Implementation and Operation of Mobility in WIDE

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Contents

- Background
- Implementation
- Operation
- Demonstration report
- Summary

Background

- Widely deployed Internet
  - Available in almost everywhere in the world
- Improvement of Communication Technology
  - Wireless LAN, Bluetooth, WiBro, etc
- Progress of Small Devices
  - Sensor nodes, Portable devices that have various communication media

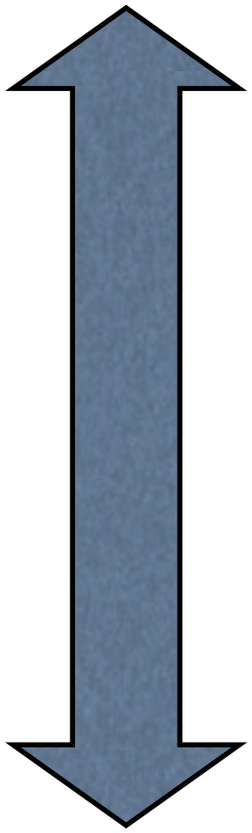
Requirements

- From users
  - Seamless usage of various communication devices
  - Seamless communication from everywhere
- From service operators
  - No big impact to the infrastructure
  - Seamless transition of applications

Mobility Technology

- L2 Mobility
  - Cellular
- L3 Mobility
  - Mobile IPv6 / NEMO
- L3.5 Mobility (?)
  - Shim6
- L4 Mobility
  - SCTP

Device dependent
Infrastructure update is required



Applications need to be modified
Terminals have to be updated

What does WIDE do?

- Realize the future Internet
  - Find all spec problems by implementing the specification
  - Provide free protocol stacks
  - Operate the service with the new protocol to find any operational problems and get experience
  - Demonstrate how can the technologies be applied

Implementation

Implementation

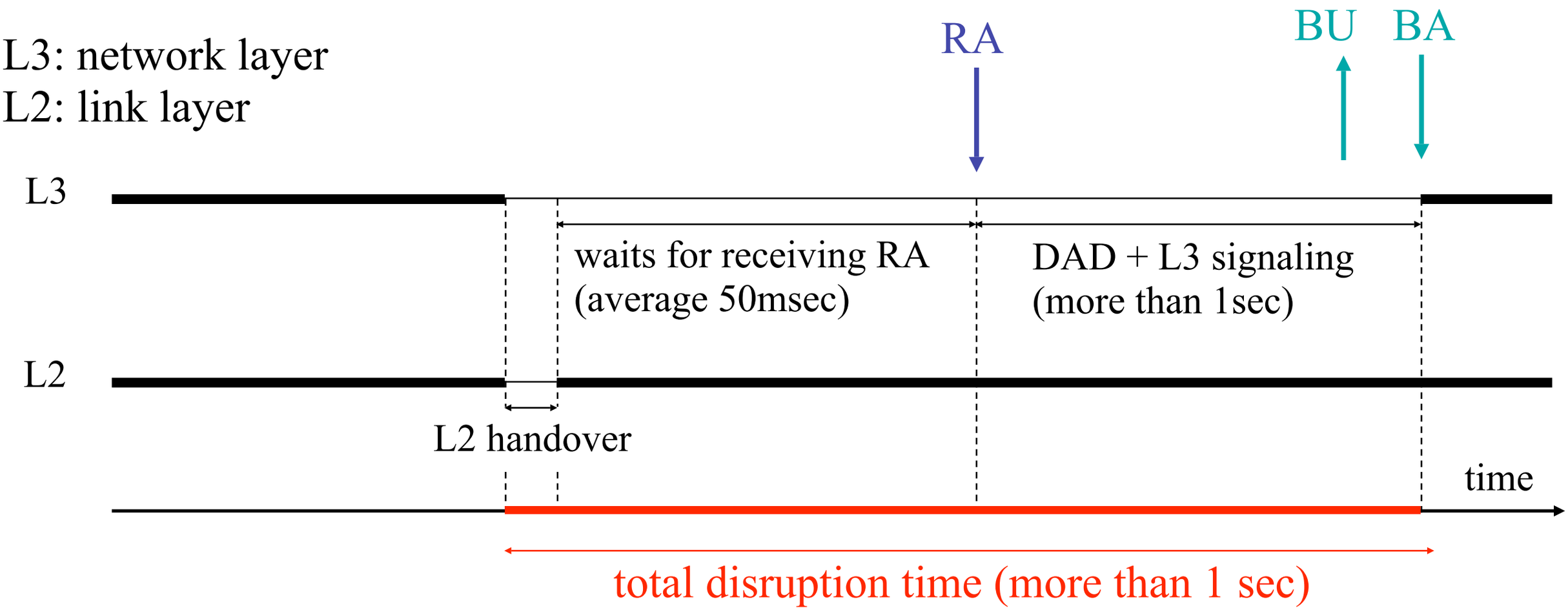
- L2 Trigger
- L3 mobility protocols
  - Mobile IPv6 / NEMO BS
  - Fast Mobile IPv6
- Operation support service
- Demonstration applications

L2 Trigger for Fast Handover

- L3 Fast Handover needs to know L2 handover information
- A standard API to interact between L2 and L3 is necessary to utilize various kinds of L2 media from L3
- draft-koki-mobopts-l2-abstractions

Current Handover Sequence

L3: network layer
L2: link layer



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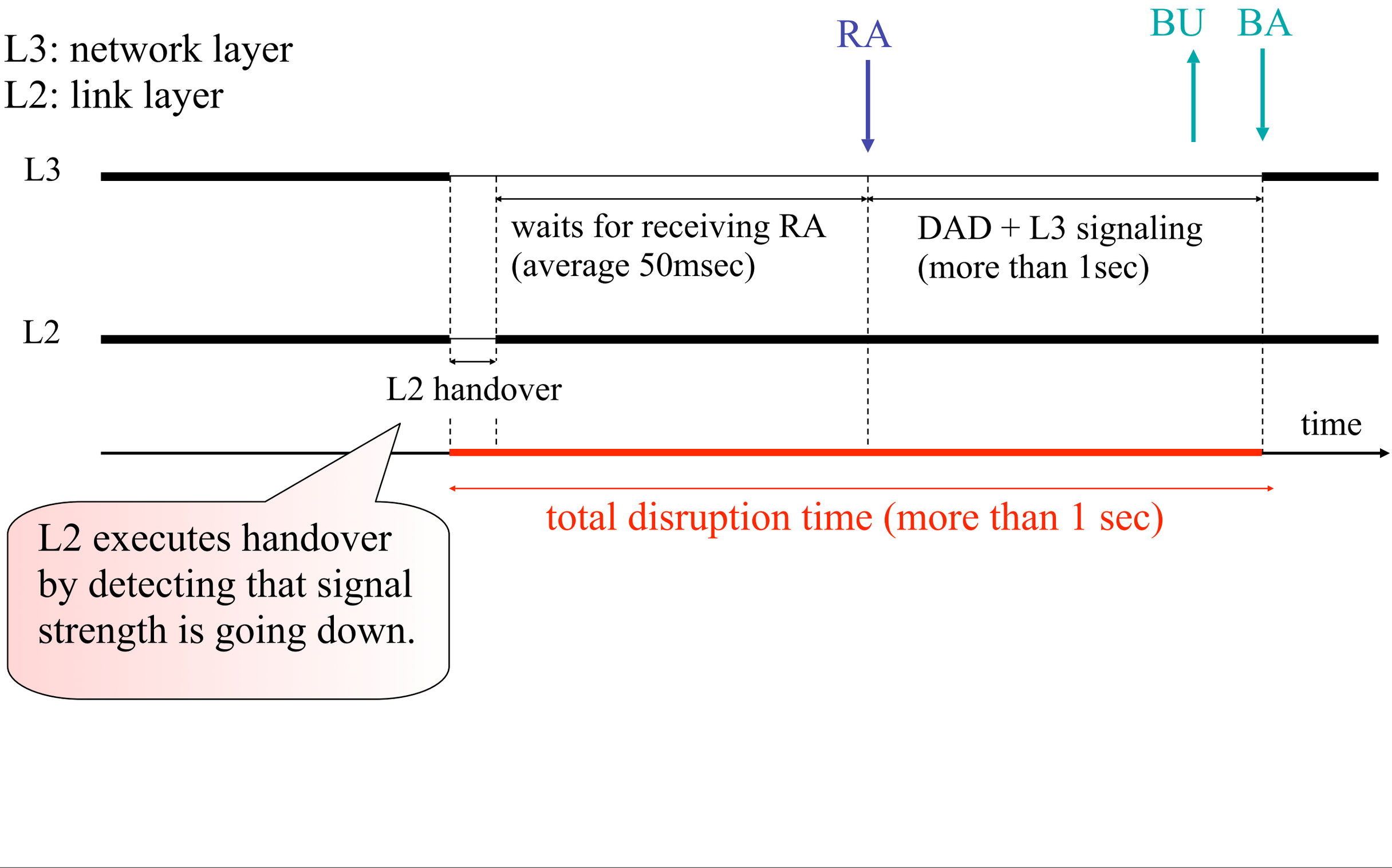

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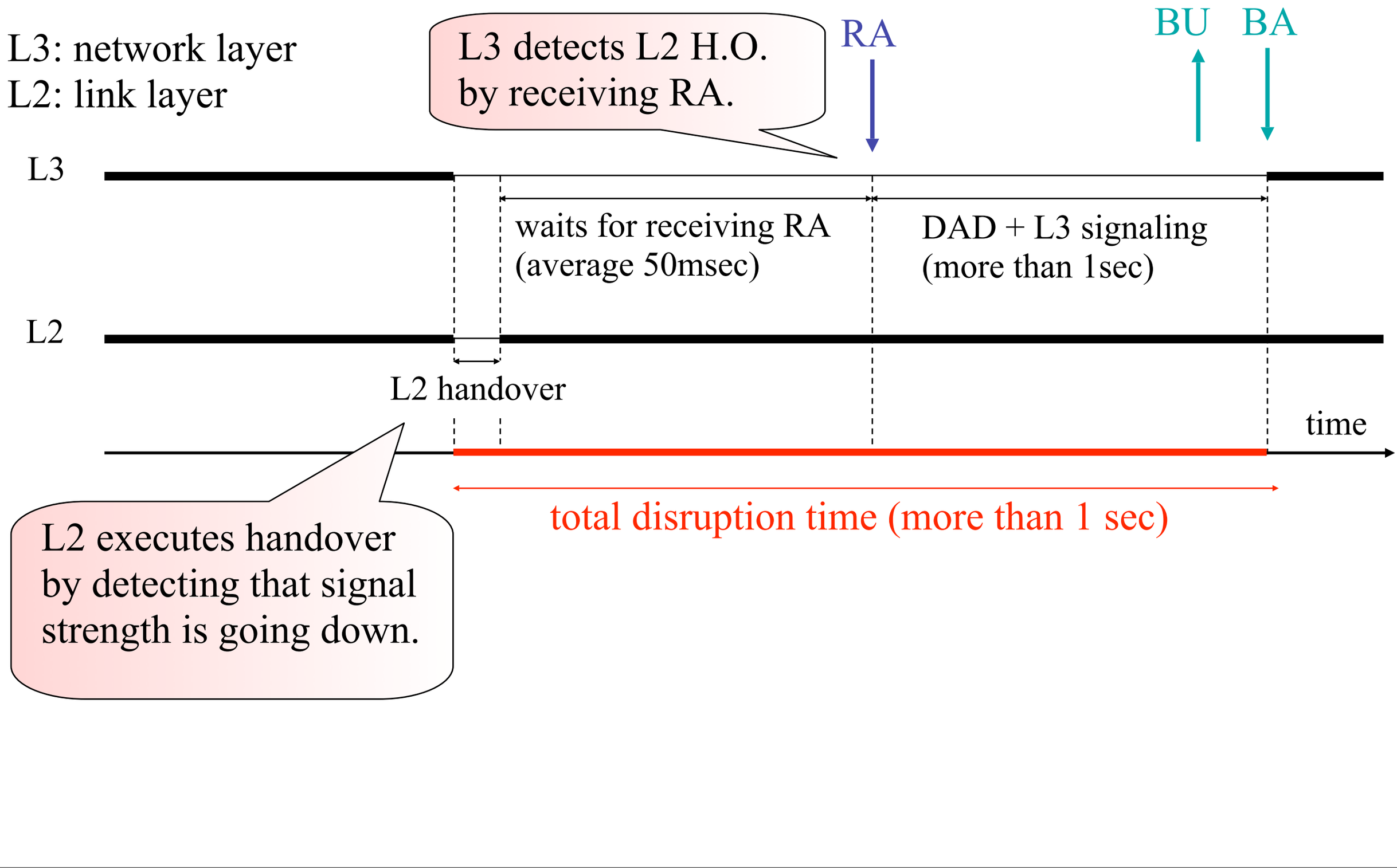

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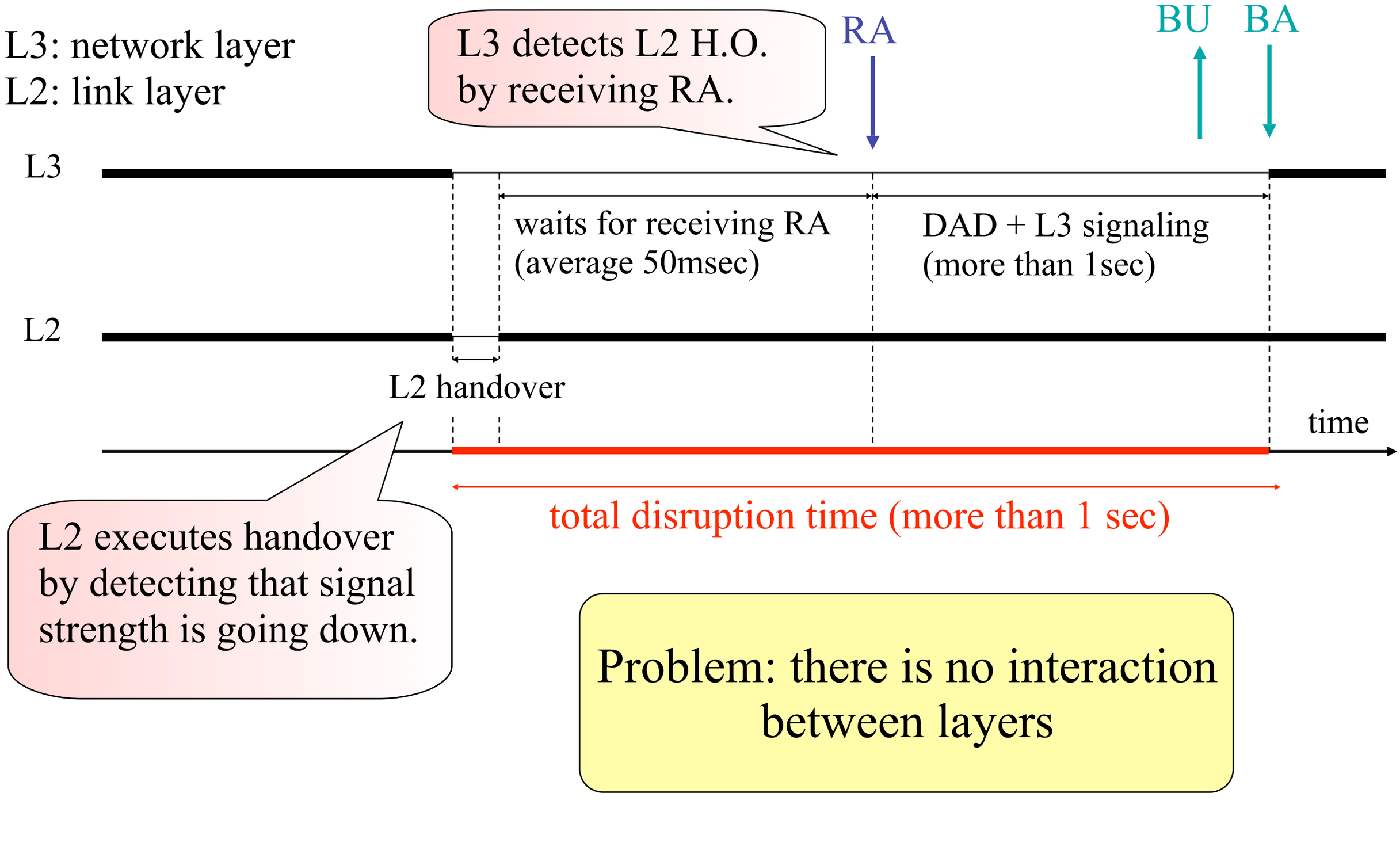
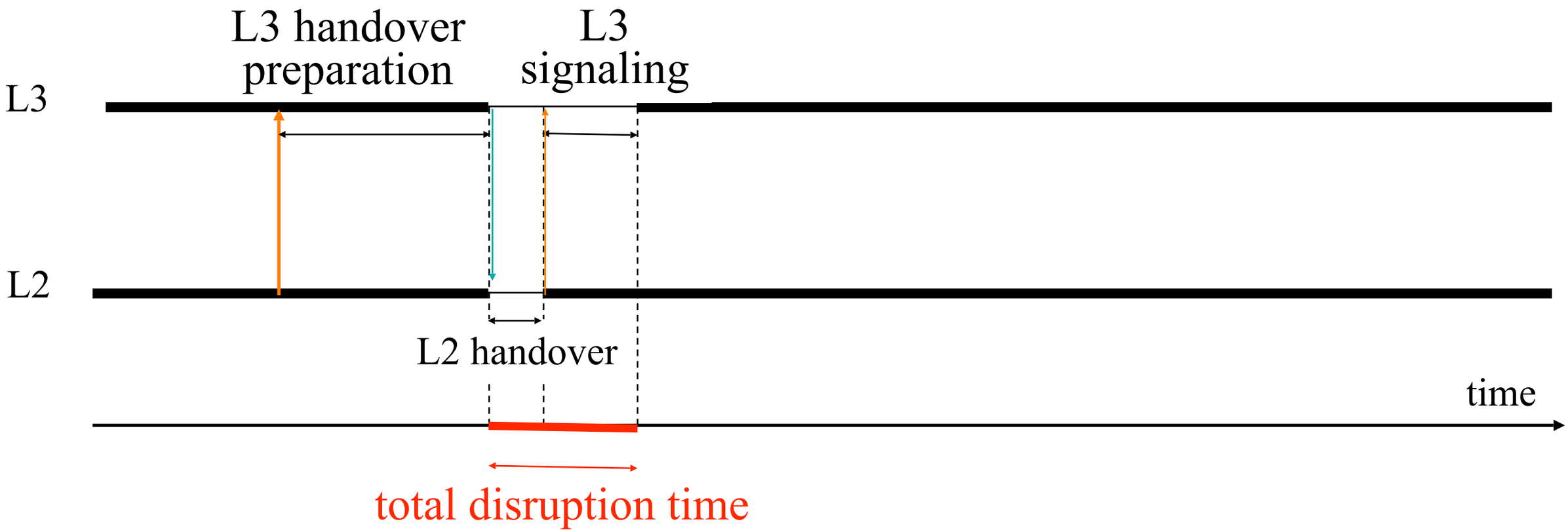


L2 executes handover by detecting that signal strength is going down.

Problem: there is no interaction between layers

Principle of L3-Driven Fast Handover

L3: network layer
L2: link layer



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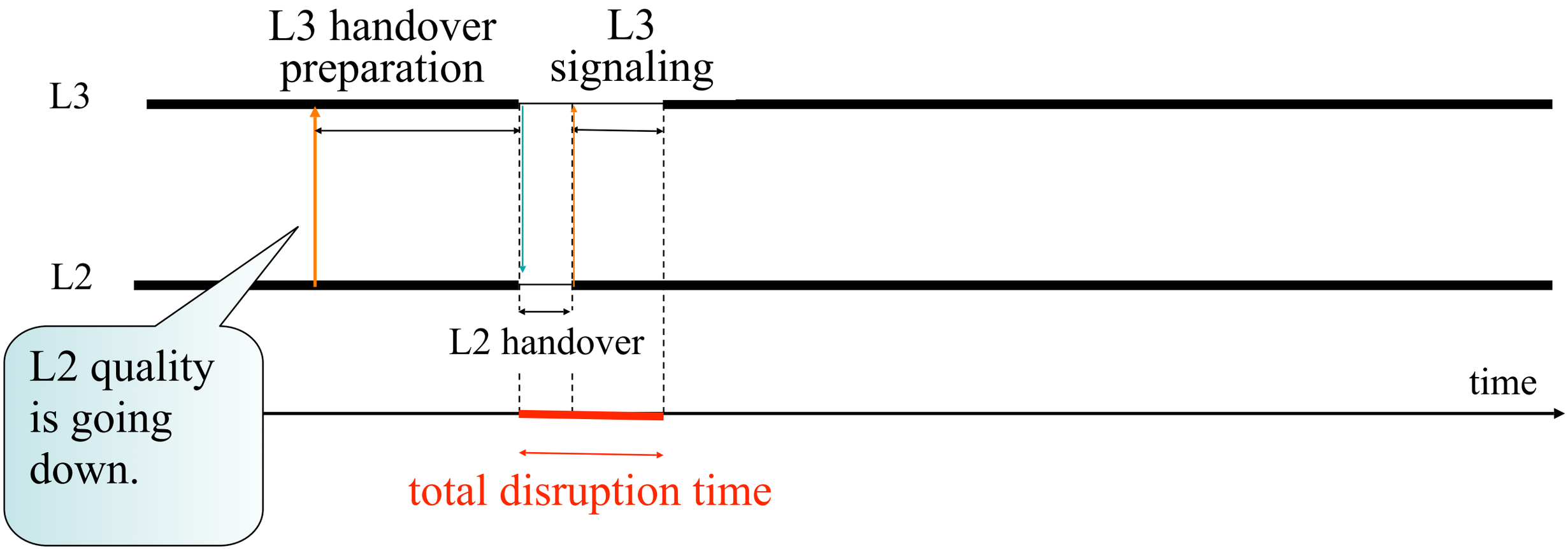

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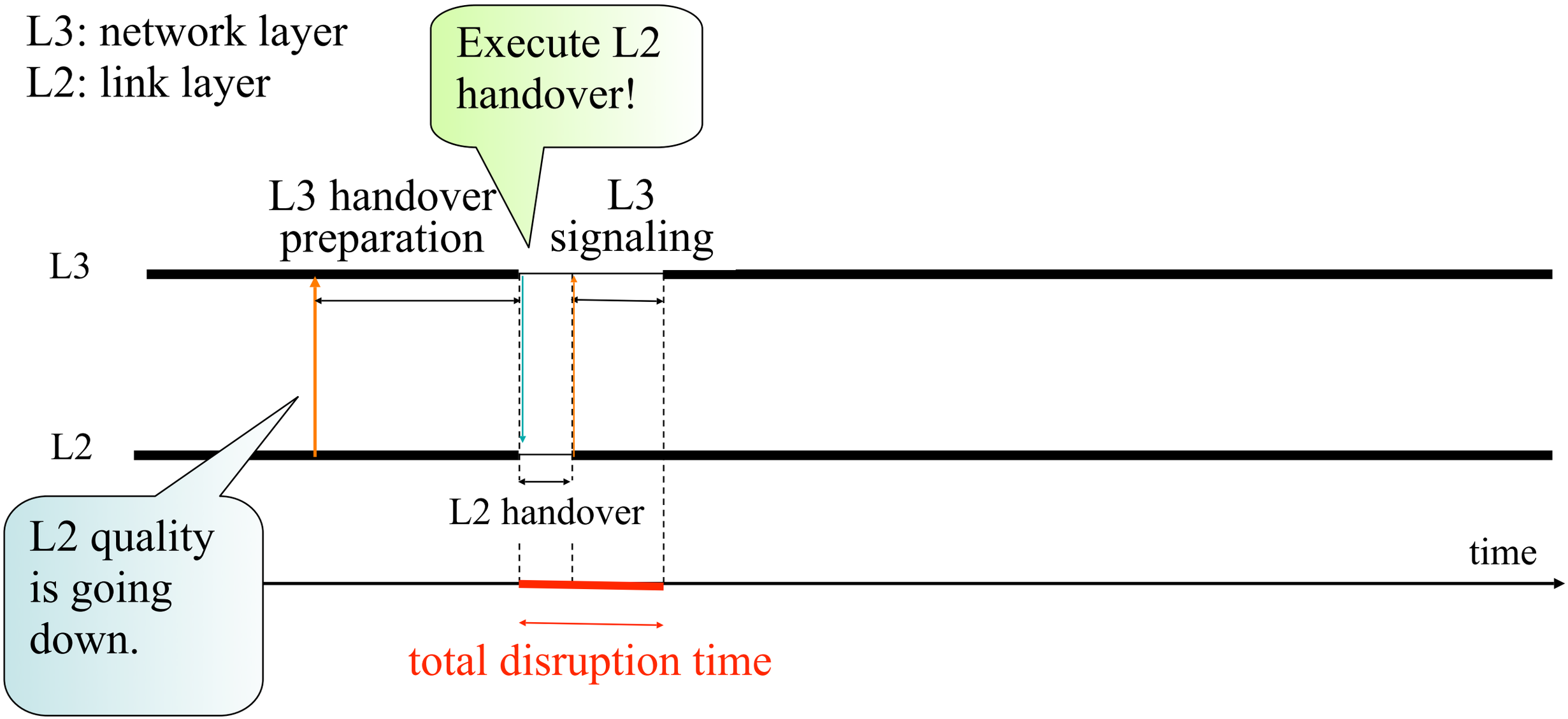

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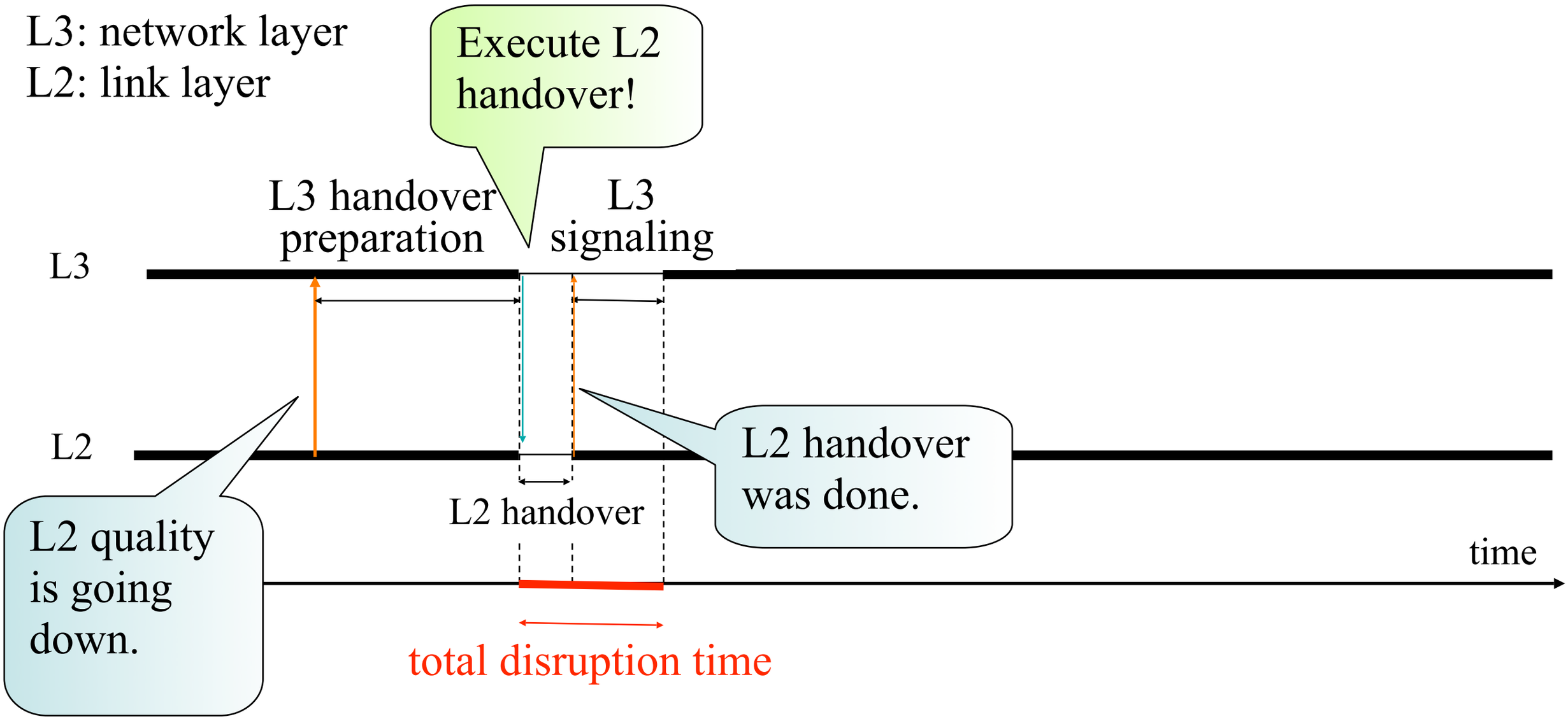

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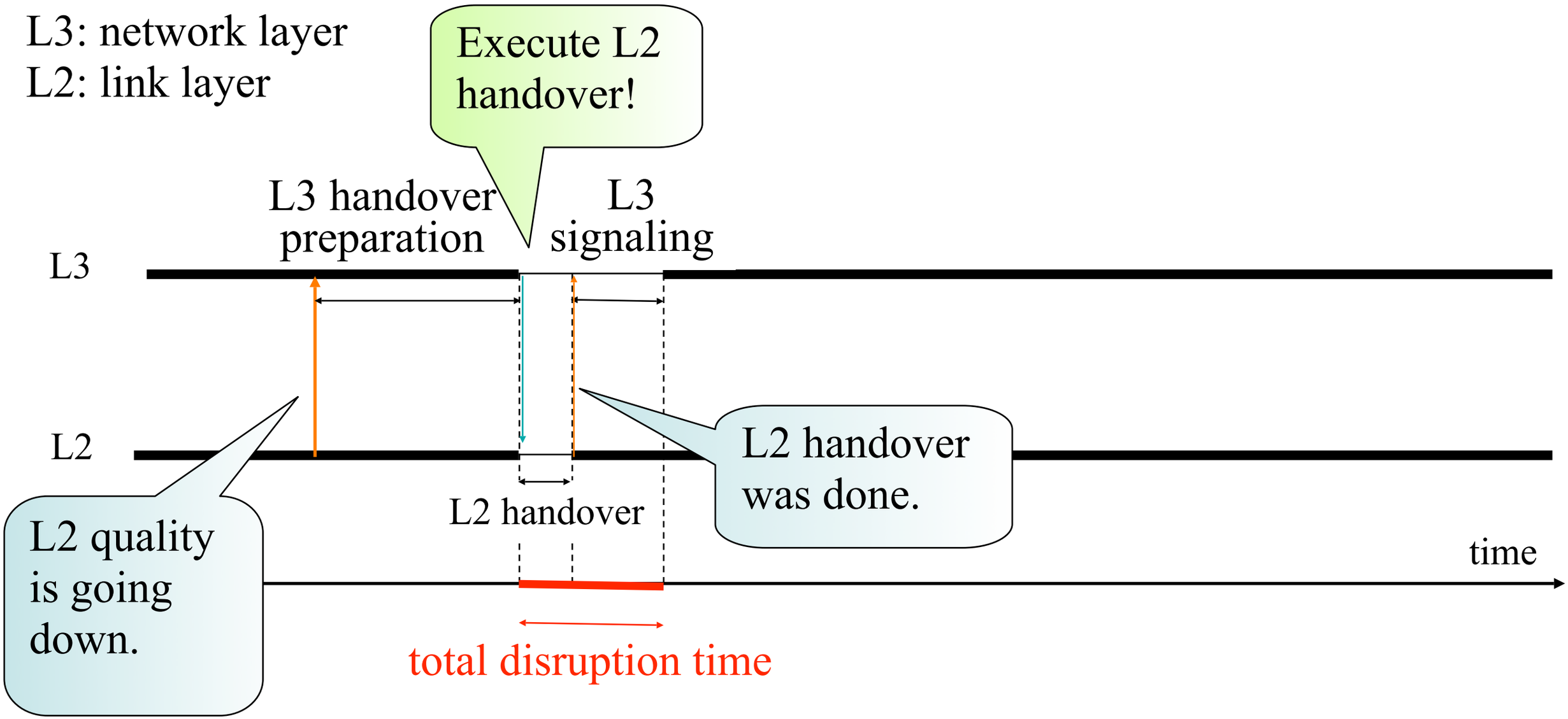
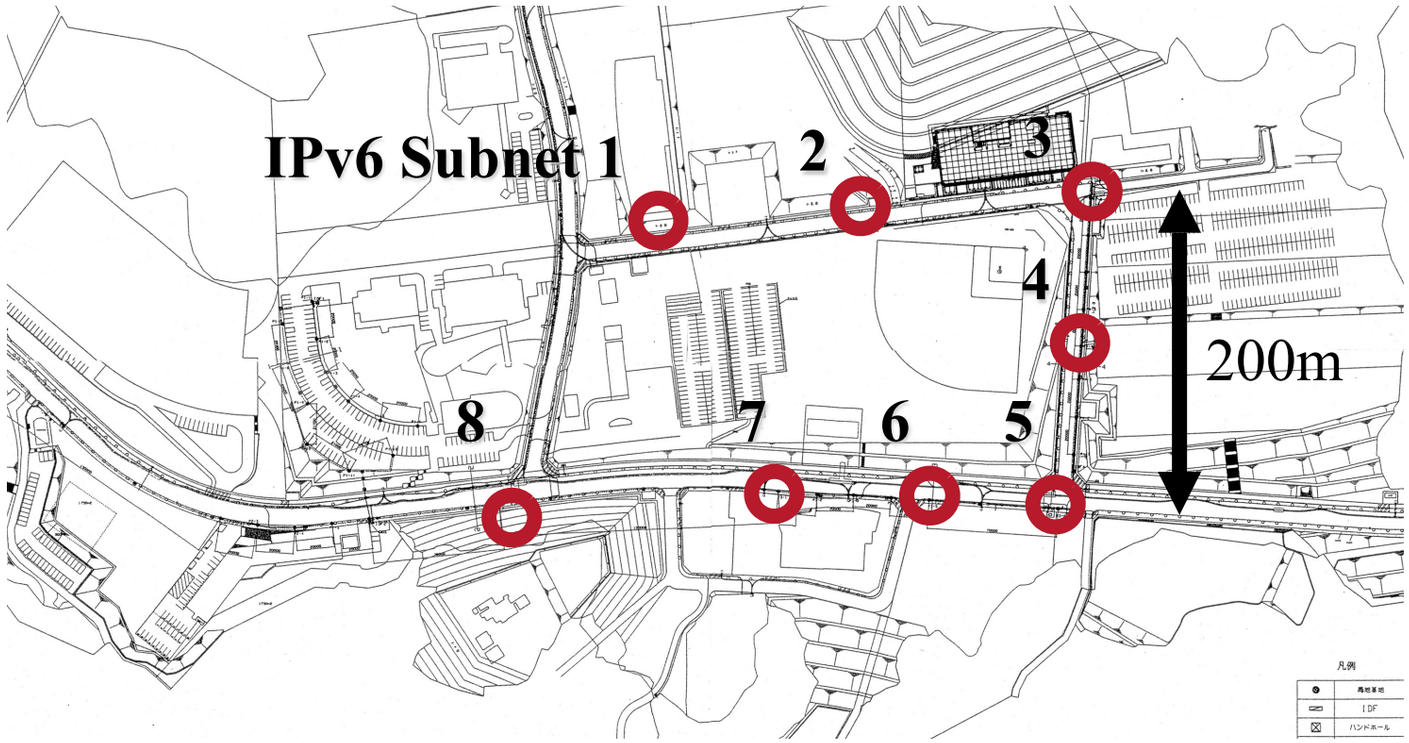


control information exchange between layers
=> dramatic decrease of handover time

Demo:L3-Driven Fast Handover Using L2 Triggers

- Application: DVTS
  - half rate: 15Mbps
  - from MN on car to fixed PC
- L3 mobility protocol: LIN6
- L2: IEEE802.11a (54Mbps)
- 8 IPv6 subnets
  - 8 access points / access routers



- Total disruption time: 3-4 ms
  - L2 handover: 1-2 ms (fixed)
  - L3 handover: 1-2 ms (depends on RTT)

QuickTime ÇÂ
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Receiver sender

L3 mobility protocols

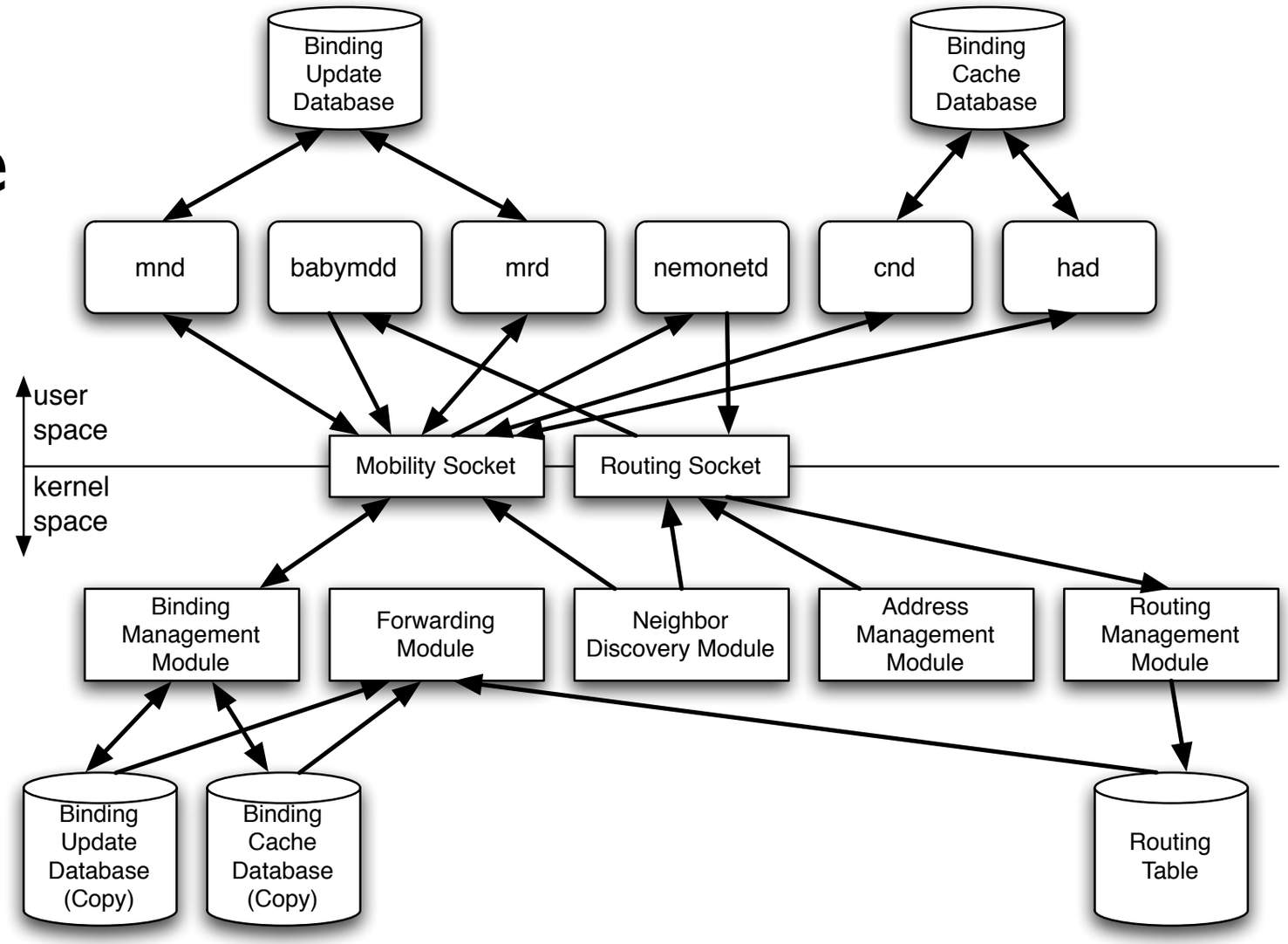
- SHISA
  - Mobility Framework for BSD Operating Systems
- USAGI MIP (UMIP)
  - Mobile IPv6 stack for Linux
  - Collaborative work with the Go-core team
- NEPL SE
  - NEMO BS stack for Linux
  - Collaborative work with the Go-core project

SHISA

- Mobility Framework for BSD Operating Systems
  - FreeBSD5.4 and NetBSD2.0.2
- Supported specifications
  - Mobile IPv6 (RFC3775)
  - NEMO BS (RFC3963)
  - MIPEXT API
  - Multiple CoA
- http://www.kame.net/, http://www.mobileip.jp/

SHISA System

- Mobility functions are provided by the combination of small programs
- MIPSOCK socket interface provides communication method between them

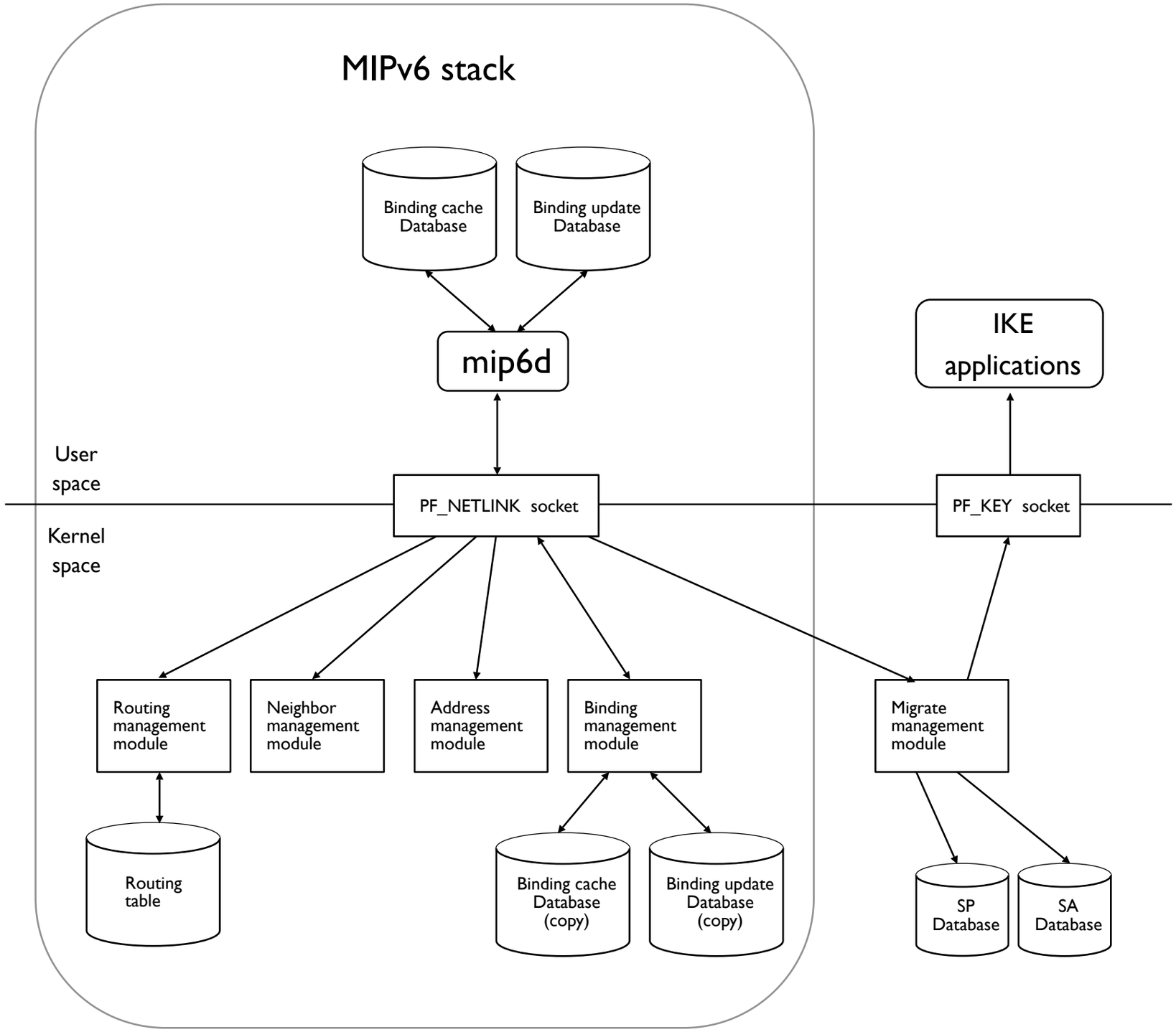


USAGI MIP (UMIP)

- UMIP is a set of patches to Mobile IPv6 for Linux (MIPL2)
- Supported specifications
  - Mobile IPv6 (RFC3775)
  - MIPEXT API
  - MIGRATE (an Interface between Mobile IPv6 and IPsec/IKE; draft-sugimoto-mip6-pfkey-migrate)
- tutorial
  - http://www.linux-ipv6.org/memo/mipv6/index.html.en

UMIP Systems

- Mobility functions are provided by a daemon (mip6d)
- PF_NETLINK is used as an interface between user and kernel space
- MIGRATE interface is used to update endpoint address of IPsec tunnel through PF_KEY socket when MN moves



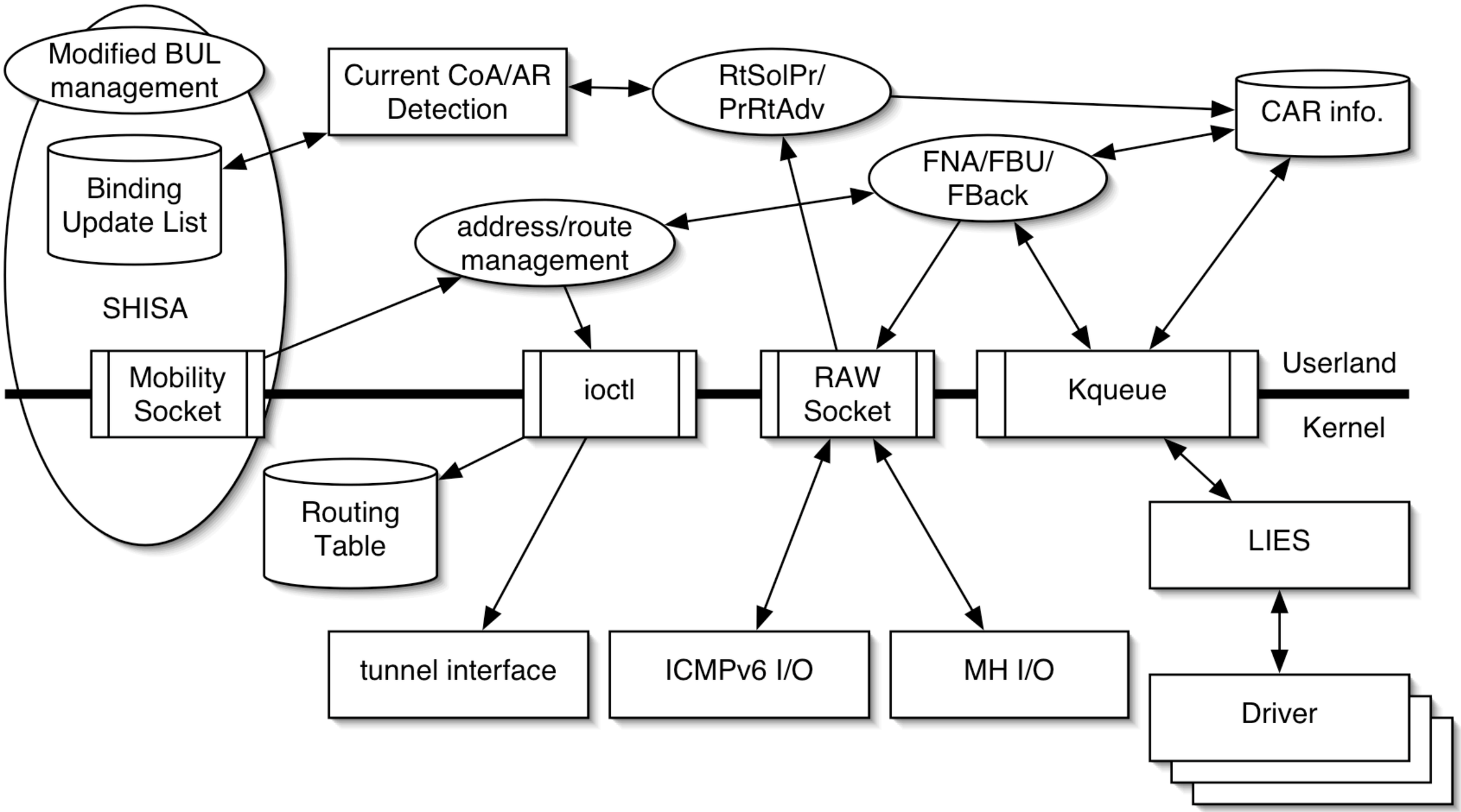
NEPL SE

- Network Mobility Stack for Linux based on NEPL (http://www.mobile-ipv6.org/)
- Some features are enhanced
  - Mobile Network Prefix Delegation
  - Multiple CoA
- http://software.nautilus6.org/

Fast Mobile IPv6

- TARZAN
  - Implementation of FMIPv6 for FreeBSD 5 operating system
  - Based on SHISA mobility stack
  - Fast Handover for Mobile IPv6 (draft-ietf-mipshop-fast-mipv6-03)
    - Support Predictive & Reactive modes
    - Development is suspended until 4068bis is published
  - http://software.nautilus6.org/

TARZAN System



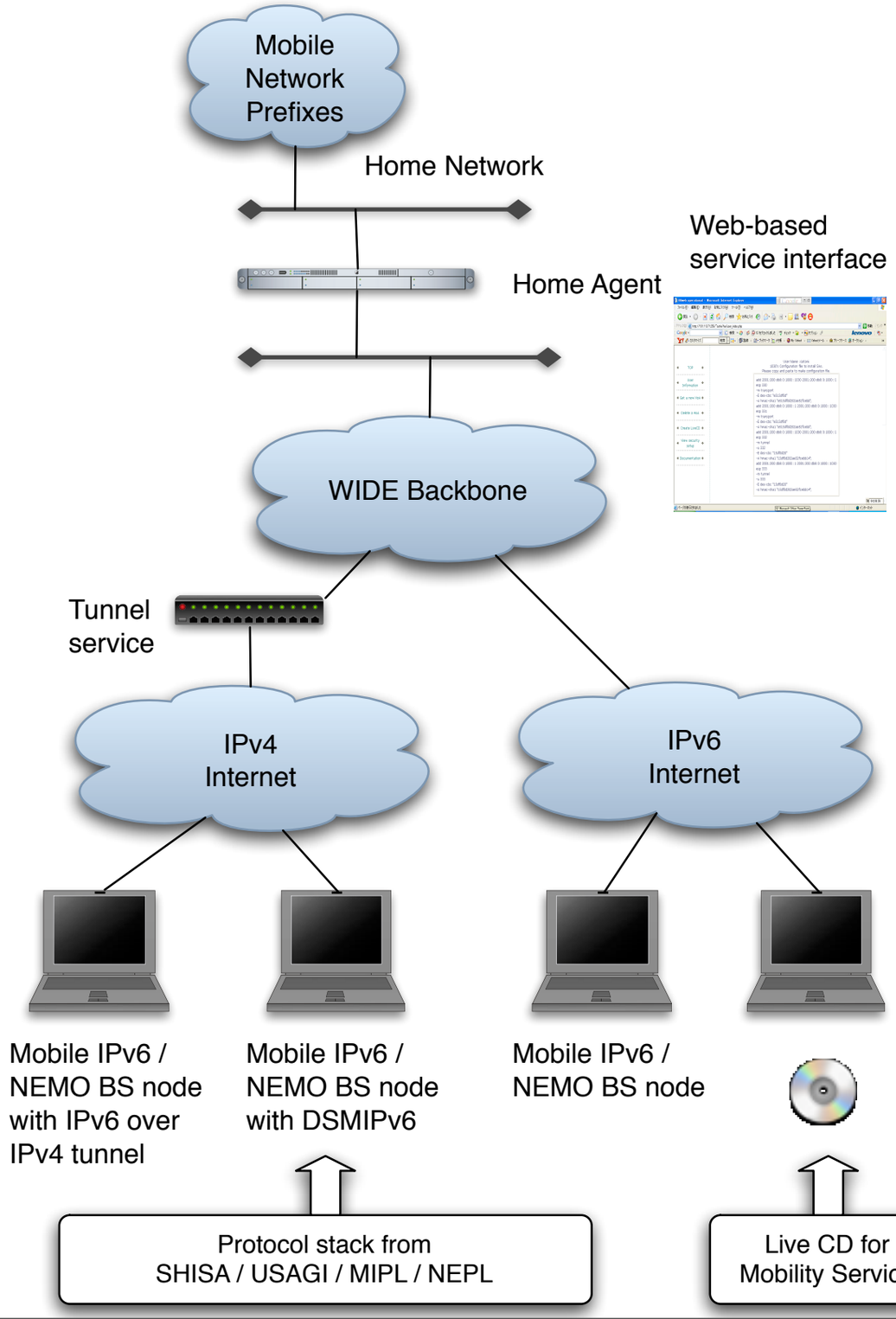
Operation

Operational Service

- Background
  - Providing only protocol stack implementation is not enough to deploy technologies
  - Implementing stacks and operation using the stacks will accelerate understanding protocols and give us much experiments

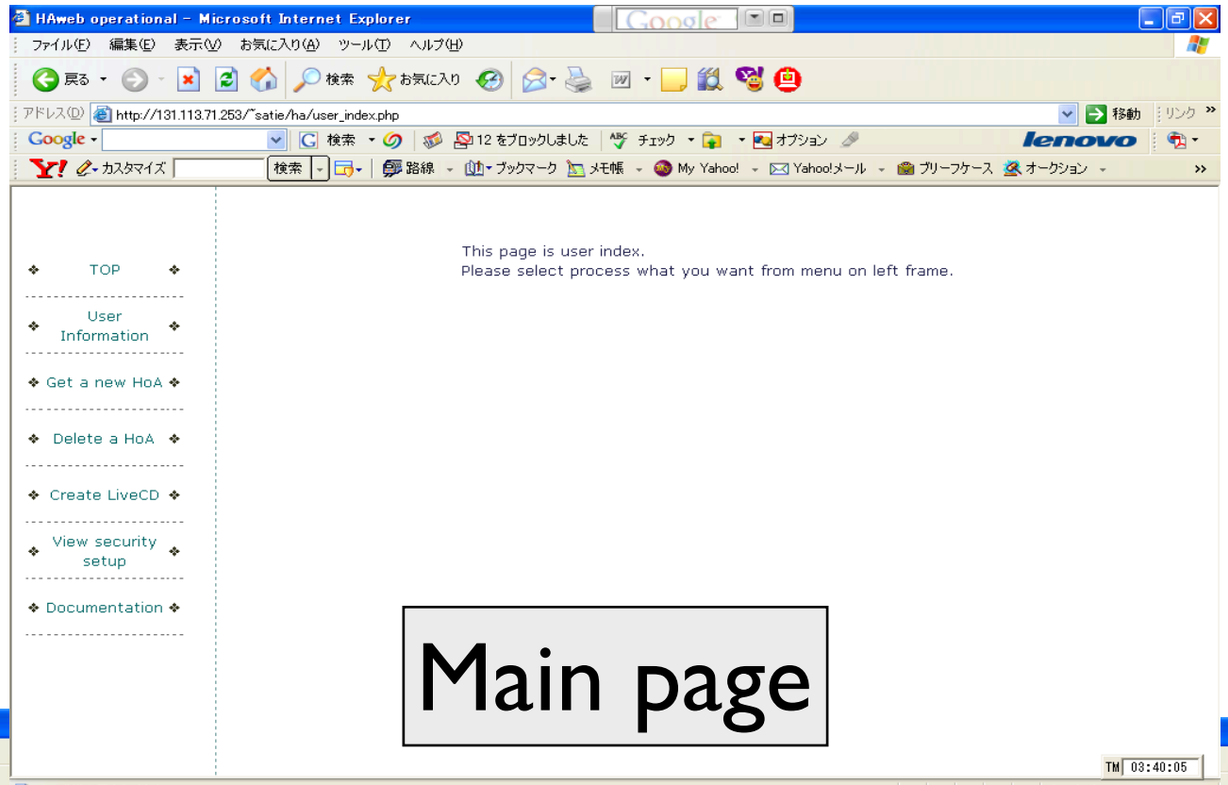
L3 Mobility Service

- Operate Layer 3 mobility service as an application service provider
- Design goals
  - Easy to use Web-based service interface
  - Supporting both IPv4/IPv6 access networks
  - Support full security defined in the specification
  - Distribute the system as an operation kit

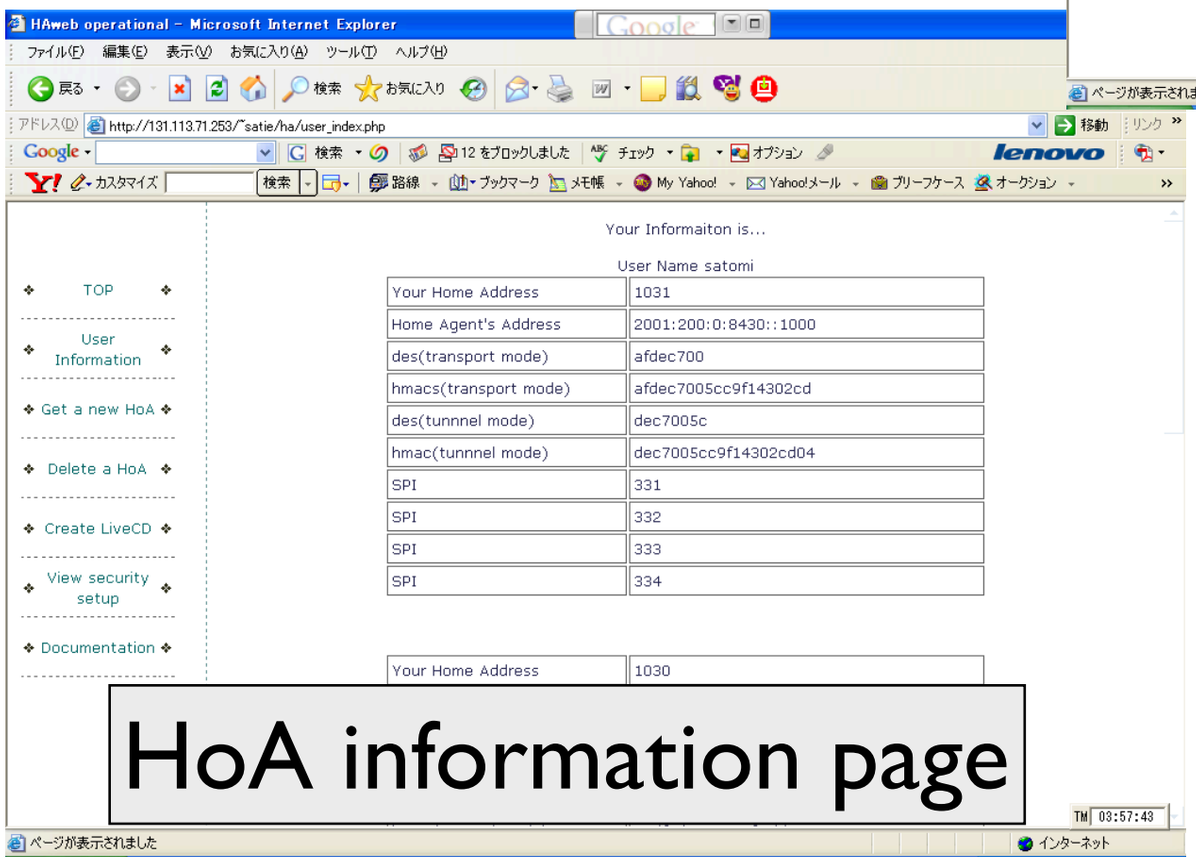


L3 Mobility Web Interface

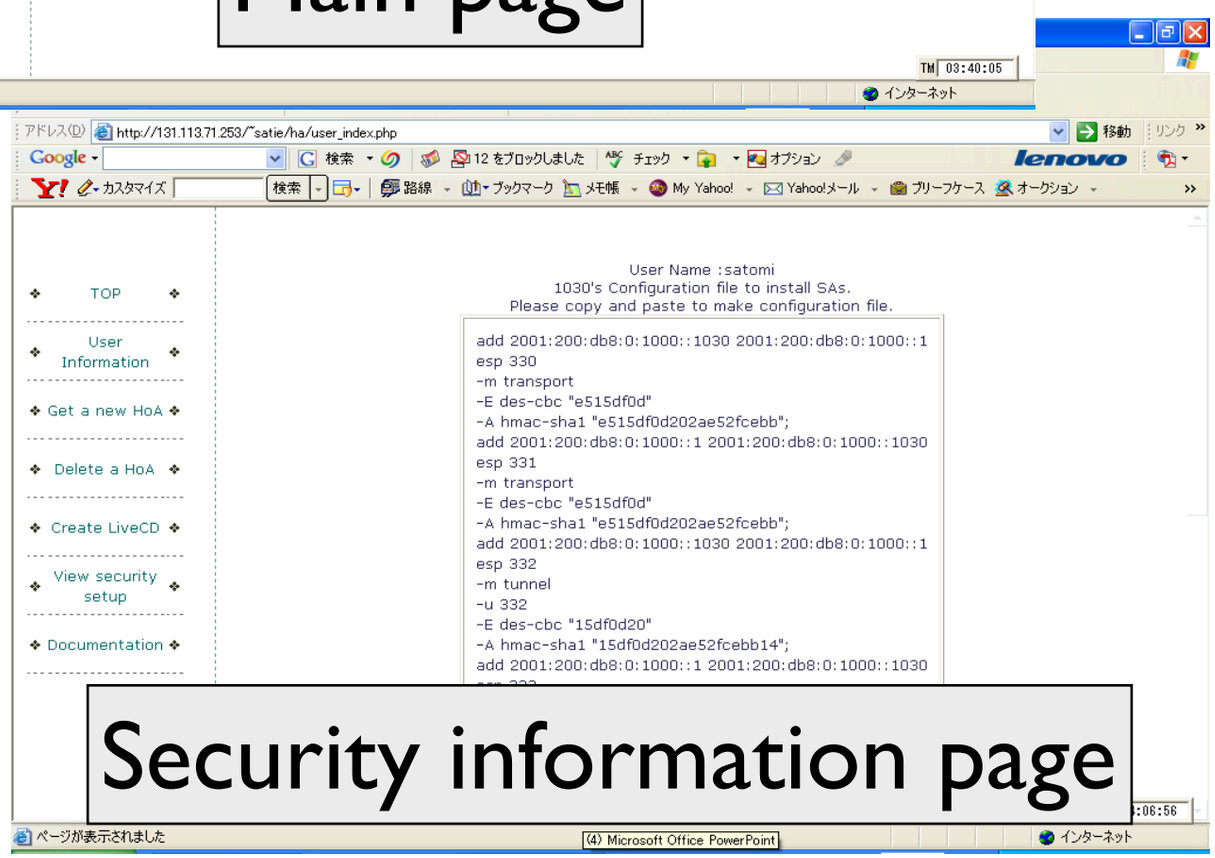
- Users can
  - Request HoA
  - Request MNP
  - Get Security Info
  - Create Live CD



Main page



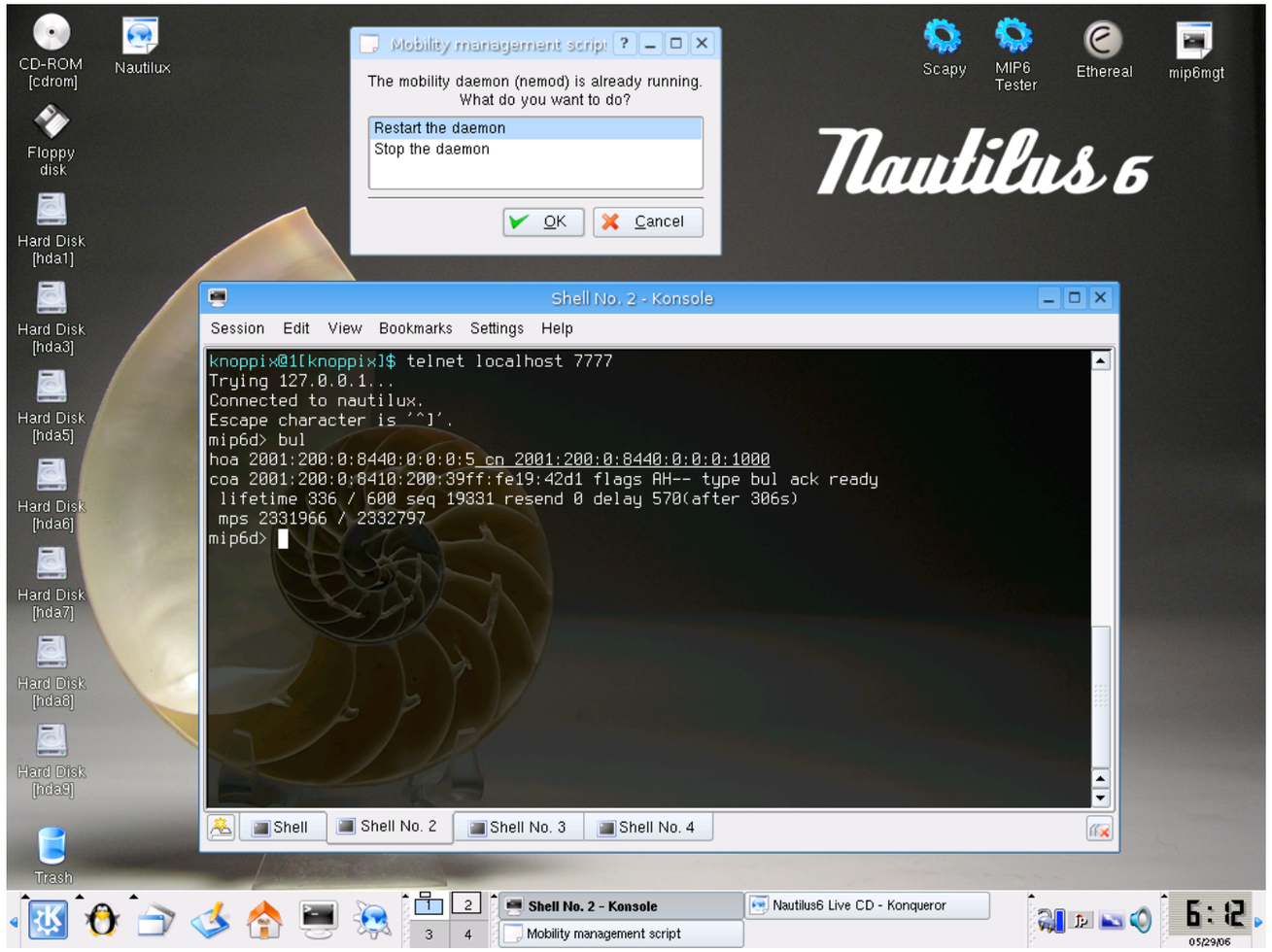
HoA information page



Security information page

Live CD for trial users

- Kernel and necessary mobility service programs are integrated
- Initial setup for mobility programs has already done
- Security setup for mobility signaling has already done for each users
- The CD is created depending on user's information (HoA, Security parameters, etc.)



Demonstration Report

Why is Demonstration Important?

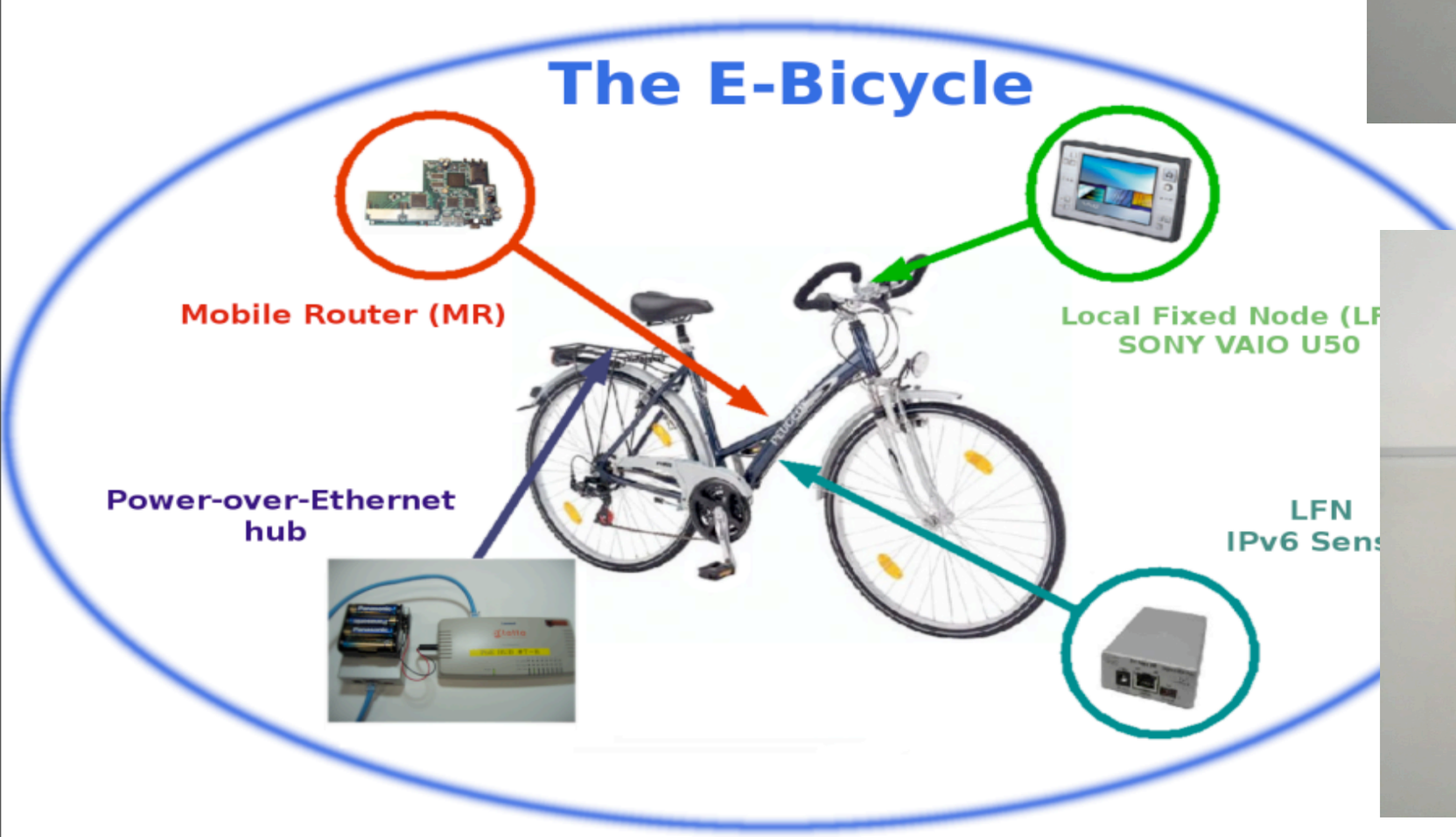
- Technology itself usually does not convince people
- Need to show how we can use the technology
- How the technology make us interesting

Demo Activities

- E-Bike / E-Bag system
- Transition support using Dual Stack Mobile IPv6 (DSMIPv6)
- Large scale operational moving network using NEMO BS technology

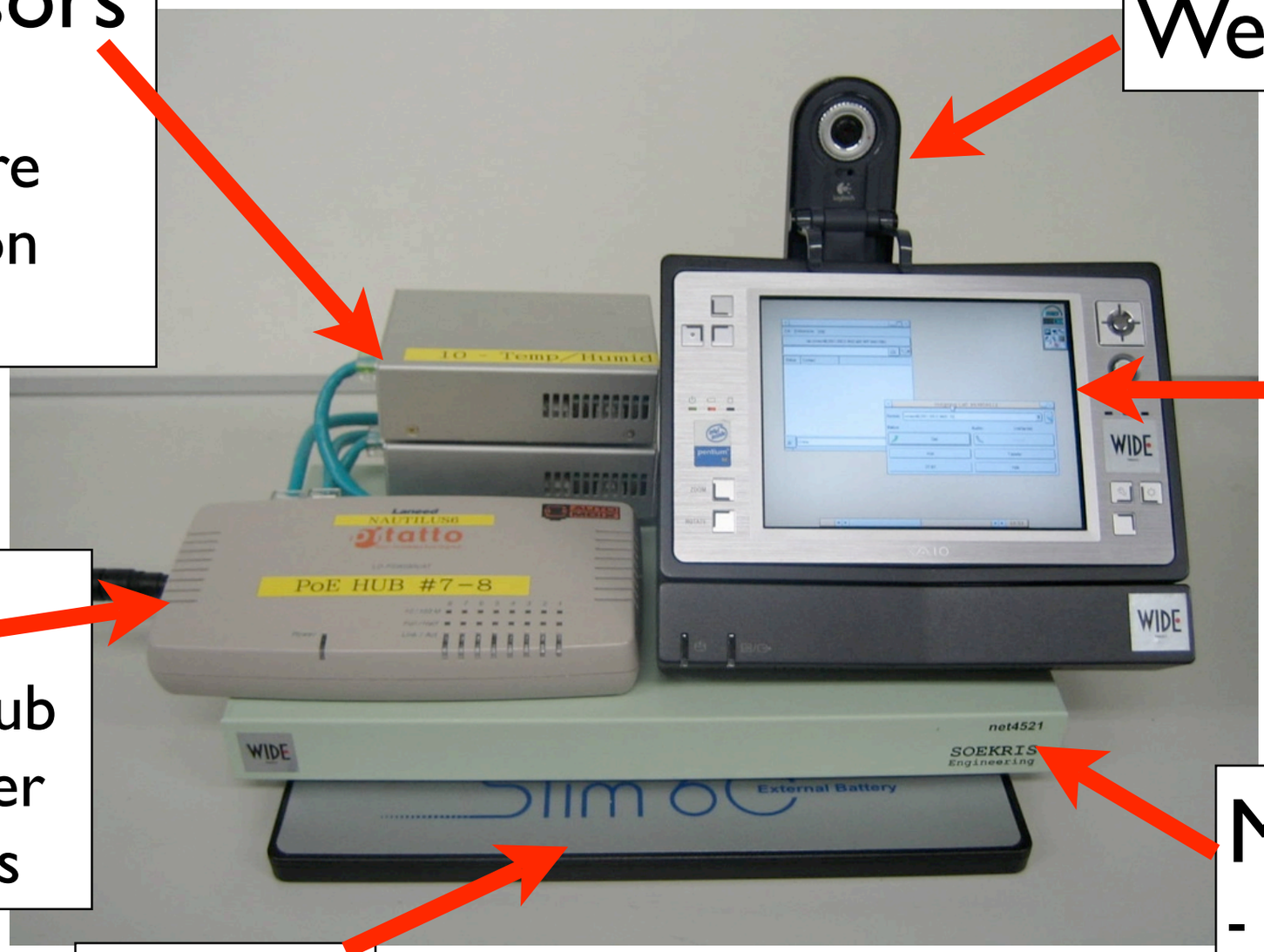
E-Bike / E-Bag

- A good example of Personal Area Network
- IPv6 sensors and a camera connected to small mobile router driven by battery



E-Bike / E-Bag Equipments

IPv6 Sensors
- Humidity
- Temperature
- Acceleration
- Direction



Web Camera

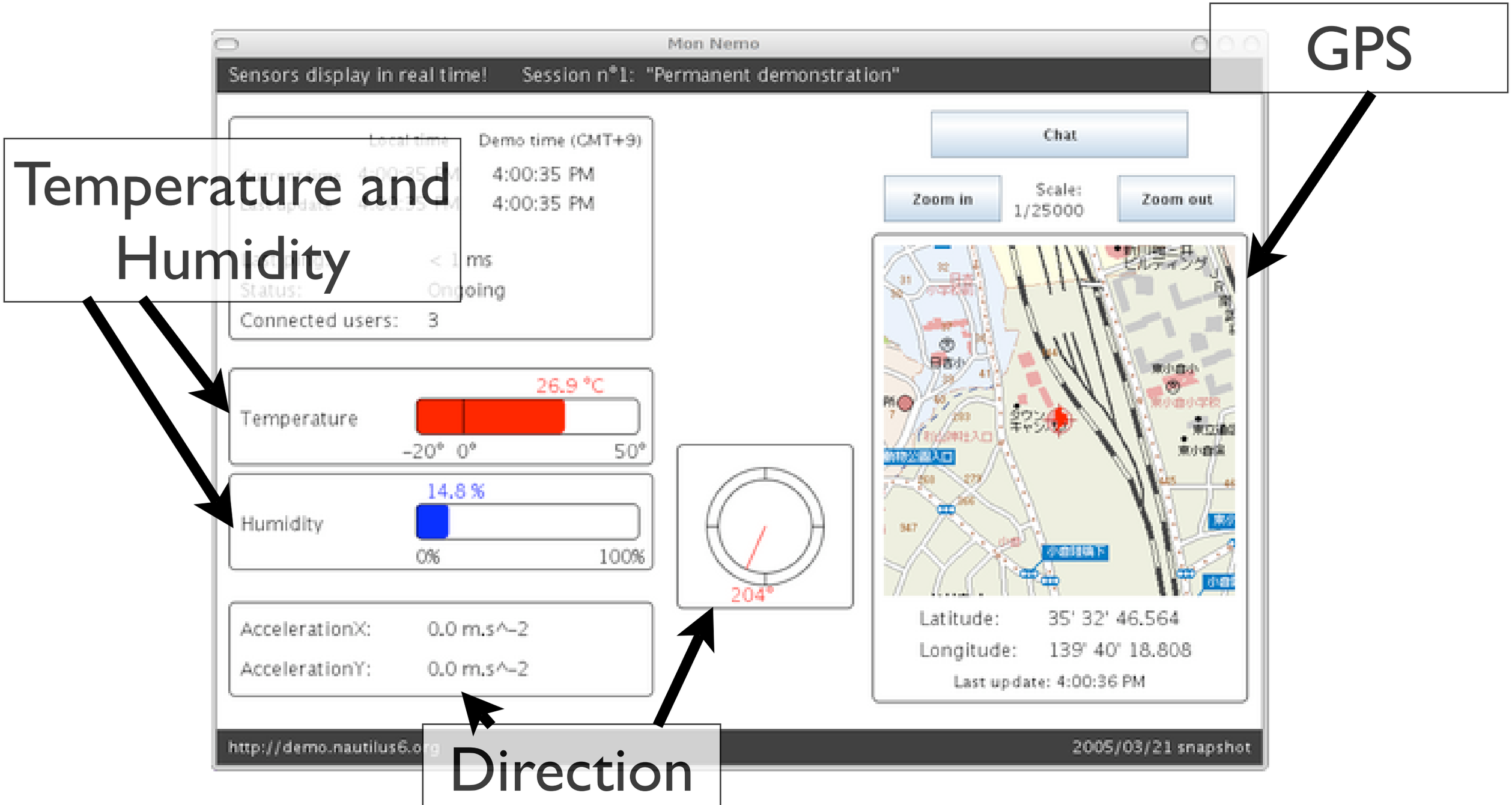
Applications
- MonNemo
- VoIP

PoE Hub
- A modified hub to supply power to IPv6 sensors

Battery

Mobile Router
- Soekris based SHISA MR

Mon Nemo
(IPv6 Sensor Monitor)

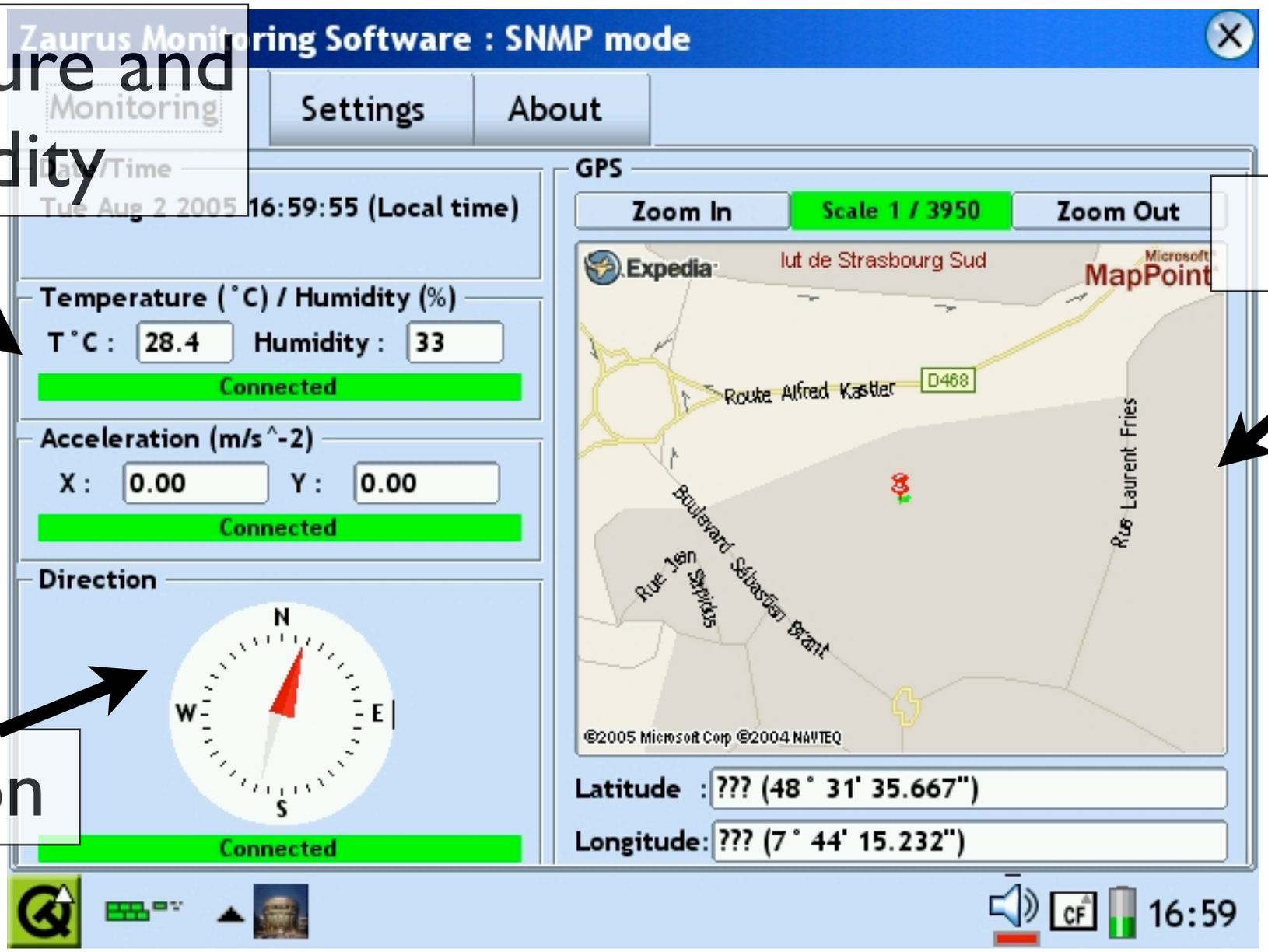


ZMS
(IPv6 Sensor Monitor)

Temperature and Humidity

GPS

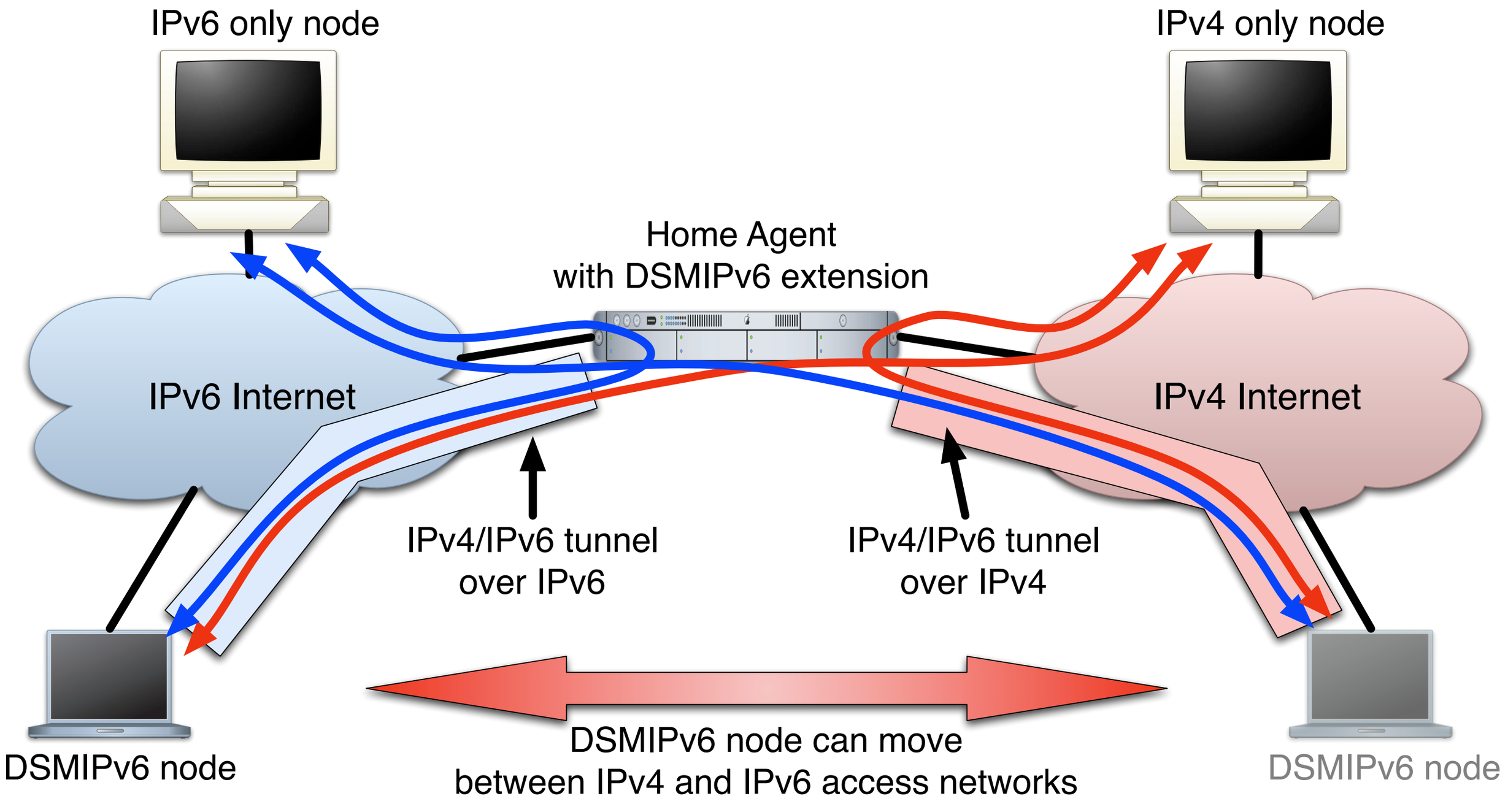
Direction



DSMIPv6 Overview

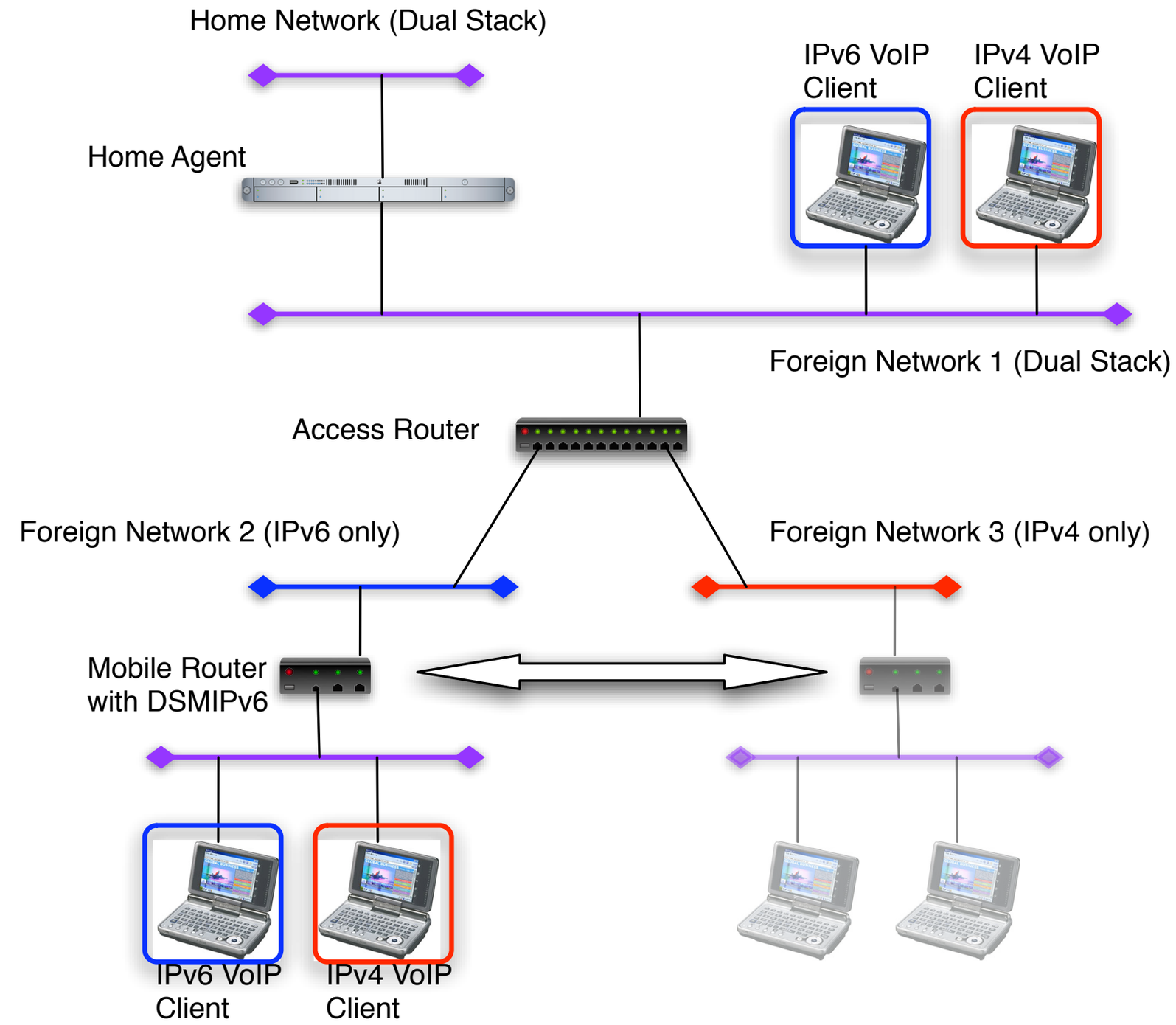
- DSMIPv6 is a kind of transition technology
- Allows MH/MR to attach both IPv4 and IPv6 access networks
- Allows MH/MR to use both IPv4 and IPv6 communication

DSMIPv6 Mechanism



DSMIPv6 Demo Topology

- IPv4 VoIP client and IPv6 VoIP client are located in a mobile network
- The clients can communicate with their peer nodes regardless of the attachment point of their mobile router, thanks to DSMIPv6
- Demonstration was performed at the 1st IPv6 Summit in Thailand, May 2006



Large Scale Mobile Network

- There are many people who tested the protocol in a small experimental test environment
- There were some approaches that used real trains in Japan (although it was for IPv4)
- We need a realistic testbed to prove that the NEMO BS protocol is useful and can be operated
- We need to have experience in operating NEMO network
- We decided to use the network used by the WIDE camp meeting

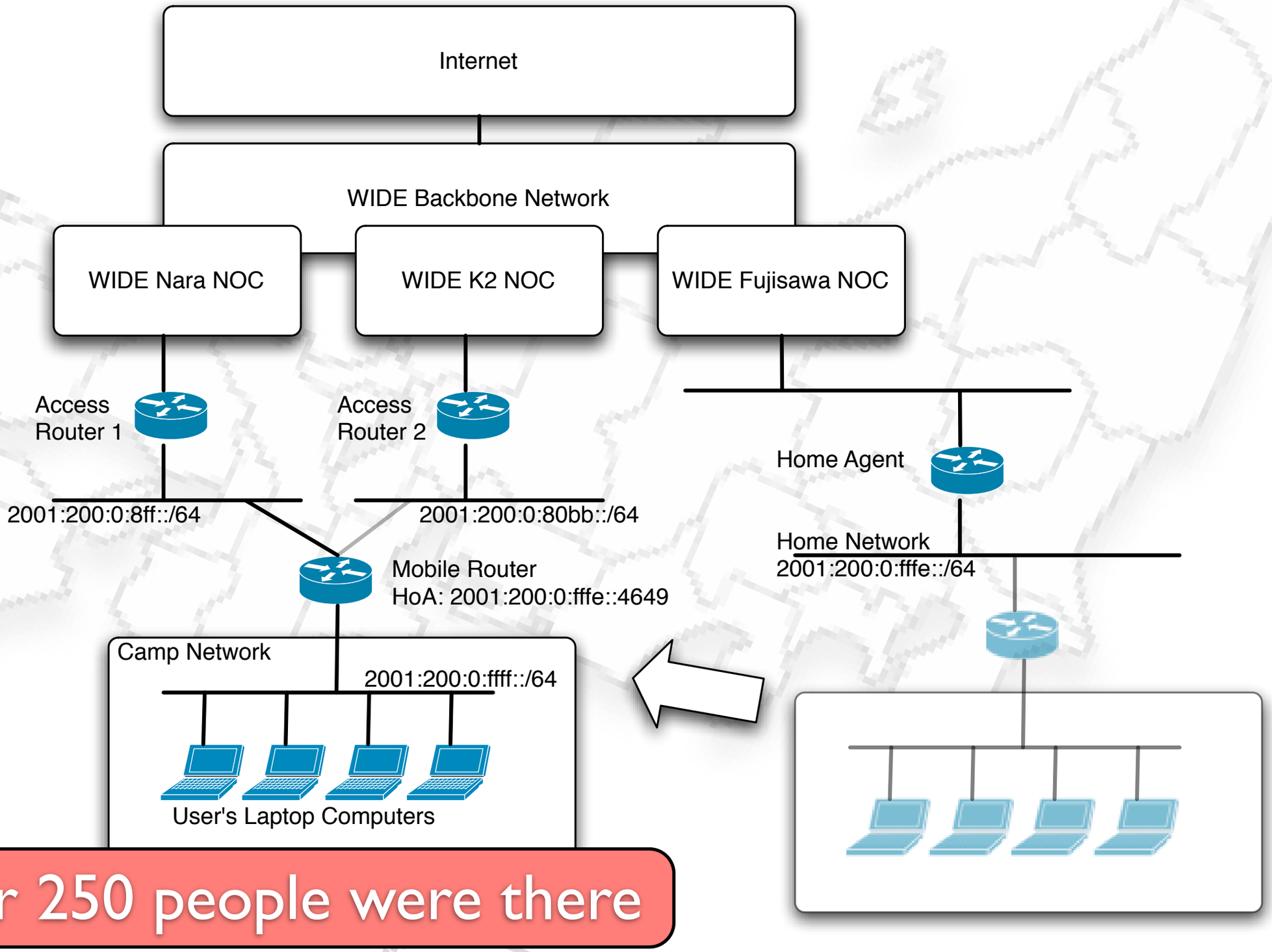
What is WIDE camp?

- 4-day meeting usually in March and September
- A temporarily network is prepared which is used as both infrastructure for participants and experimental network
- 200~250 WIDE members usually participate in the meeting
- Most of participants bring their own laptop computers

Large Scale Mobile Network

- Goals of this demonstration
  - To prove the NEMO BS protocol can be operated with real traffic
  - To get experience to construct NEMO network and to operate NEMO network
  - To find any implementation issue
  - To advertise the NEMO technology

Network Topology at WIDE camp (Sep. 2005)



Over 250 people were there

Result

- The mechanism worked, but...
- The loss rate on the nodes inside the mobile network was much larger than that of the mobile router

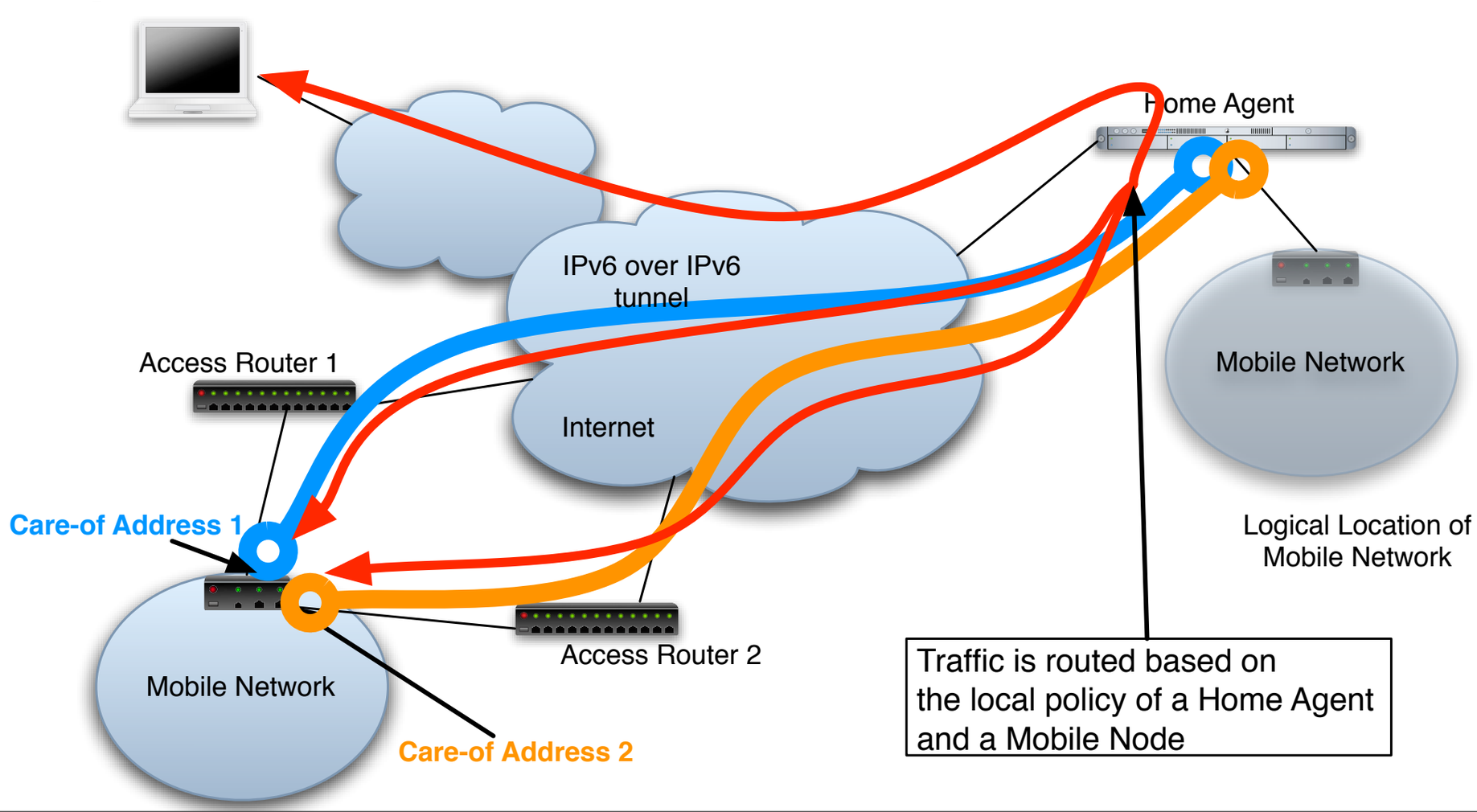
From	Sent/Received	Loss rate
Nodes inside the mobile network	10842/7408	31.7%
Mobile Router	2280/2249	1.4%

Seamless Handover using Multiple Interfaces

- Service disruption cannot be avoided as long as there is only one network interface
- Using multiple interfaces will reduce the service disruption
- We tried to use multiple CoA registration and diverted traffic to a new interface before disconnecting from an old interface

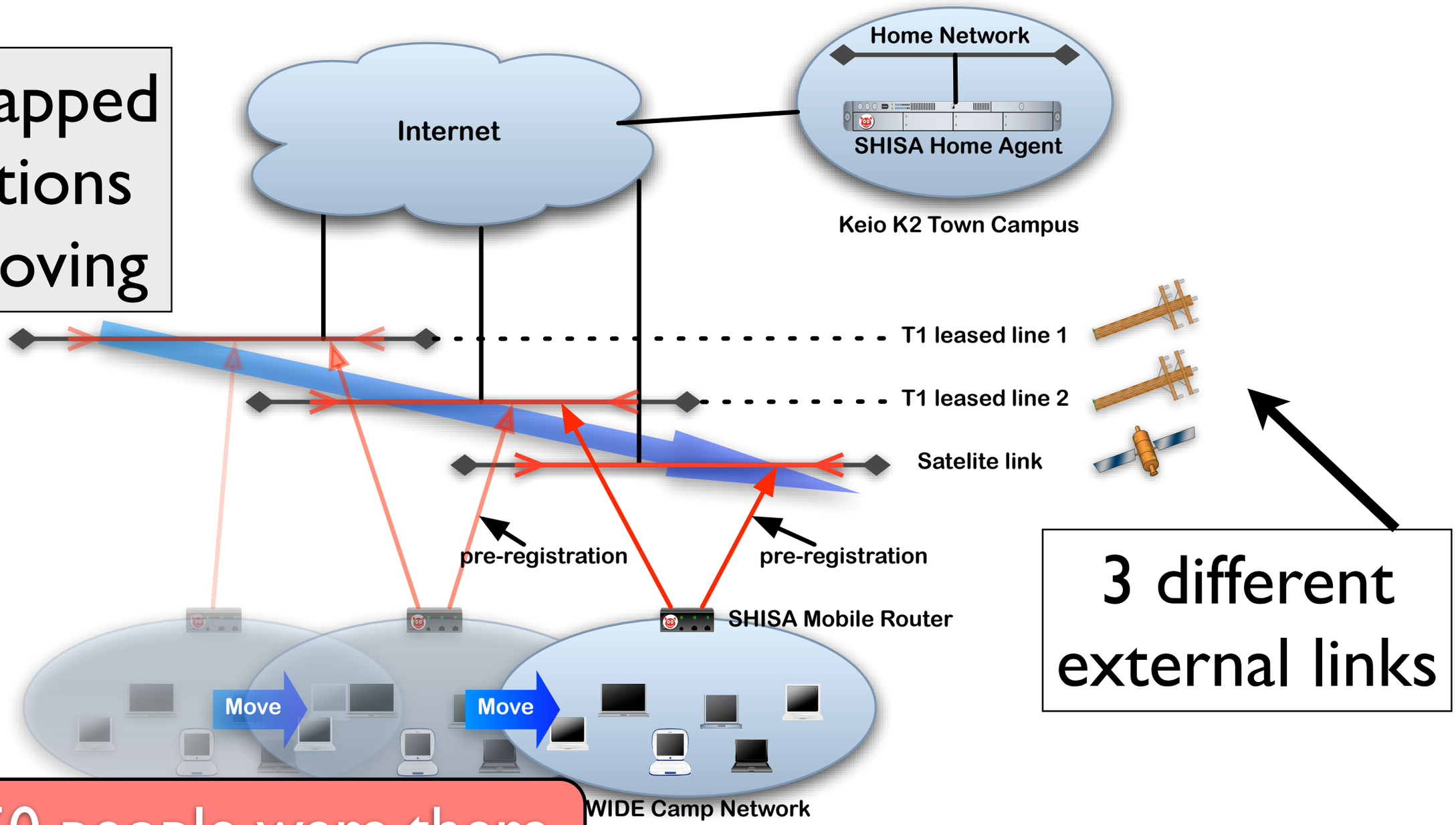
Multiple CoA Registration

- Multiple Interfaces at Mobile Host / Router
- Simultaneous registration of its CoAs
- Multiple tunnel connections between MH/MR and HA



Network Design at WIDE camp (Mar. 2006)

Overwrapped connections while moving



3 different external links

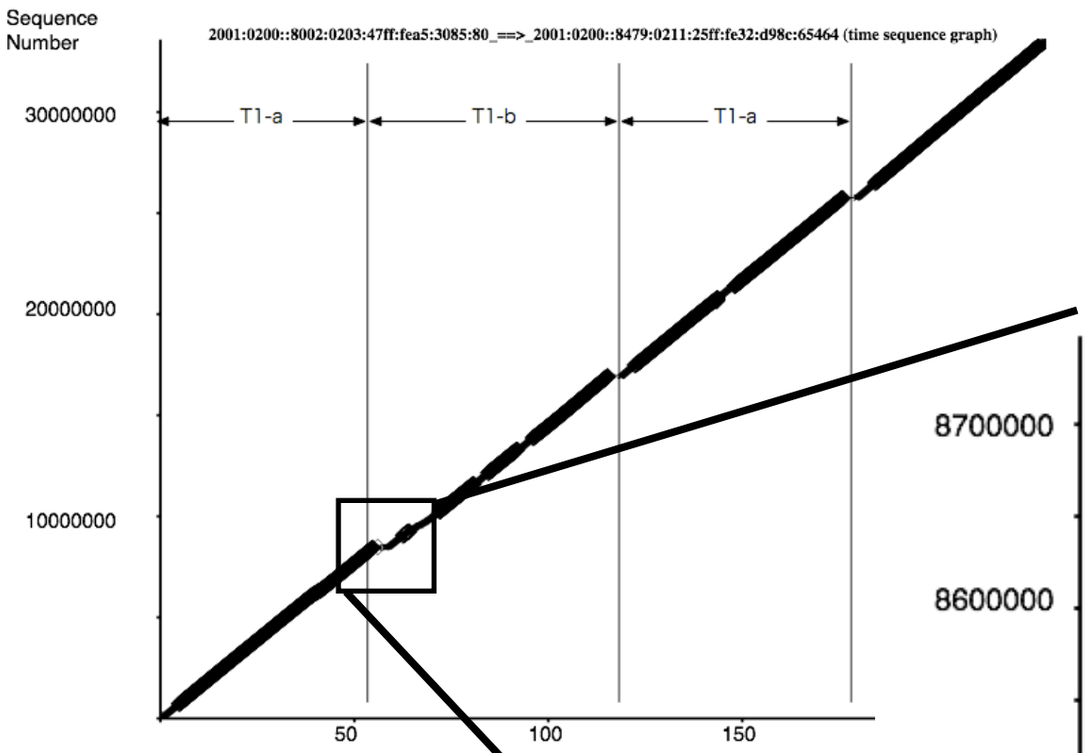
Over 250 people were there

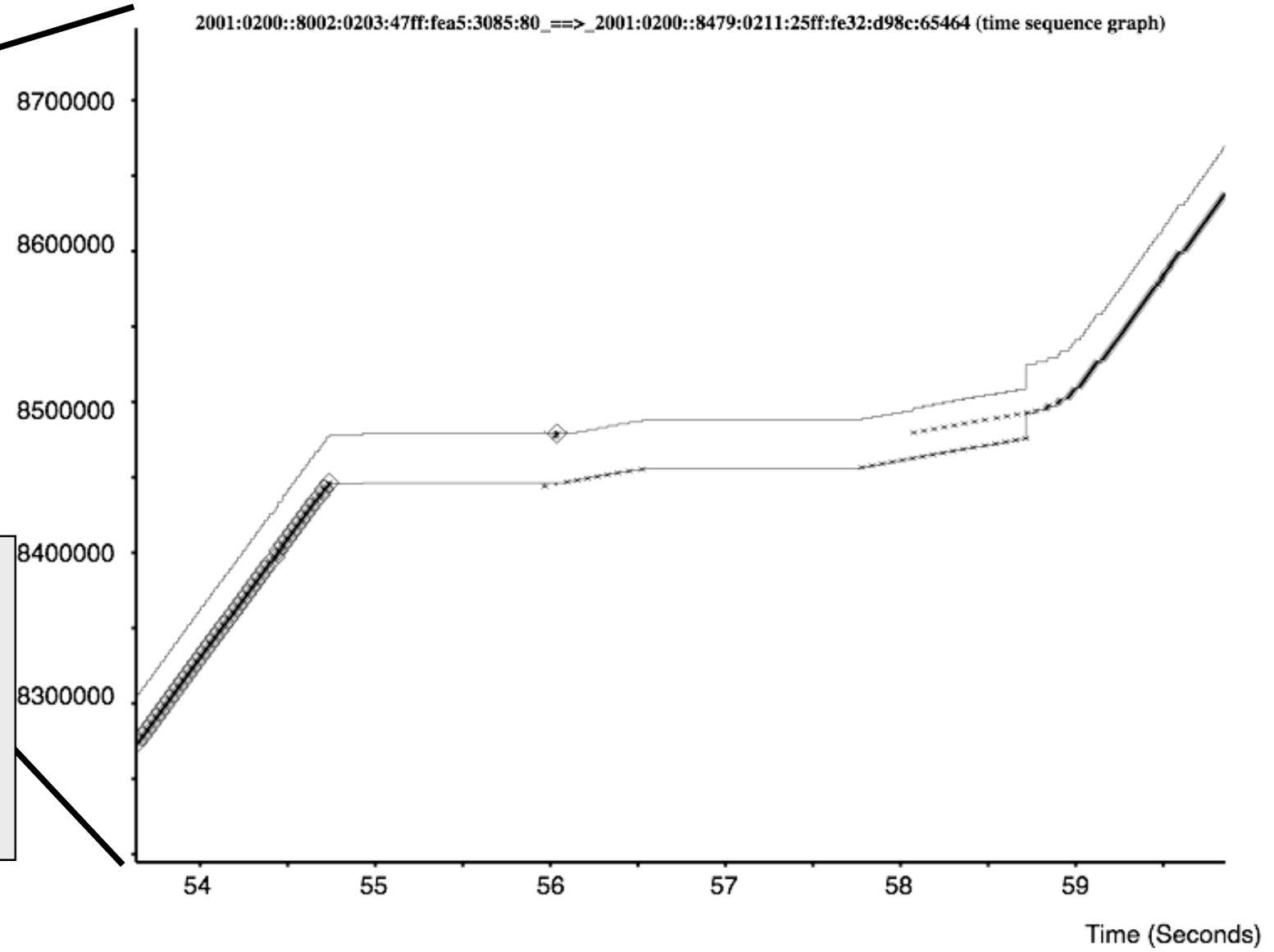
Result

- Packet loss rate was reduced
  - But, still got high loss rate sometimes
- Other problems were also found

From	Sent/Received	Loss rate
Nodes inside the mobile network	20472/19808	3.2%
	39601/35811	9.6%

TCP suspension





TCP Stream was suspended for a while when moving

Summary

- WIDE project is trying to develop technologies that are considered necessary in future mobile networking environment
- Implementation is important as well as researching problems
  - Implementing something give us many hints on researching
- Operational activity is also important
  - We are not only working for researching but making the world better

Future Plan

- Complete implementation and integrate them to BSD, Linux tree
- Perform many demonstration and operation to get experience and to advertise technologies
- Design and propose new technologies/ protocols based on experiments of demo and operation

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Thank you !