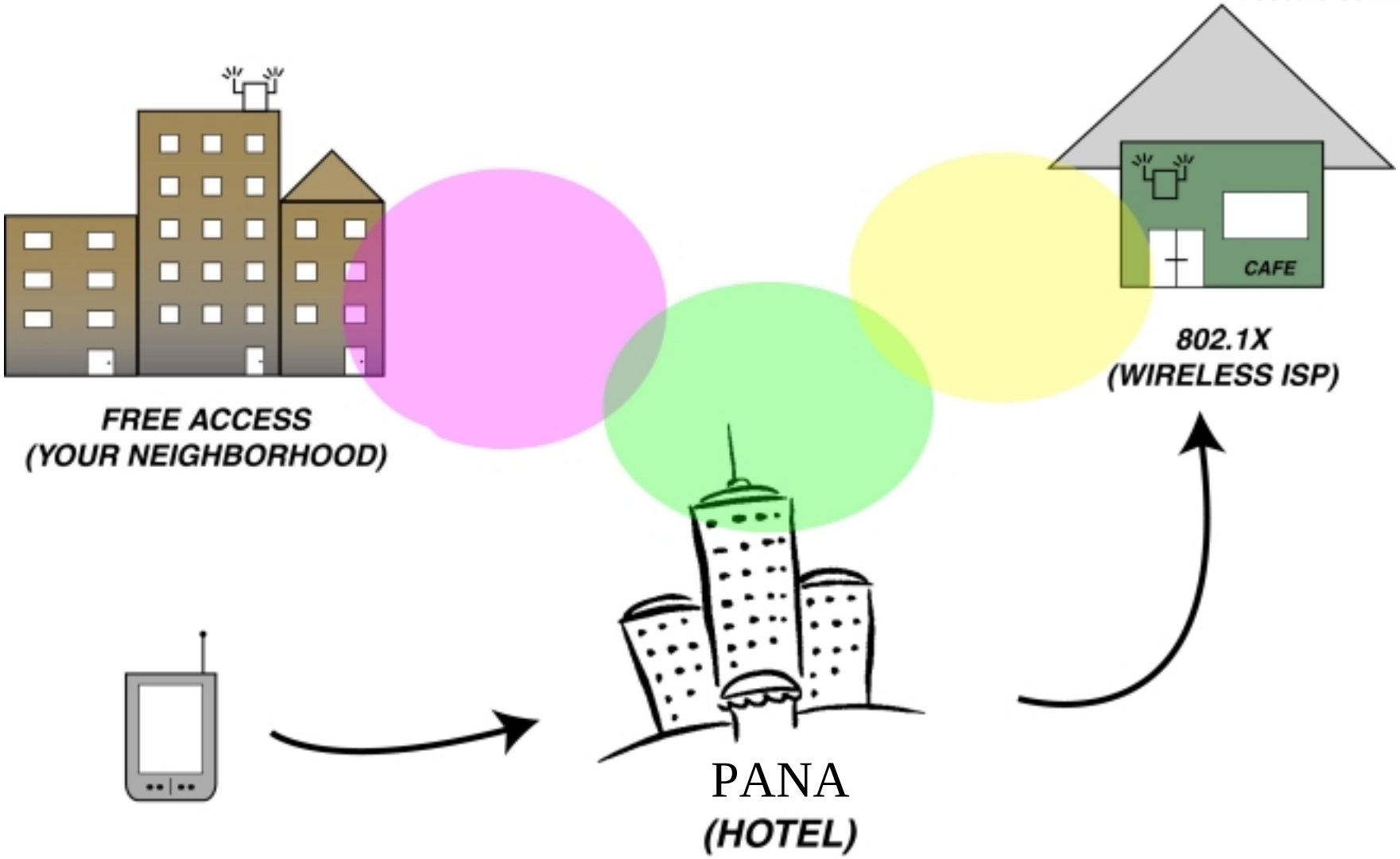
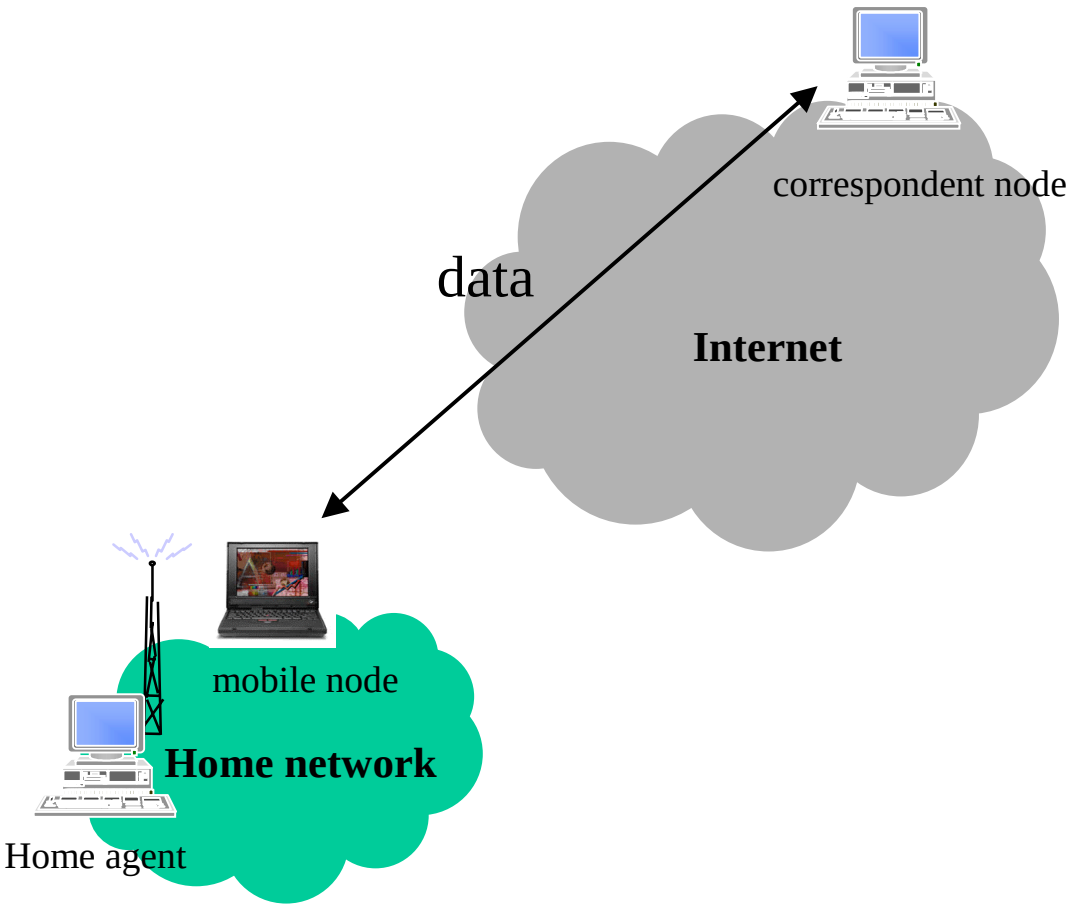
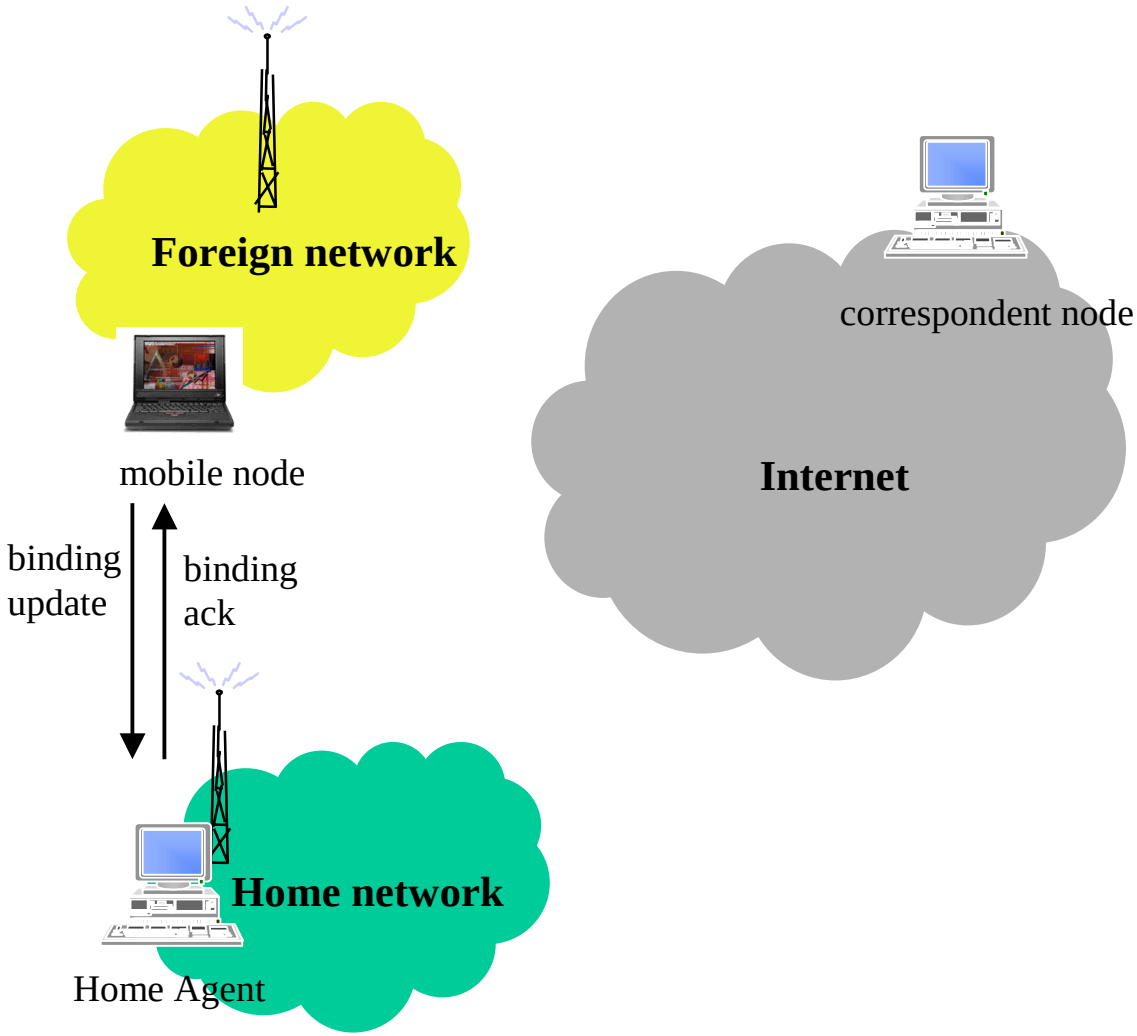


Mobile IPv6 Operation



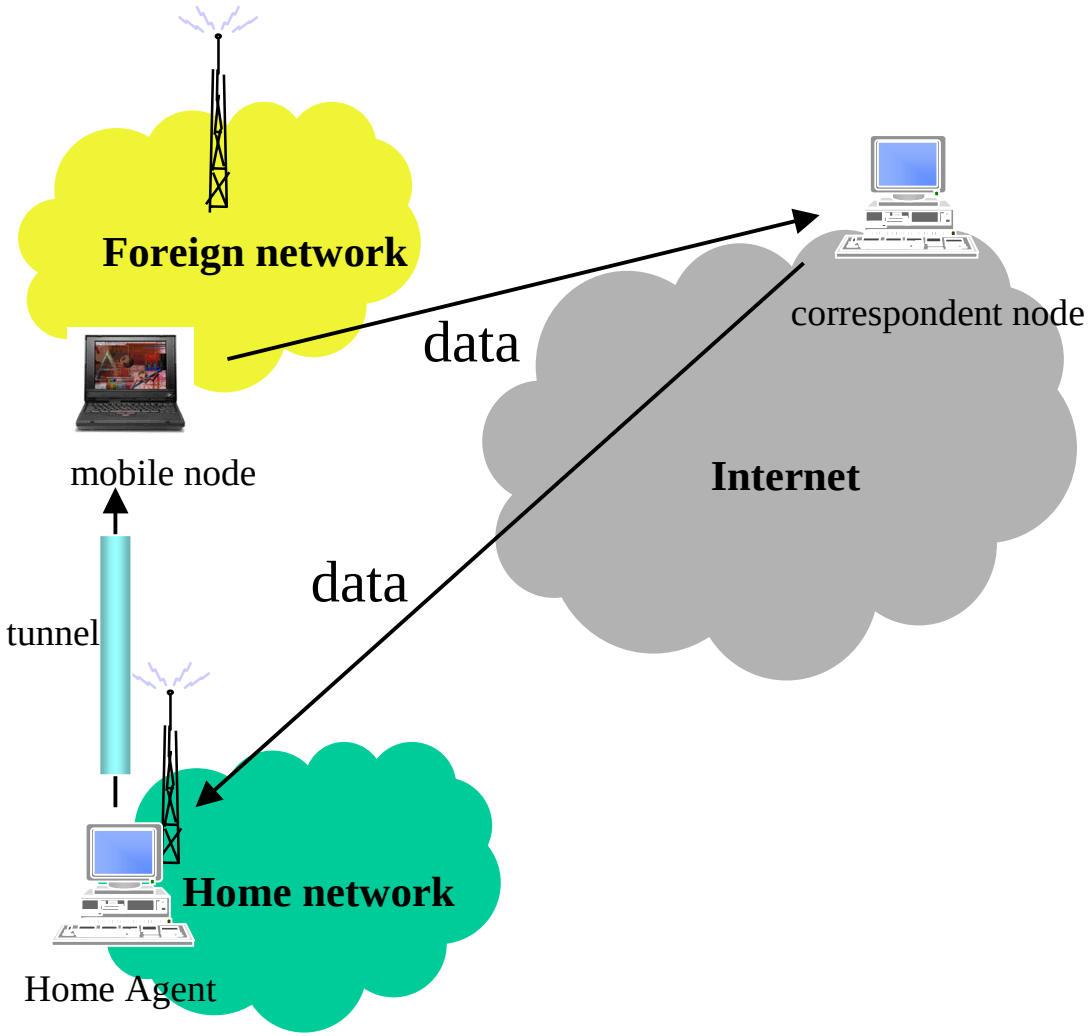
- Mobile node at home
  - **end2end communication**

Mobile IPv6 Operation



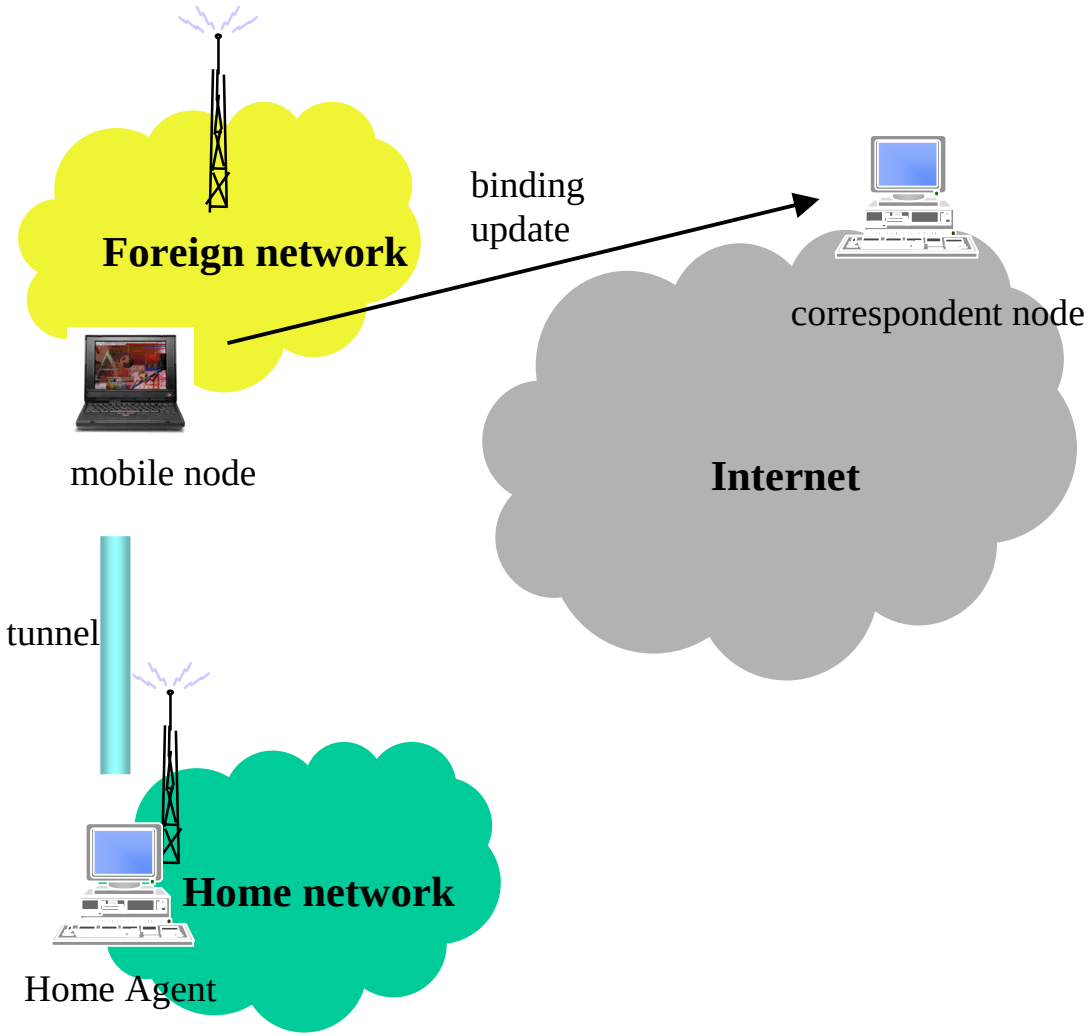
- Mobile node at home
  - **end2end communication**
- Mobile node moves to a foreign network
  - **Cannot communicate with correspondent node until…**
- Mobile node registers with home agent

Mobile IPv6 Operation



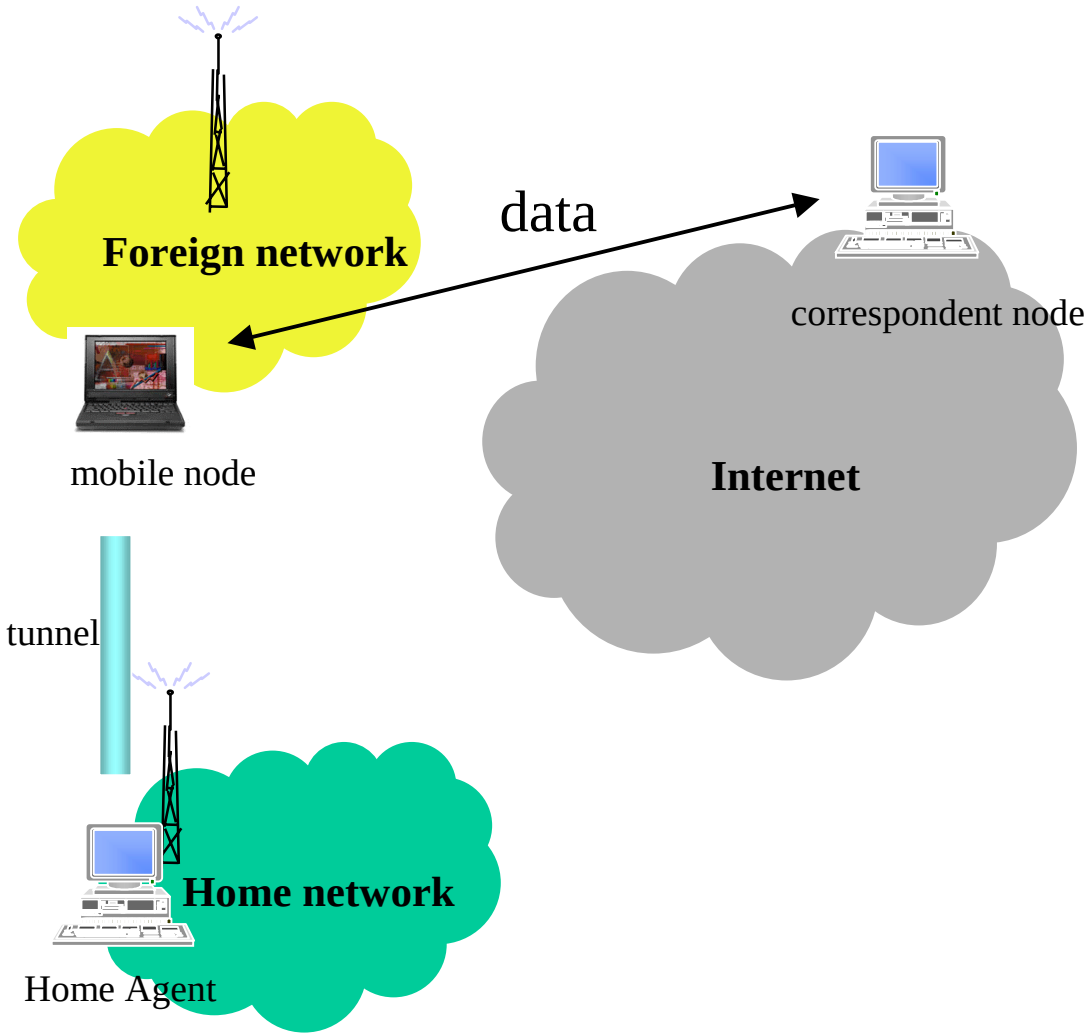
- Mobile node at home
  - **end2end communication**
- Mobile node moves to a foreign network
  - **Cannot communicate with correspondent node until…**
- Mobile node registers with home agent
- Tunnel is established
- Forward traffic
- Reverse traffic
- Mobile node away from home
  - **end2end communication**

Mobile IPv6 Operation



•Mobile node can also send binding updates to correspondent node

Mobile IPv6 Operation



- Mobile node can also send binding updates to correspondent node
- Route optimization
  - **no triangular routing**

Mobile IPv6 – A natural extension to IPv6

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IPv6 Header Extensions

Destination options header

Routing header

ICMPv6 Router Discovery

Router Advertisements
Router Solicitations

Stateful Address Autoconfiguration
Stateless Address Autoconfiguration

Neighbor Advertisement

Mobile IPv6 – A natural extension to IPv6

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MN makes its location known to HA (or CN)

CN sends packets directly to MN at new location

MN Connect to HL or FL? Moved to another FL?

MN Obtaining a care-of address

HA intercepts packet for MN

Mobile IPv6 – A natural extension to IPv6

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IPv6 Header Extensions

MN makes its location known to HA (or CN)

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Neighbor Advertisement

Mobile IPv6 – Mobile IPv4 Comparison

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- Huge address space of IPv6 makes MIPv6 deployment more straightforward.
- No Foreign Agent in Mobile IPv6
- MIPv4 is not deployed widely enough to satisfy current mobility needs
  - Shortage of globally routable IPv4 address
  - Use of Private IPv4 addresses with NATs hampers MIPv4 deployment in many cases.
- IPv6 autoconfiguration simplifies the CoA assignment for mobile node.
- Optimised routing built-in: MIPv6 avoids triangular routing

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Mobile IPv6
Current Development areas

Fast hand-off

LMM (Localized Mobility Management)

AAAv6

QoS

Fast Hand-off

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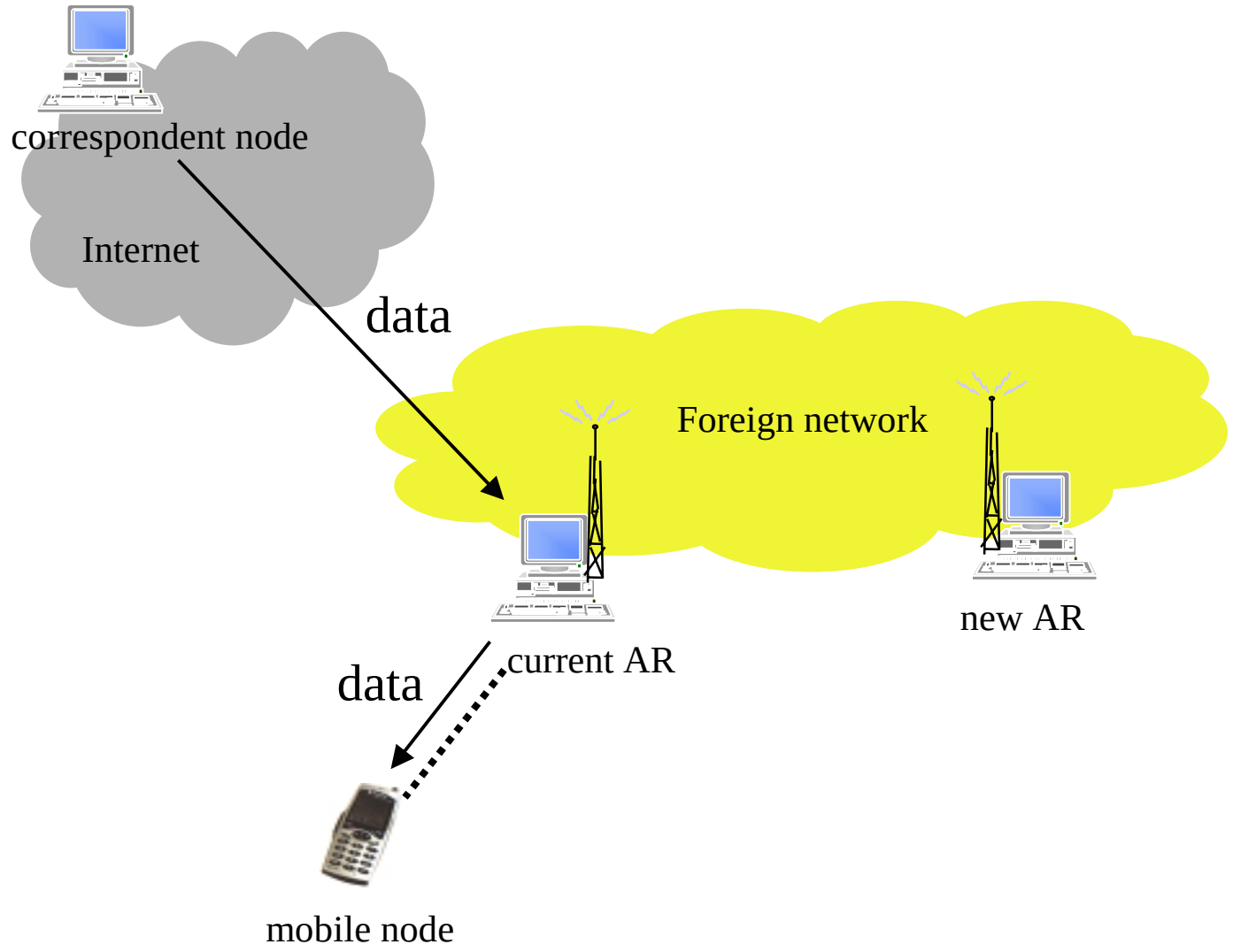
- Minimize latency and packet loss due to hand-offs
  - Critical for real-time services (audio, video)
- Mobile Node (MN) is not connected until it
  - Acquires a new ”care-of address” (CoA)
  - Registers with Home Agent
- To understand the problem space – let’s look at the current proposed solution (work in progress)
  - Mobile Node gets a new CoA and link parameters before hand-off
  - New Access Router (AR) gets ready to serve MN
  - As soon as MN leaves the current link, old AR starts forwarding traffic to new AR.

Fast Hand-off (current proposal)



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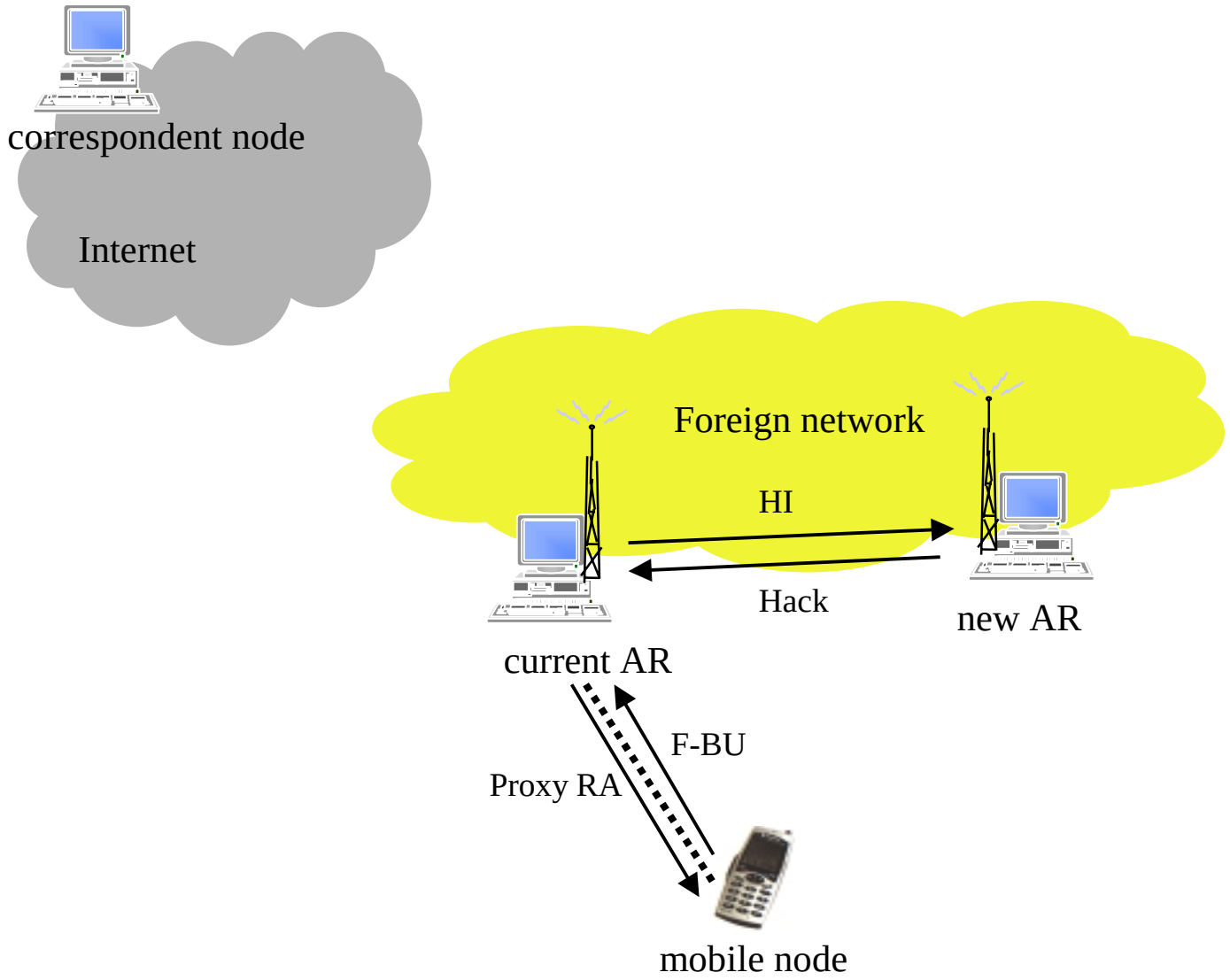

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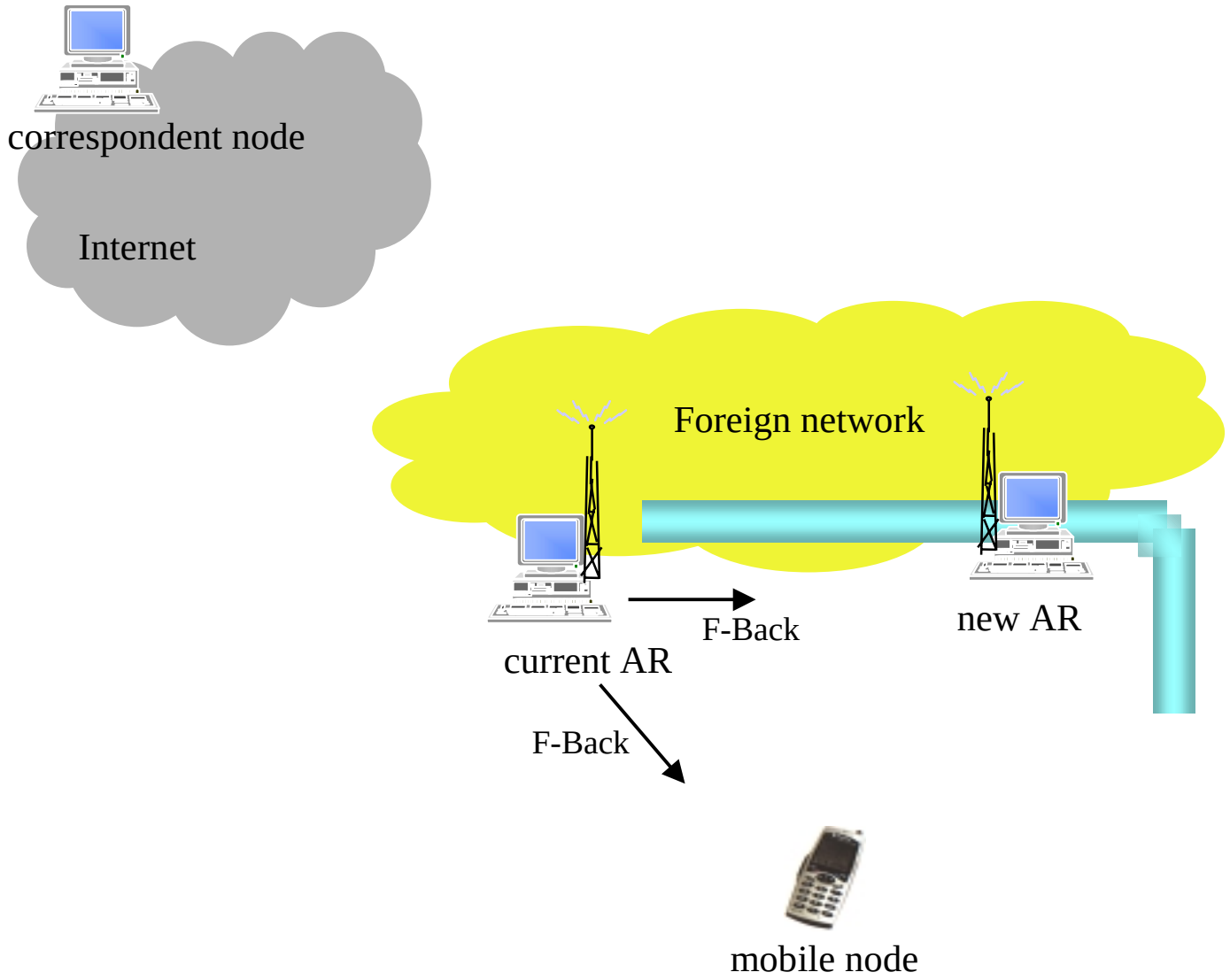

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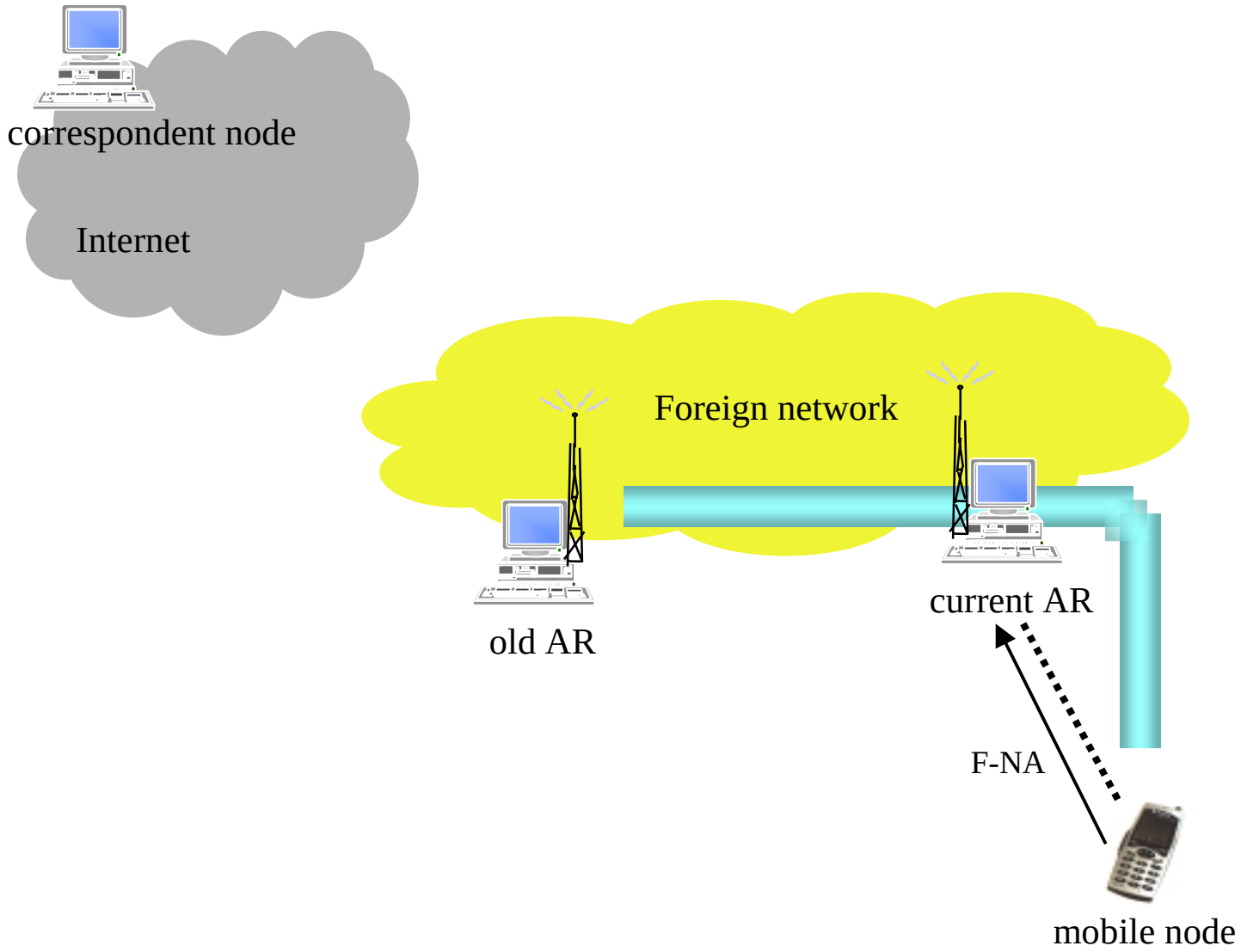

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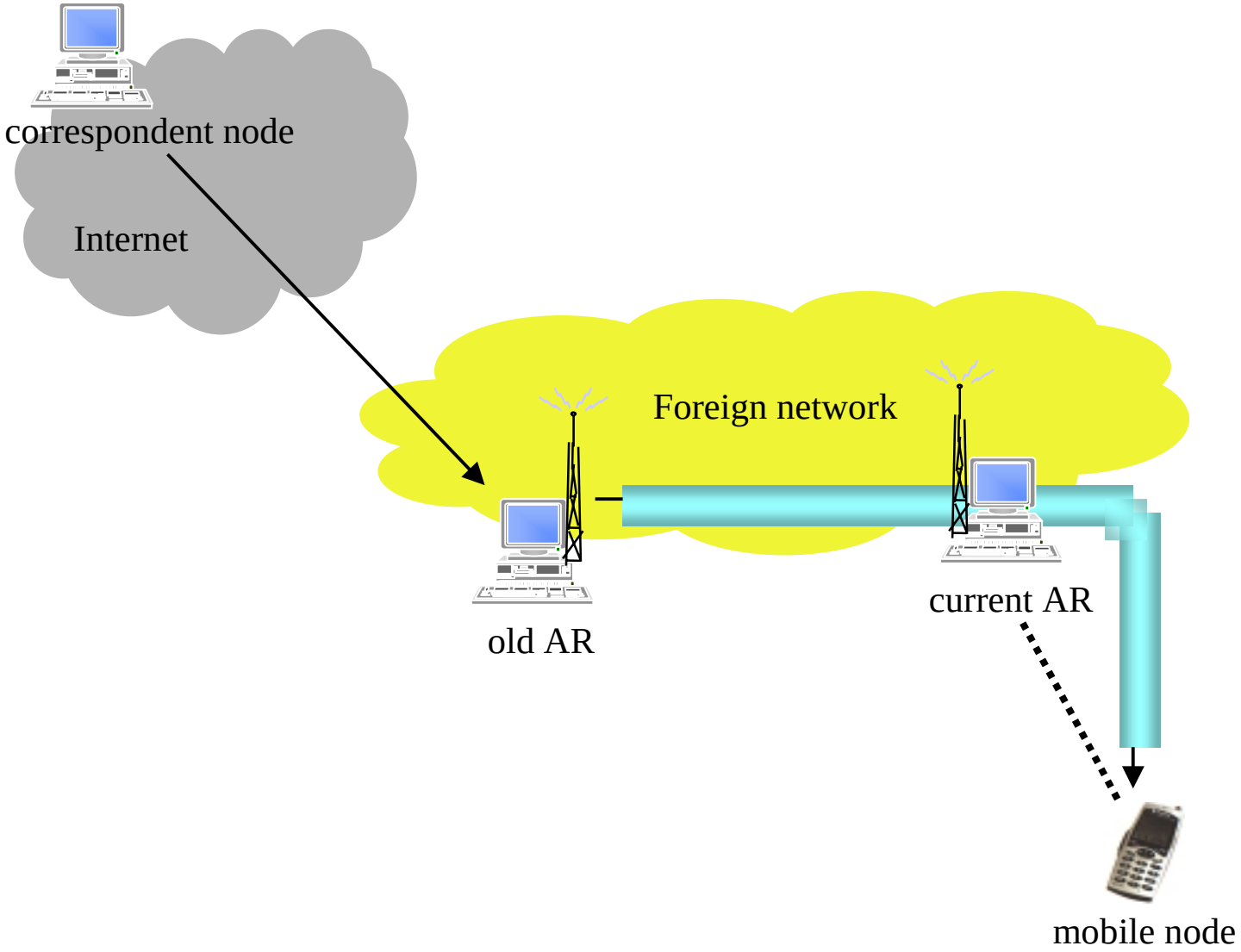
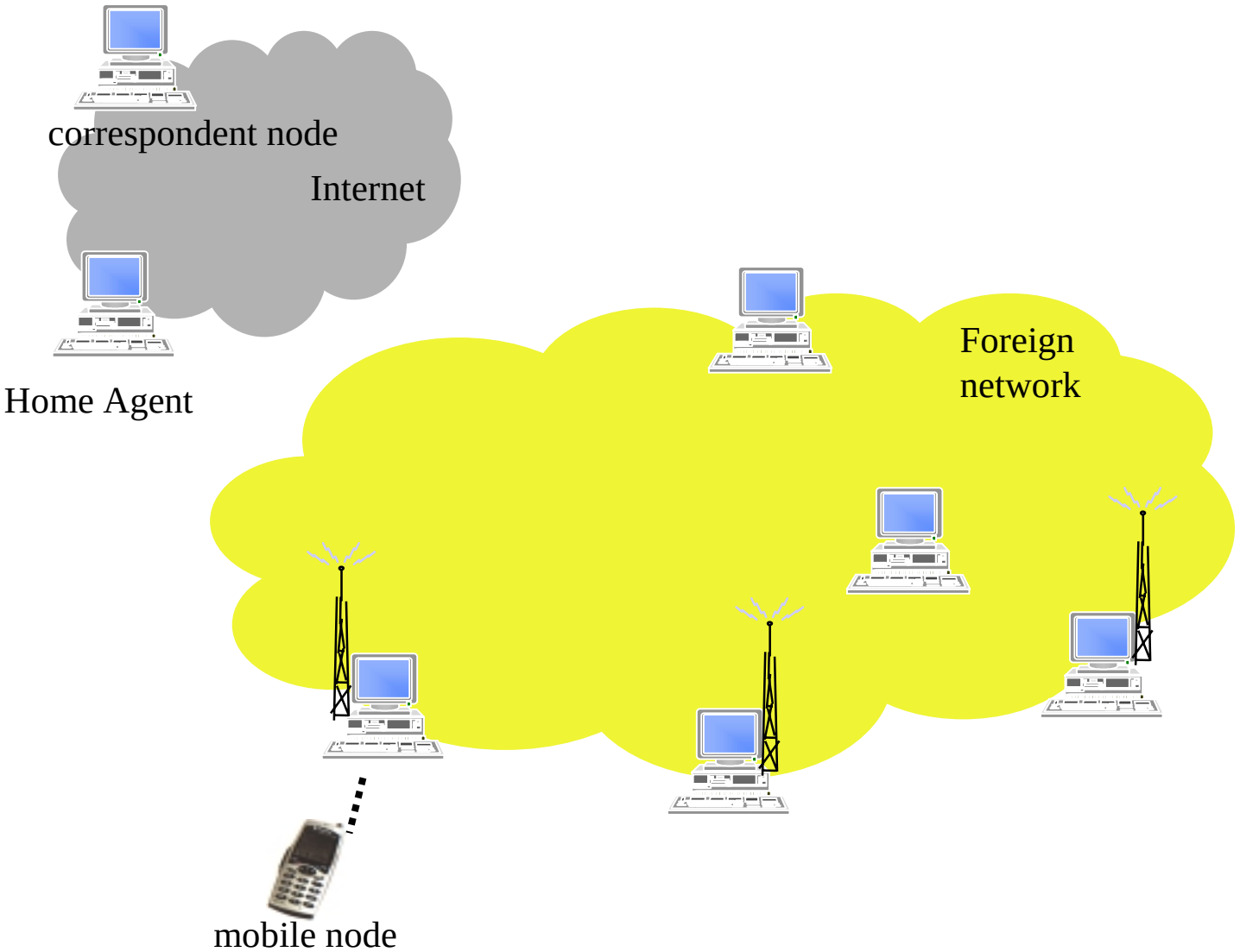


Localized Mobility Management



Localized Mobility Management

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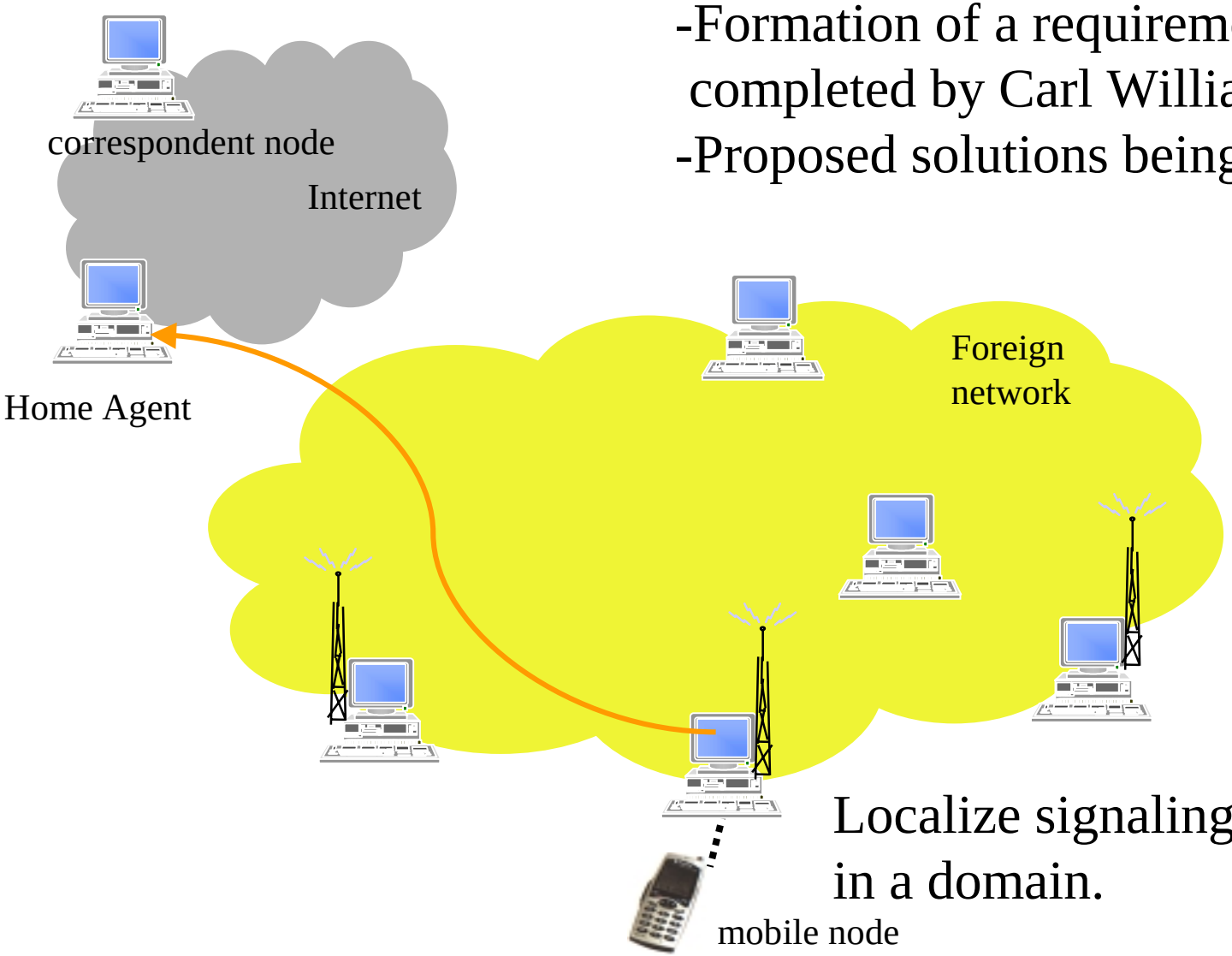
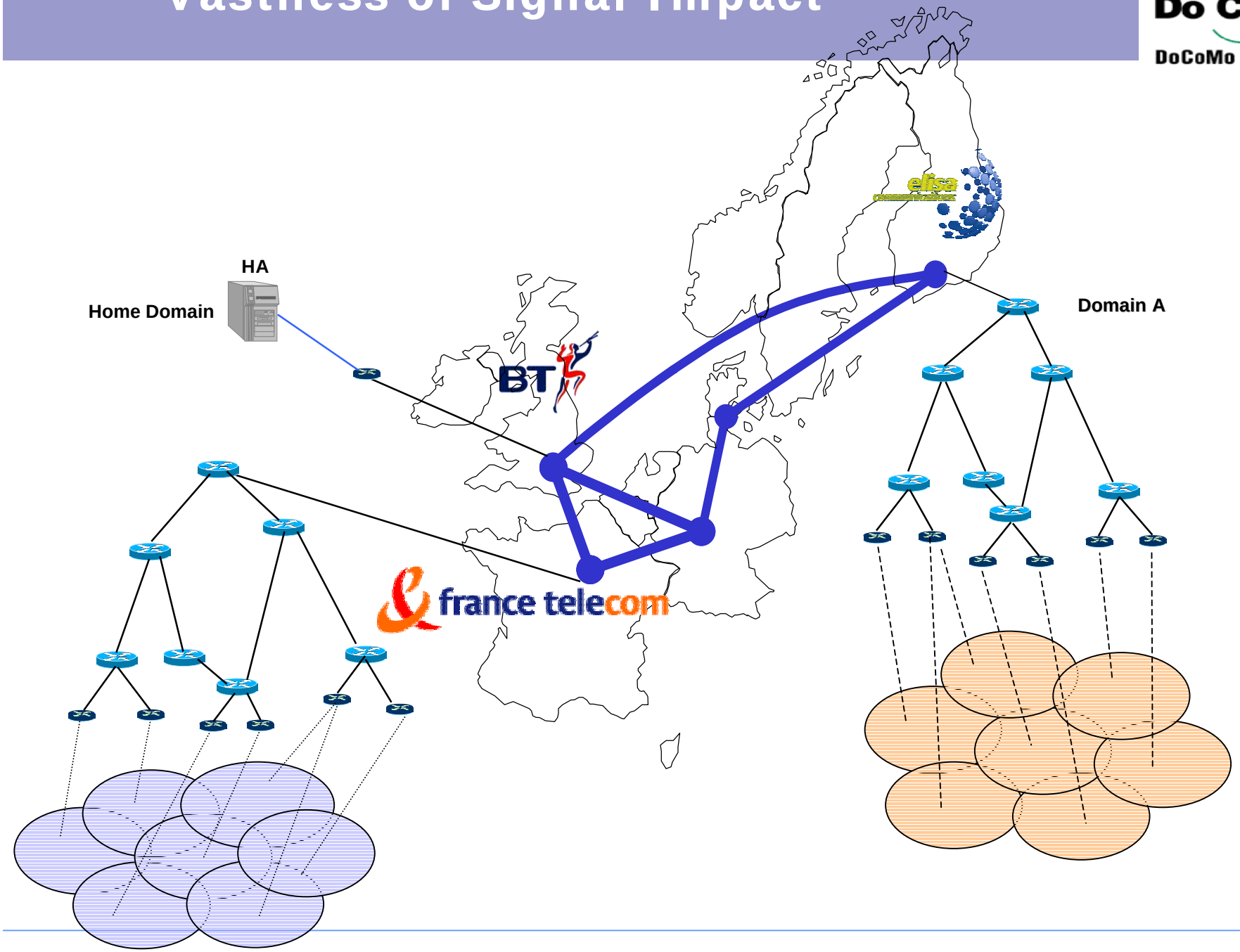
IETF MIP W.G. Status on LMM
-Formation of a requirements document completed by Carl Williams (DoCoMo)
-Proposed solutions being discussed.



Localize signaling when moving in a domain.

Vastness of Signal Impact



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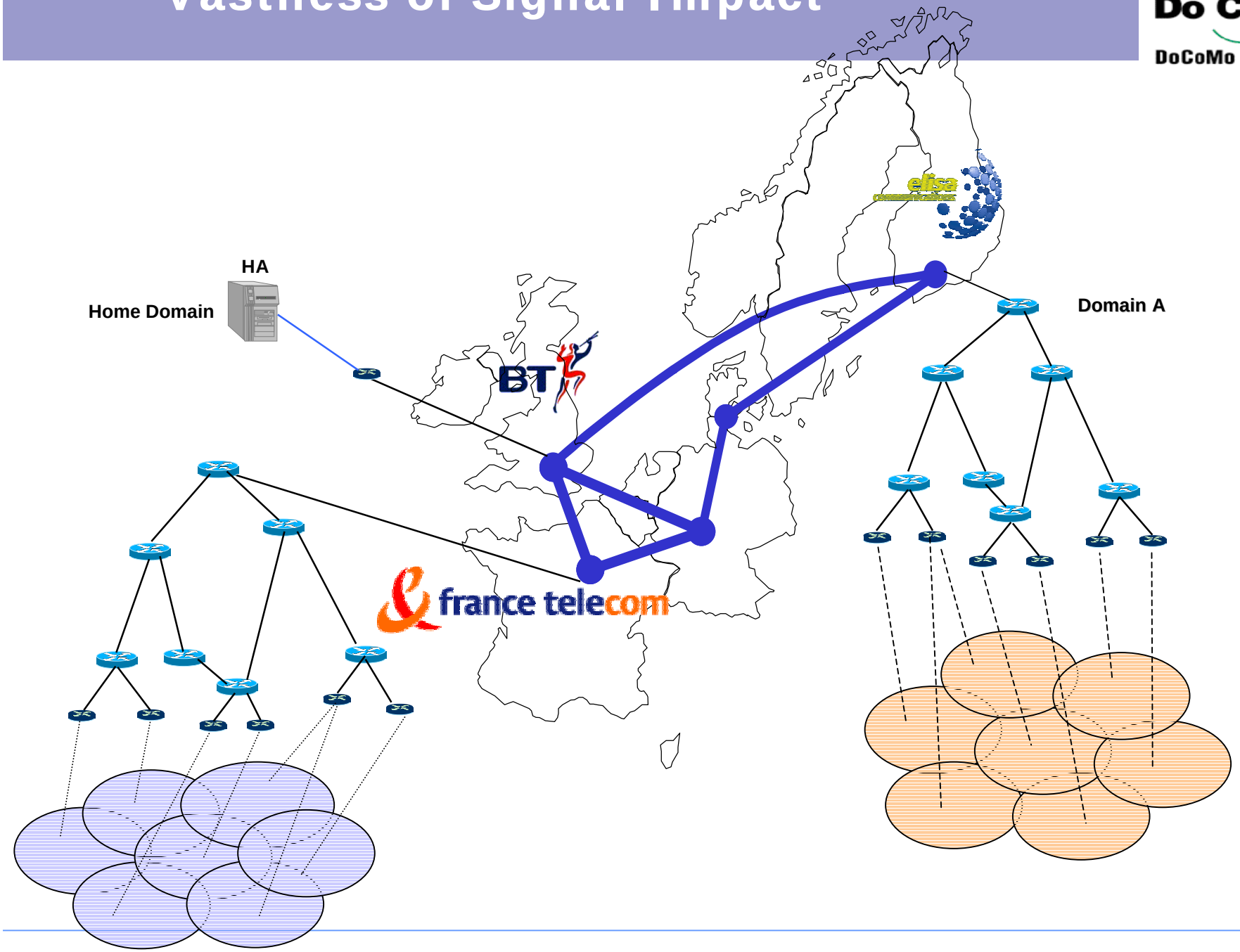

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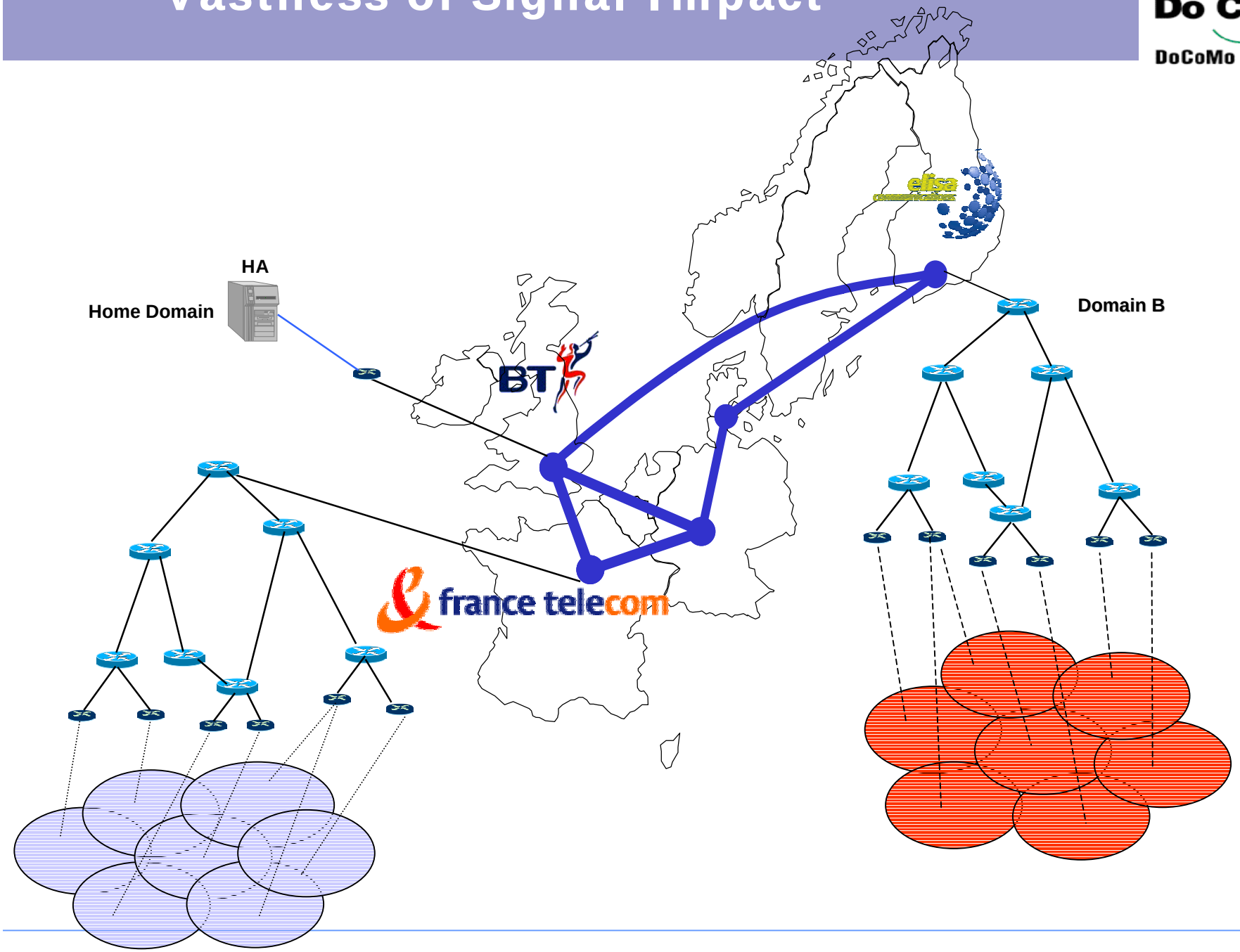

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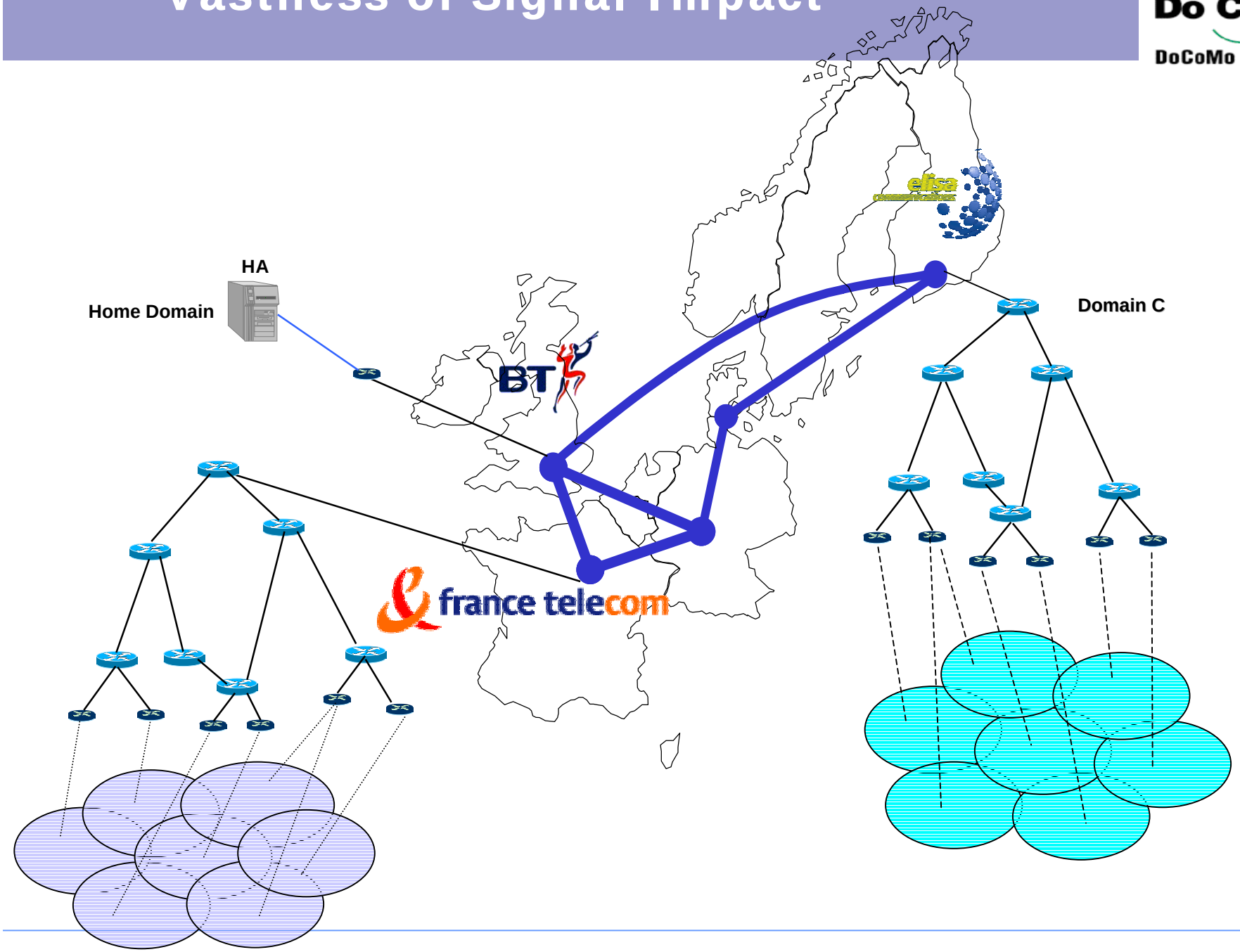

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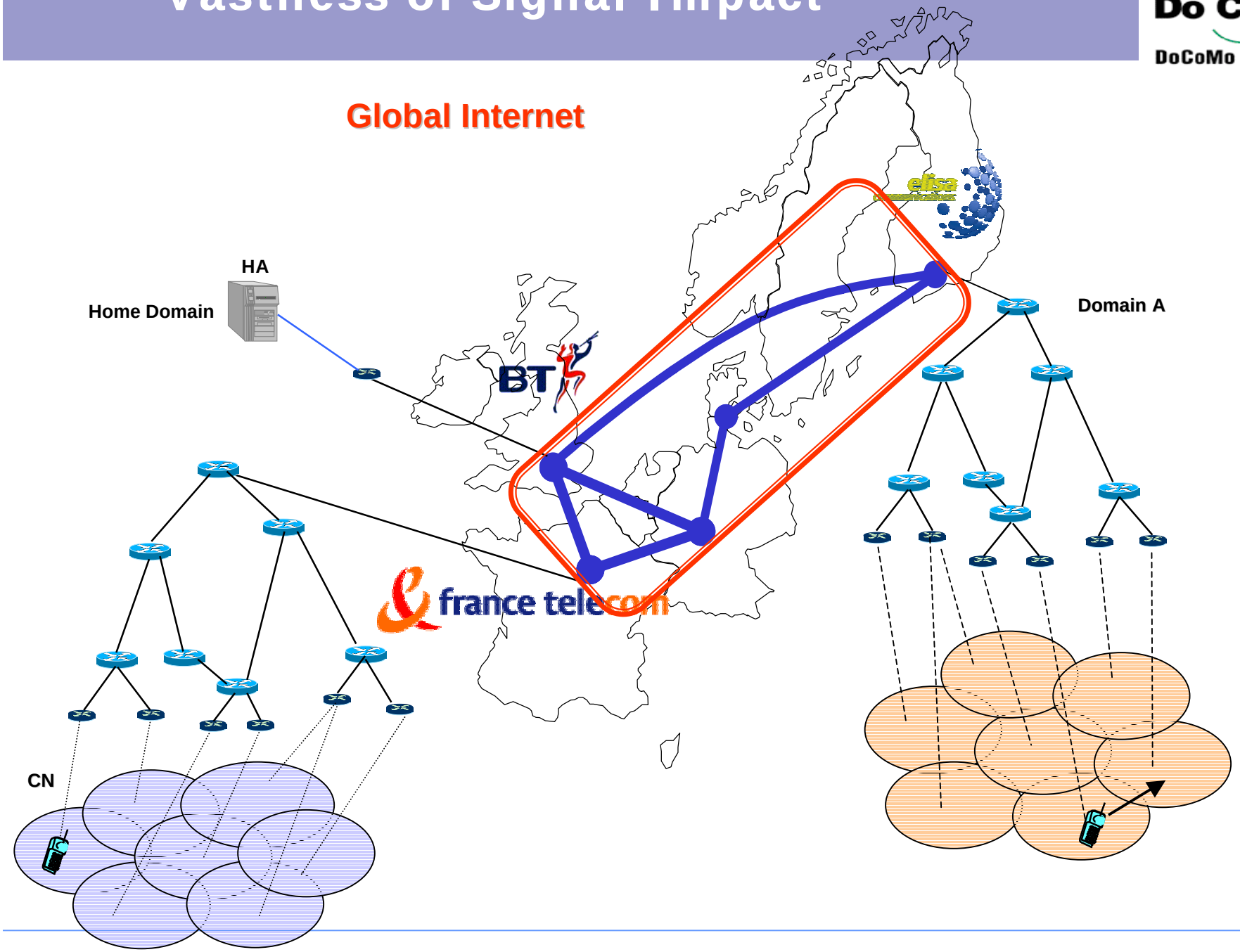

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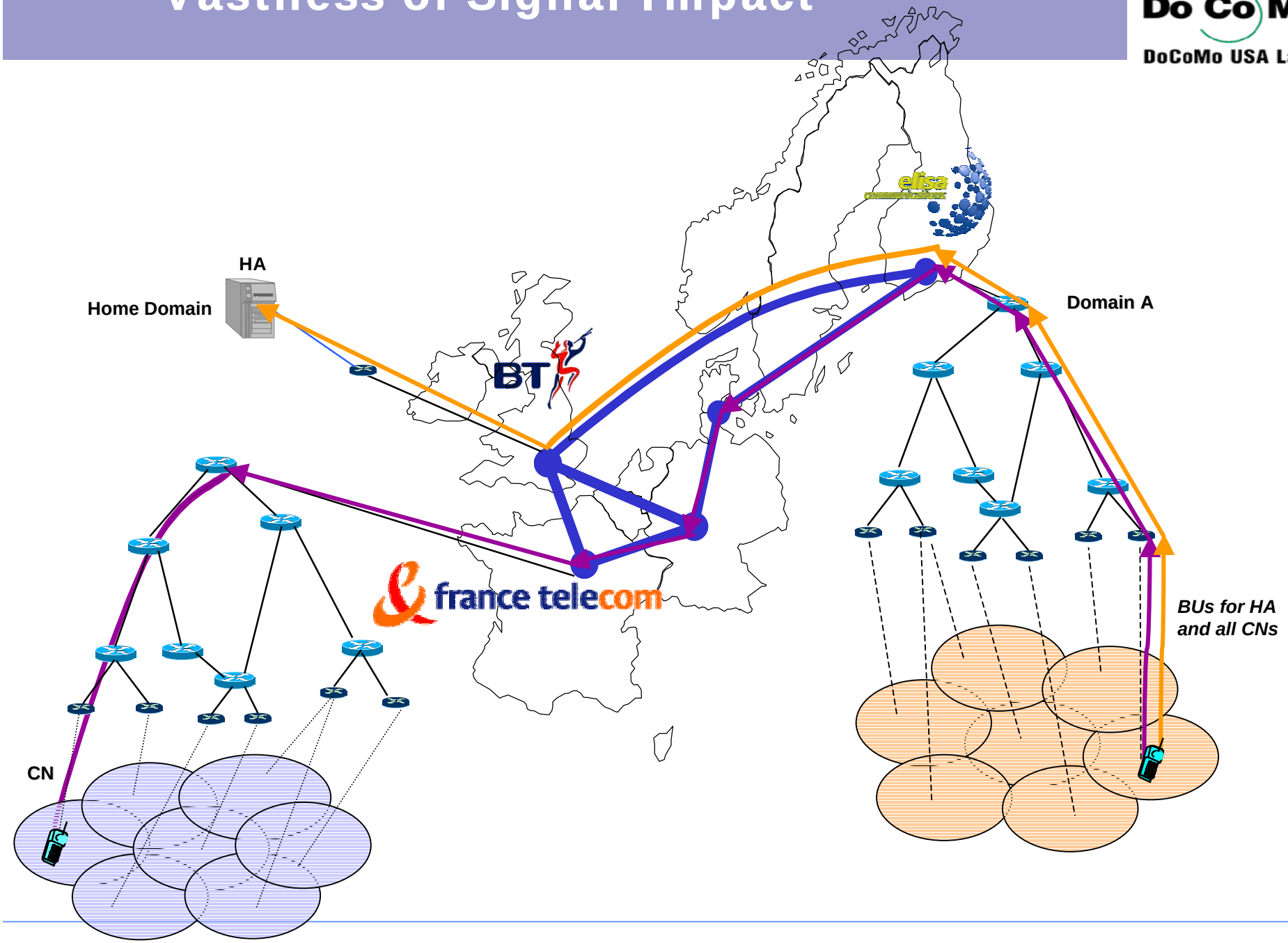

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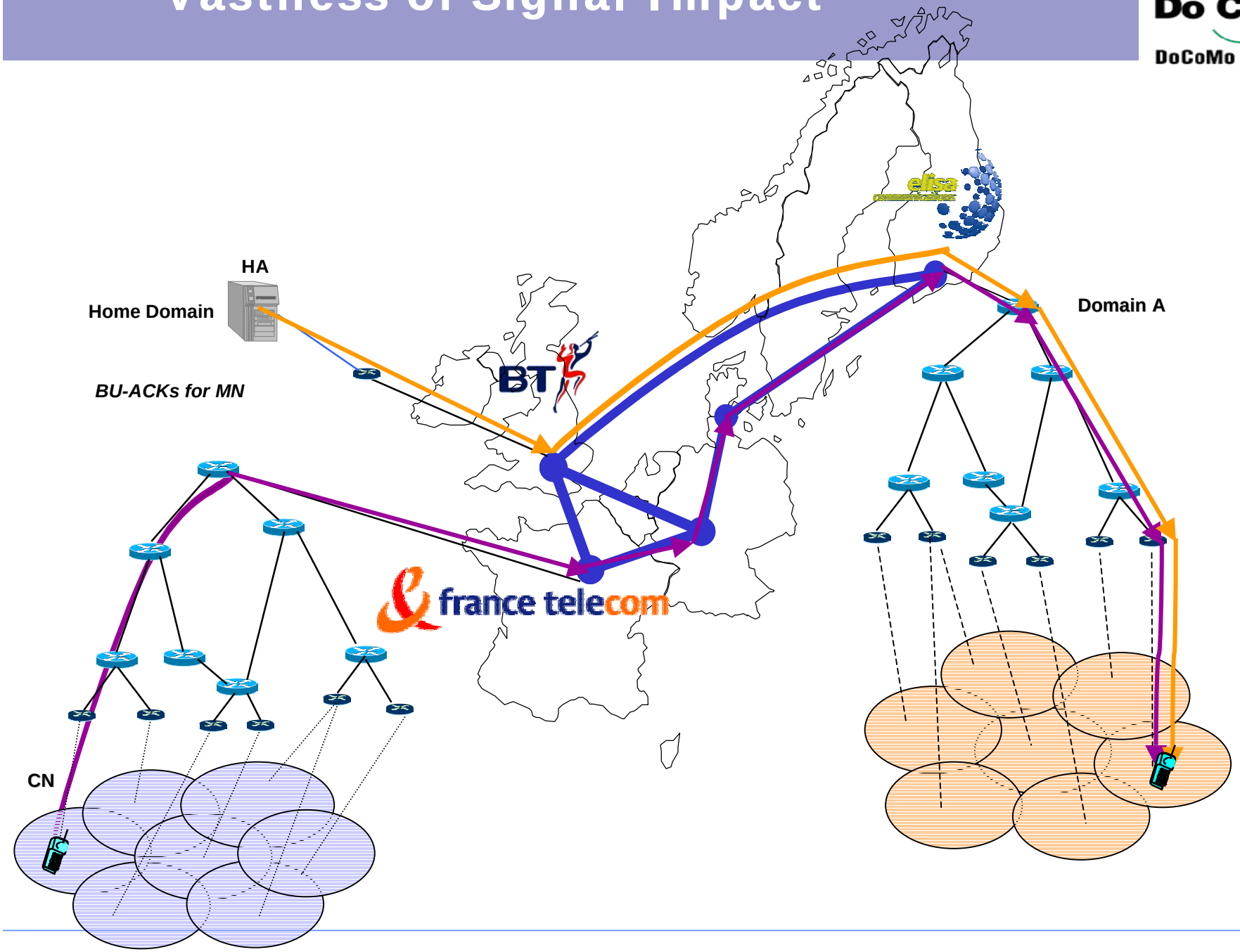

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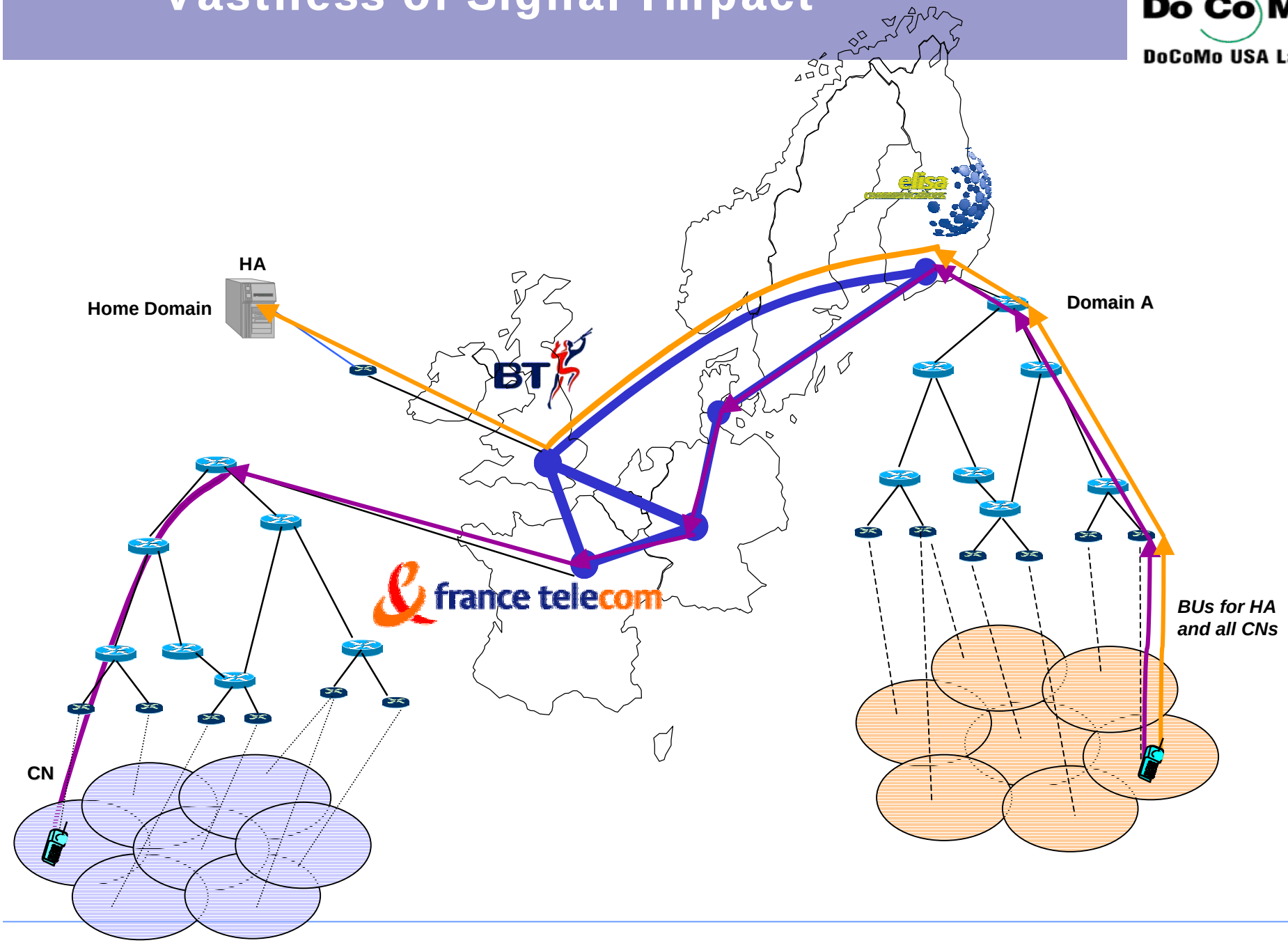

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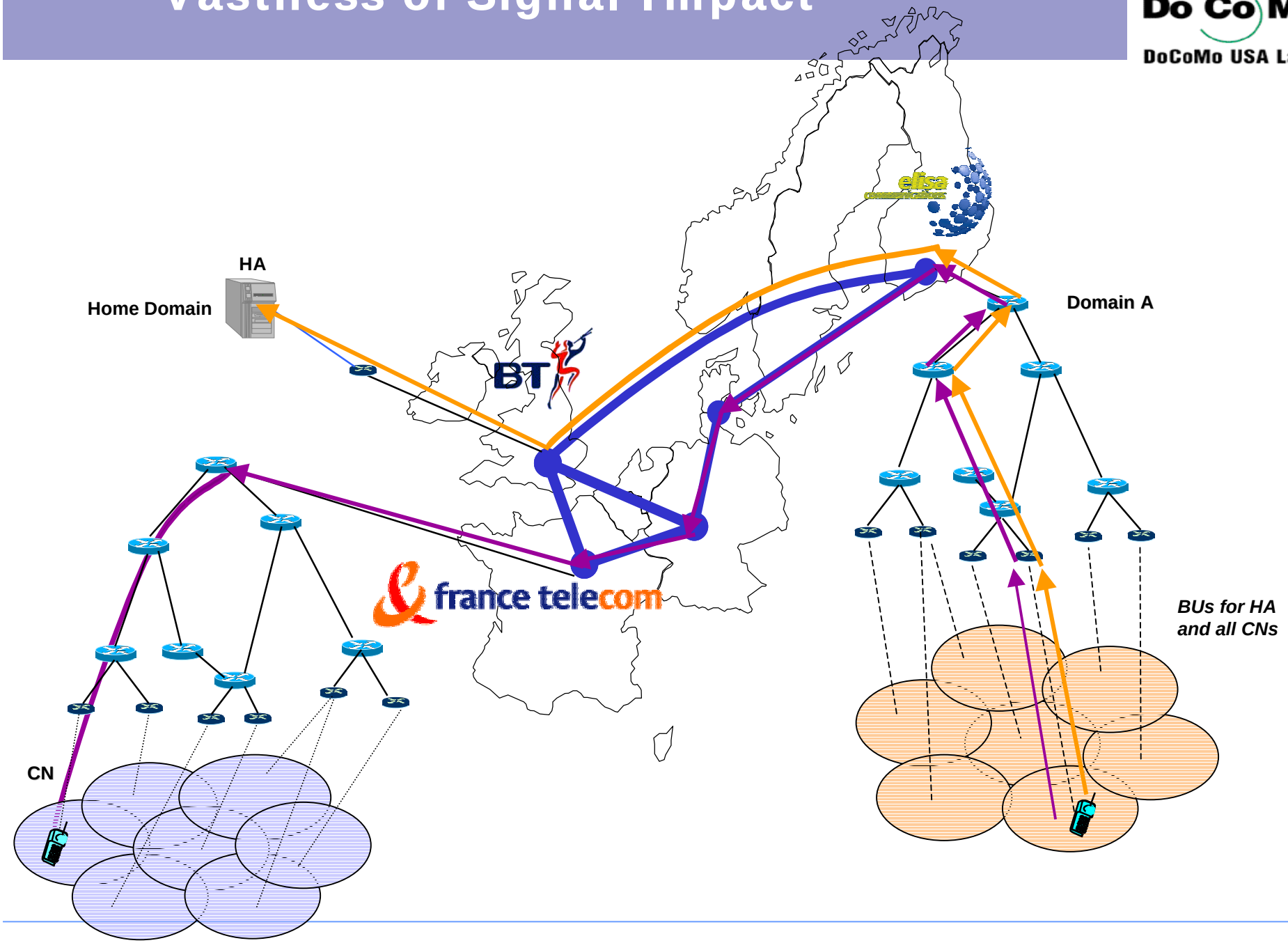


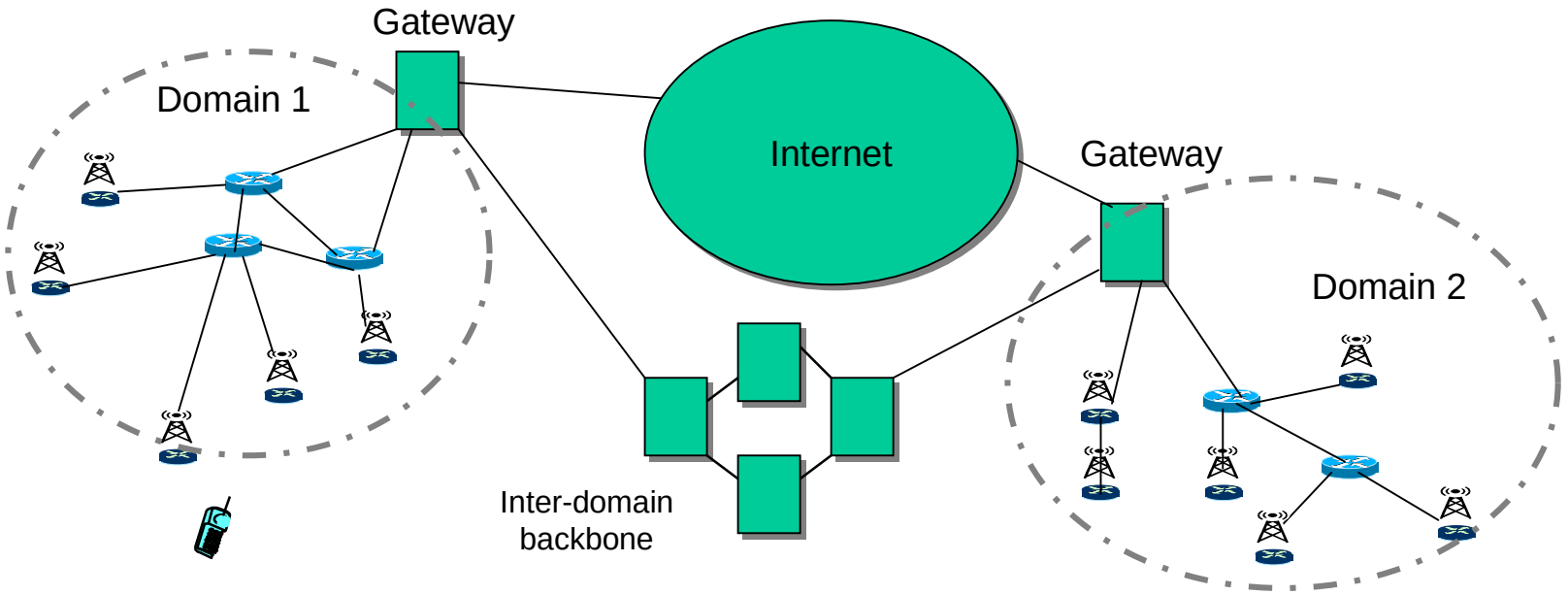
Micro-mobility for Mobile IPv6

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.



Expected Mobility Landscape Model

Mobile IPv6 Micro-mobility

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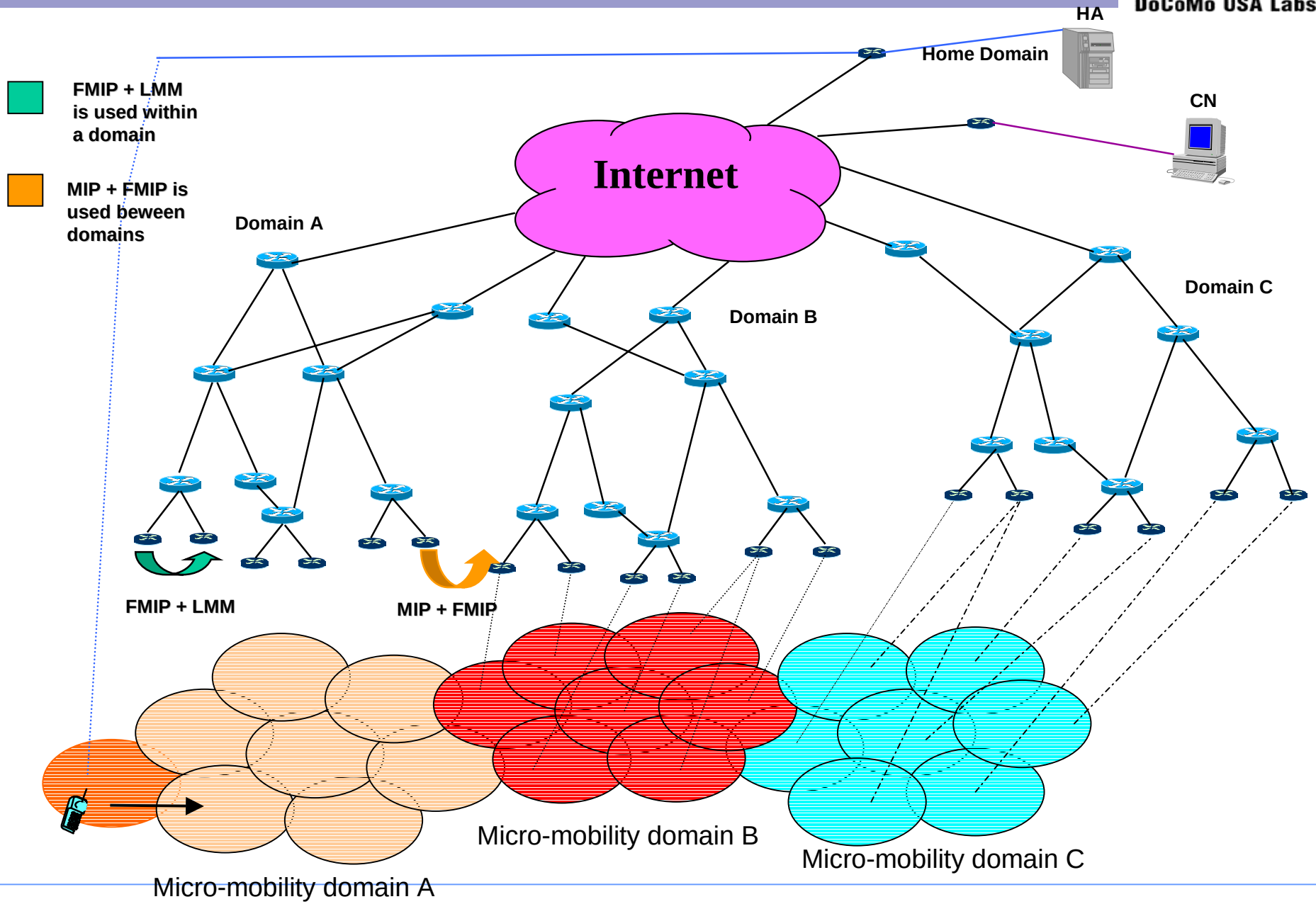

AAAv6 and QoS Status

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- **Mobile IP/AAA Status**
  - **DIAMETER has been selected for IPv4, and thus for IPv6 unless there is some unforeseen technical barrier.**
  - **AAAv6 Inernet Draft(s) submitted.**
  - **Stateless and stateful variations.**
  - **Access control needed at neighbor cache.**

- **QoS (Next Steps in Signaling (nsis) IETF Working Group)**
  - **Important in mobile environments for VoIP, etc.**
  - **QoS interruption is possible during MIP handover time. This interruption should be minimal.**
  - **IETF is working on producing generic QoS requirements for Mobile IP, that applies to both Mobile IPv4 and Mobile IPv6.**

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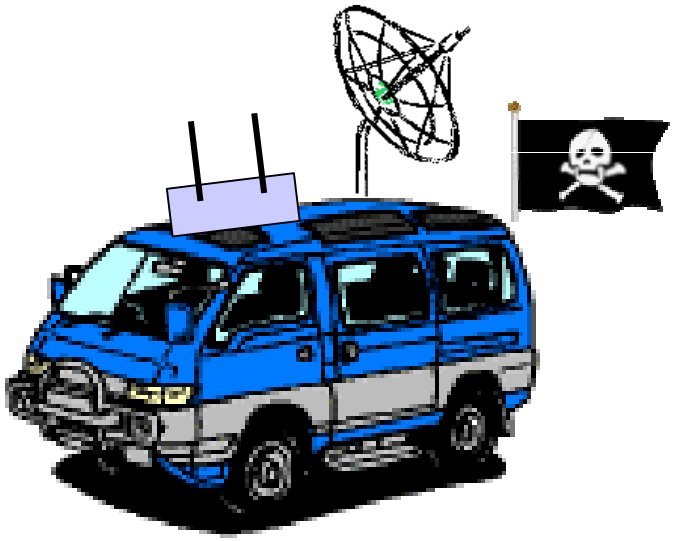
Other IPv6 wireless/mobility related IETF efforts

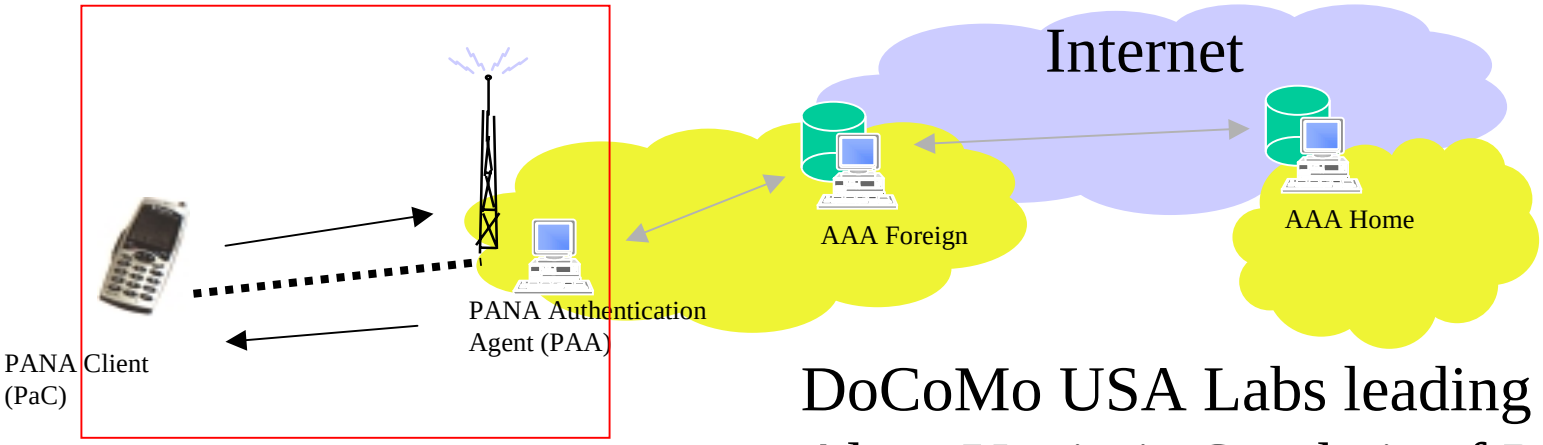
Secure Network Access



Modern Day Pirates

PANA Working Group

- Protocol for Carrying ***Authentication for Network Access***
- To define a IP-layer (e.g., IPv6) carrier for authentication and basic authorization process
  - Link-layer independent
- Part of ALL-IP architecture



DoCoMo USA Labs leading effort.
Alper Yegin is Co-chair of PANA

Other IPv6 IETF wireless activities

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- MONET (Mobile Networks) BOF
  - Focus on IPv6 Mobile Networks
  - Concern with situations where an entire network changes it point of attachment to the Internet and thus its reachability in the topology.

- MANET (Mobile Ad-hoc Networks)
  - Status: Number of Mobile Ad-hoc solutions defined. Possible advancement to experimental documents.
  - Working on more further out mobility issues (research?)

- L2 Triggers BOF
  - Pre-BOF to be held at IETF-53 on Monday evening at 10:00pm.
  - Discuss L2 triggers for wireless/mobility needs

Seamless Mobility IETF Working Group

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- For Seamless Mobility (SEAMOBY)
  - Context transfer between edge device
    - AAA information
    - Security context
    - QoS
    - Header Compression Information
  - IP Paging
    - Dormant node host alert
  - Micro-mobility
    - Local mobility protocol in a smaller domain
    - This work is transferred to IRTF.

Positioning L2 vs. L3

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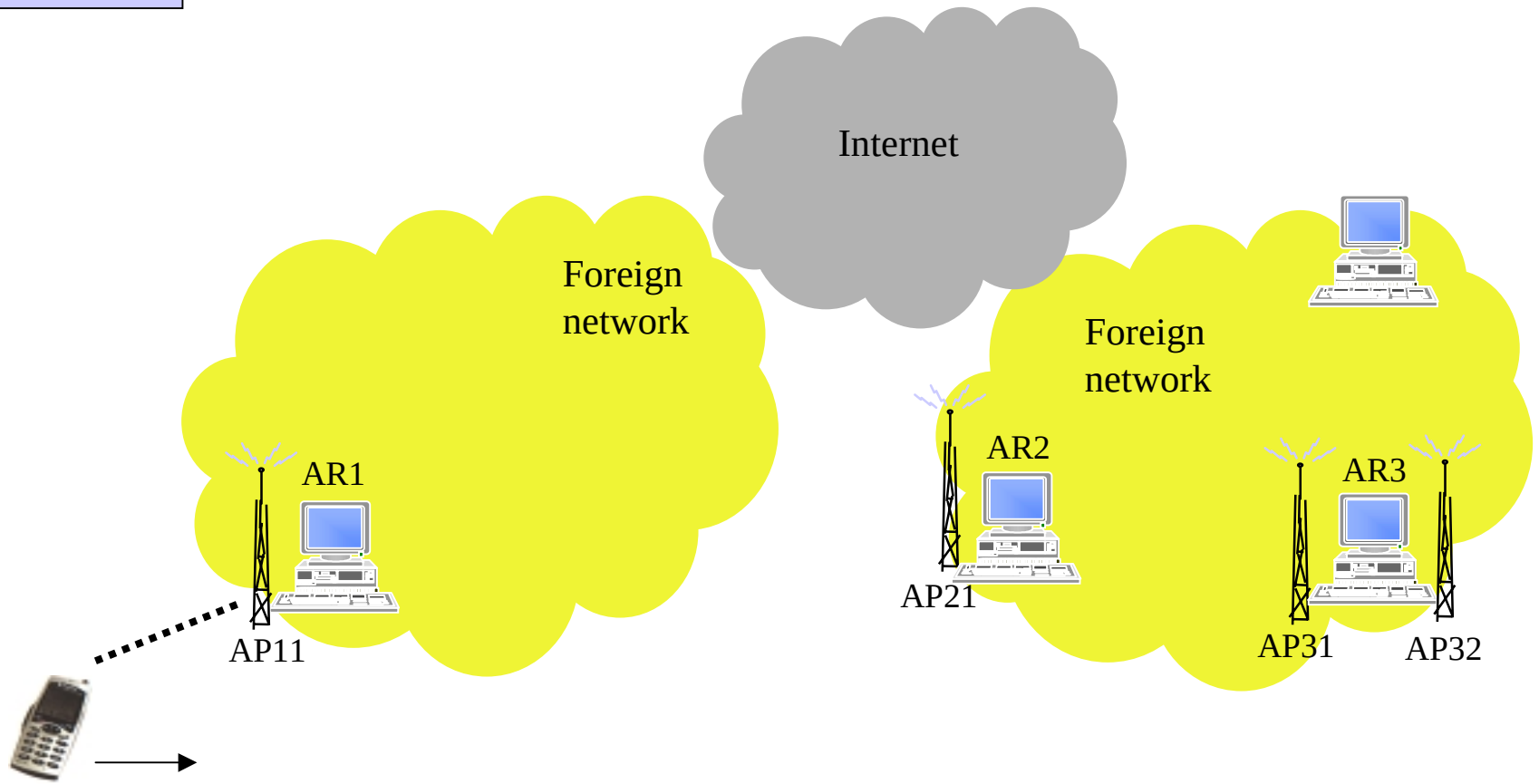
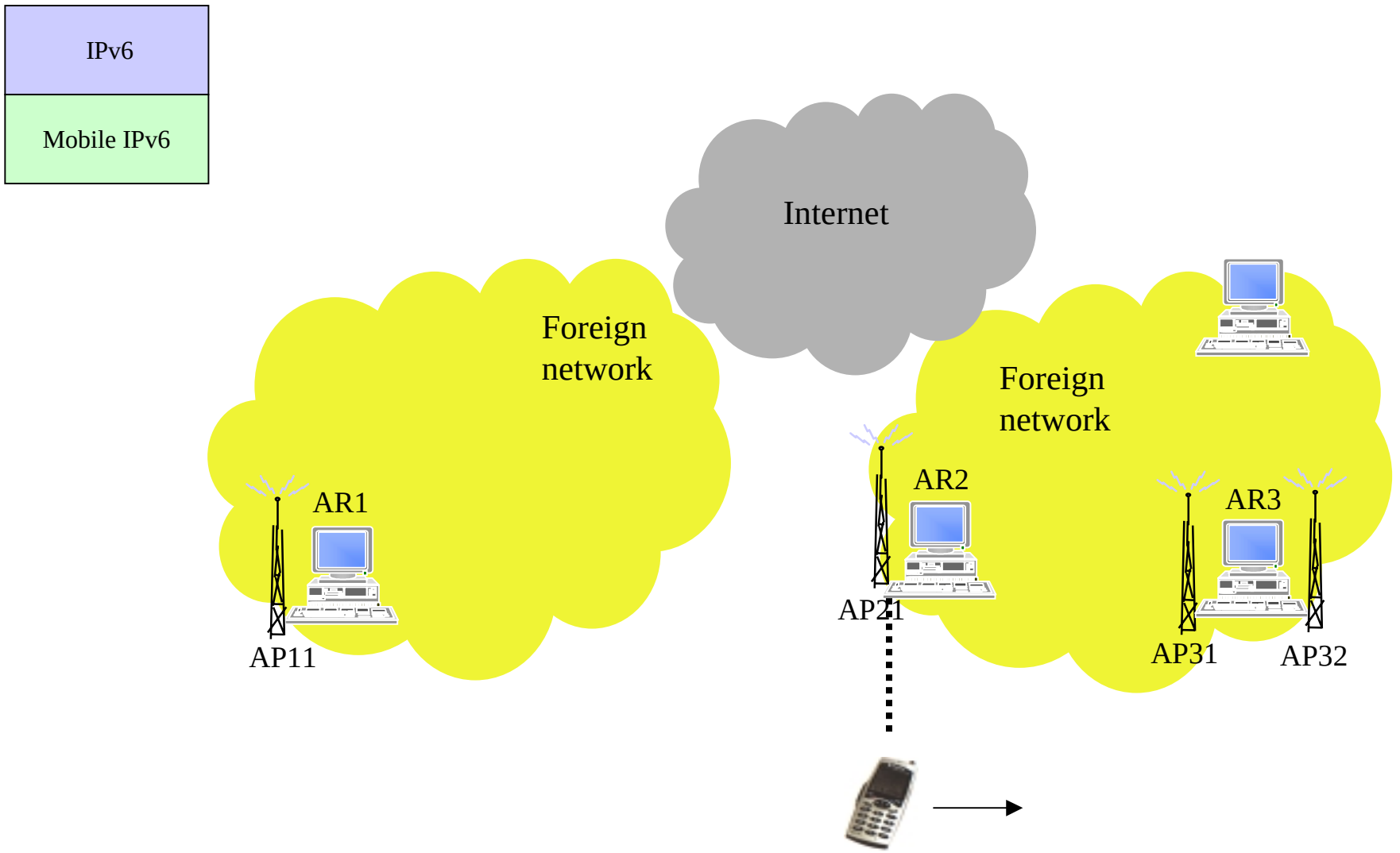
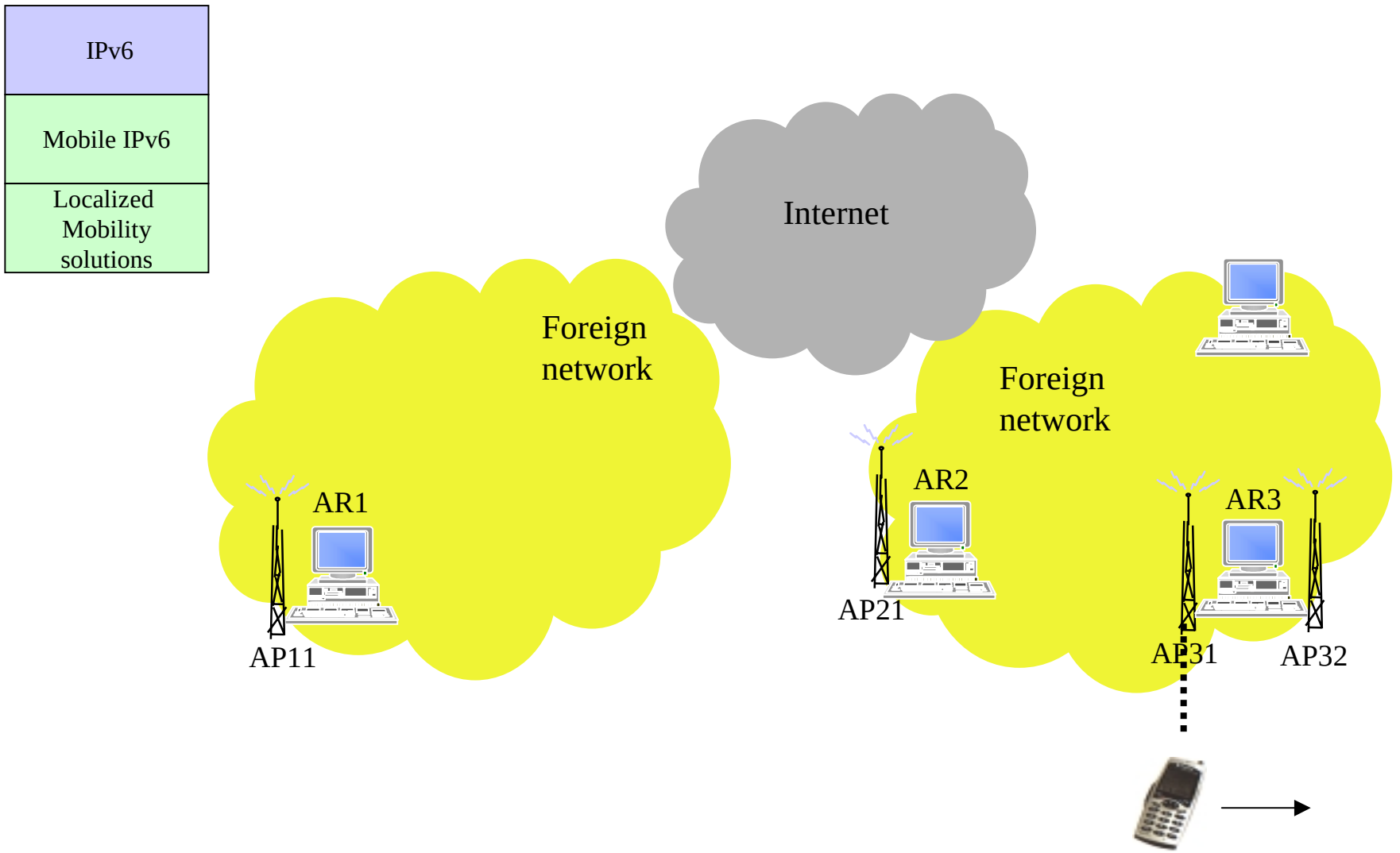
IPv6



Positioning L2 vs. L3



Positioning L2 vs. L3



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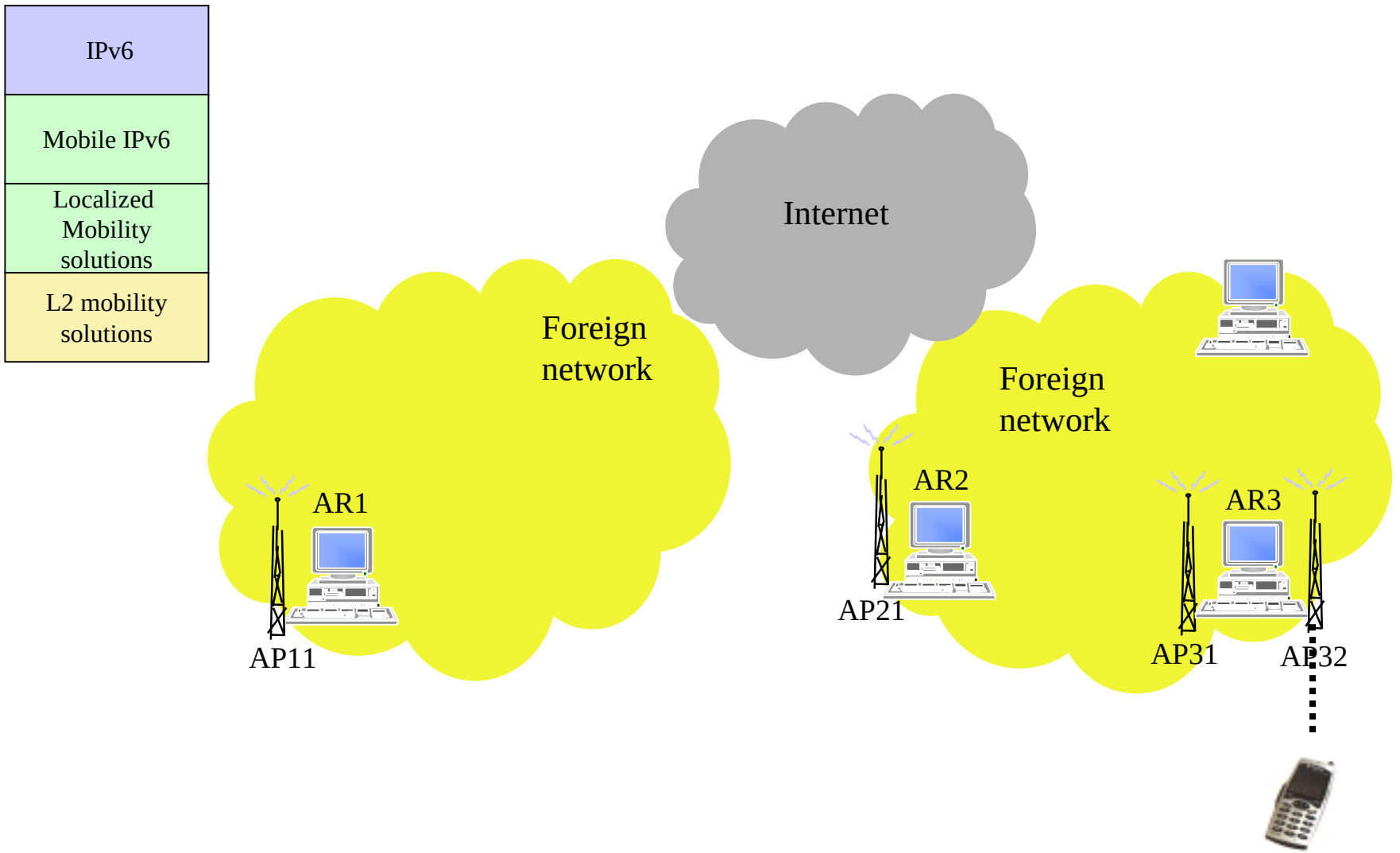

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Mobile IPv6 Implementations

State of Mobile IPv6 Implementations

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- Nokia

- Nokia adopted Mobile IPv6 for cellular phone
- Mobile IPv6 Home Agent

  http://press.nokia.com/PR/20010/806305_5.html

  http://www.nokia.com/

- Ericsson
  - Ericsson Radio: Mobile IPv6 Home Agent, Mobile node, and Correspondent node (BSD). Releases of source code with KAME IPv6 snapshots.
  - Ericsson Telebit: Mobile IPv6 (home agent) router
  - Mobile IPv6 research information will soon be posted at:

    http://v6lab.net/

State of Mobile IPv6 Implementations

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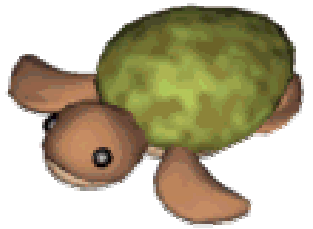
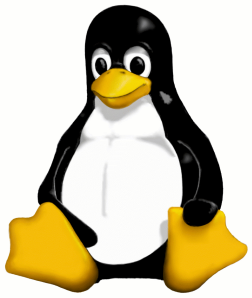
- KAME (UNIX BSD)
  - Ericsson prototype delivered with KAME main snapshots. KAME MIPv6 will eventually be Ericsson/NEC/Keio chimera.
  - Kame is publicly available (with MIPv6) at:

    http://www.kame.net



- University of Helsinki (Linux)
  - Mobile IPv6 Home Agent Available at:

    http://www.mipl.mediapoli.com



- Keio University (UNIX BSD)
  - Mobile IPv6 MN/CN/HA implementation (code soon to be released). Part of WIDE project.
  - Will coordinate/merge with KAME – soon.....

    http://neo.sfc.wide.ad.jp/~mip6

State of Mobile IPv6 Implementations

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- **Sun Microsystem (Solaris)**
  - **Solaris Mobile IPv6 Correspondent Node prototype**
  - **Mobile IPv6 Correspondence Node will be included as part of Solaris in calendar year 2002.**

  http://www.sun.com/solaris/ipv6

- **Compaq**
  - **Compaq Mobile IPv6 Correspondent Node early adopter kit (EAK) soon to be available for download.**
  - **Compaq Mobile IPv6 Correspondence Node will be included as part of Compaq AlphaServer in CY2002.**

  http://www.compaq.com/ipv6

COMPAQ
Inspiration Technology

State of Mobile IPv6 Implementations

DoCoMo USA Labs

- **Microsoft**

  - Mobile IPv6 Correspondent Node in Windows 2000 tech preview and Windows XP product release later this year.

  - Microsoft Home Agent and Mobile Node support being done in collaboration with Lancaster University.

  http://msdn.microsoft.com/downloads/sdks/platform/tpipv6.asp

- **Siemens**

  - Siemens Testbed Implementation includes IPv6 Mobility agents and hosts based on Linux-based solutions.

  - For information on Linux-based Mobile IPv6 solutions see:

  http://www.li.org/

State of Mobile IPv6 Implementations

NTT DoCoMo
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- **Lancaster University, Lancaster, UK**
  - Collaborative effort with Microsoft
  Beta versions of the code freely downloadable:
  http://www.cs-ipv6.lancs.ac.uk/ipv6/MobileIP

State of Mobile IPv6 Implementations

DoCoMo USA Labs

- NEC 
  - Mid-capacity core router will suport Mobile IPv6
  - NEC has mobile node and home agent source code that is released on KAME site at:

http://www.6bone.nec.co.jp/mipv6/internal-dist/

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Mobile IPv6 Interoperability

Mobile IPv6 Interoperability

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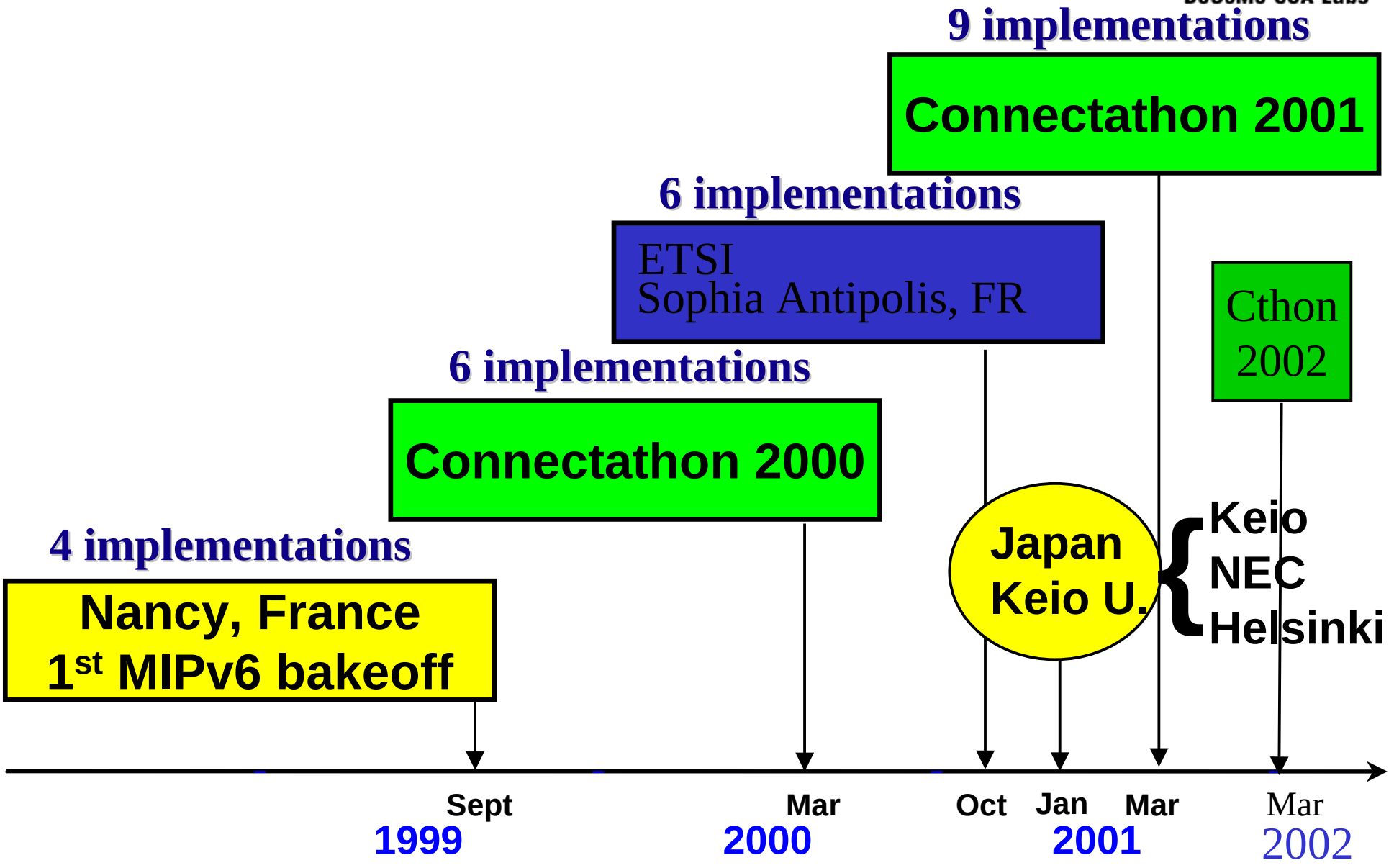

Mobile IPv6 Interoperability

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Connectathon Report (2001)

www.cthon.org

March 5th- 8th
San Jose, CA

9 Mobile IPv6 Implementations
44 engineers working on Mobile IP technology

Mobile IPv6 Conformance Test suites (3 present)

Tahi
- 22 Home Agent tests
- 6 CN tests

Ericsson-Hungry
- TTCN-3 based
- CN/HA tests

University of New Hampshire
- Packet Shell based tests
- CN and HA tests

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From these Mobile IPv6 bake-offs it is the consensus from the implementers [independent of securing binding updates] that:

Mobile IPv6
IS
STABLE

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Upcoming Mobile IPv6 Bake-offs

ETSI

Fall 2002: ETSI, Sophia Antipolis, France

Held Annually in Early March, San Jose, CA

Mobile IPv6 Industry Initiatives (sample)

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ERICSSON SmarTone BT

Smart trails

- Collaboration between BT, SmarTone and Ericsson.
- Intended to demonstrate IPv6 applications, IPv6/IPv4 internetworking, IPv6 over GRPS and Mobile IPv6.

InternetCAR Project (Japan)

Keio University, SFC TMKN Research Groups

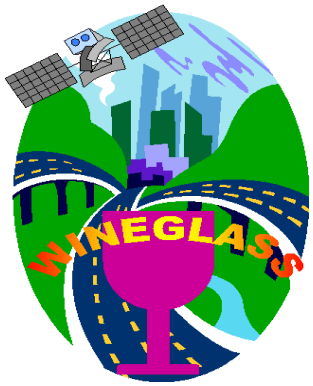
Keio University

- Collaboration with major car makers and NTT.
- Connect Automobiles to the Internet.
- Provides a platform to develop applications which deals with information of automobiles.
- The Mobile IPv6 on InternetCar
  * KAME, Multiple Interface support

http://www.sfc.wide.ad.jp/InternetCar/

Mobile IPv6 Industry Initiatives (sample)

NTT DoCoMo
DoCoMo USA Labs



Wine Glass (EC funded)

- Wireless IP Network as a Generic Platform for Location Aware Service Support
- Mobile IPv6 studies included in Mobility Management research

http://www.domobili.cselt.it/WineGlass

Moby Dick

- Facilitate development of seamless Mobility and differentiated Services in a Future IP Network.
- Development, implementation and test e2e components based on IPv6 (includes Mobile IPv6). Will actively contribute to standardization bodies (IETF) to do this.
- Study inter-working of Mobile IPv6, QoS and AAA.

http://www-int.berkom.de/~mobydick/

NTT DoCoMo USA Labs

Concluding Remarks

Concluding Remarks

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- With IPv6 the mobility support has been on the list of required features from the beginning.
- The work for a Mobile IPv6 security solution is targetted to be complete by Minn, IETF-53. Implementers are expected to update their code and MIPv6 security interoperability testing can happen at the fall bake-off.
- As a result of the Mobile IPv6 bake-offs it is the consensus from the implementers [independent of securing binding updates] that Mobile IPv6 is stable.
- The Mobile IPv6 specification is on its way to becoming a standard, so it is expected that virtually all IPv6 deployments will include at least the minimal mobile IP support (i.e., the correspondent node functions).


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Improving the Internet