

An Operational Demonstration of a Mobile Network with a Fairly Large Number of Nodes

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also

Nautilus6/KAME/WIDE Project

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- Our requirements for NEMO operation
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Background

- NEMO (Network Mobility) protocol for IPv6 (NEMO BS) specification has been specified as RFC3963 in January 2005
- The usage of NEMO BS is to provide an IPv6 network to moving entities, such as buses, trains, and so on
- Protocol specification work has been done and we need a next step to operate the protocol

Realistic Testbed Needed

- 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?

- WIDE (Widely Integrated Distributed Environment, <http://www.wide.ad.jp/>) Project is a consortium consists of many universities and companies
- Working on technologies in various levels of distributed environment, from data-link layer to application layer
- Two 2-day meeting and two 4-day meeting every year to meet each other and discuss our

WIDE camp meeting

- 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

Goals of 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

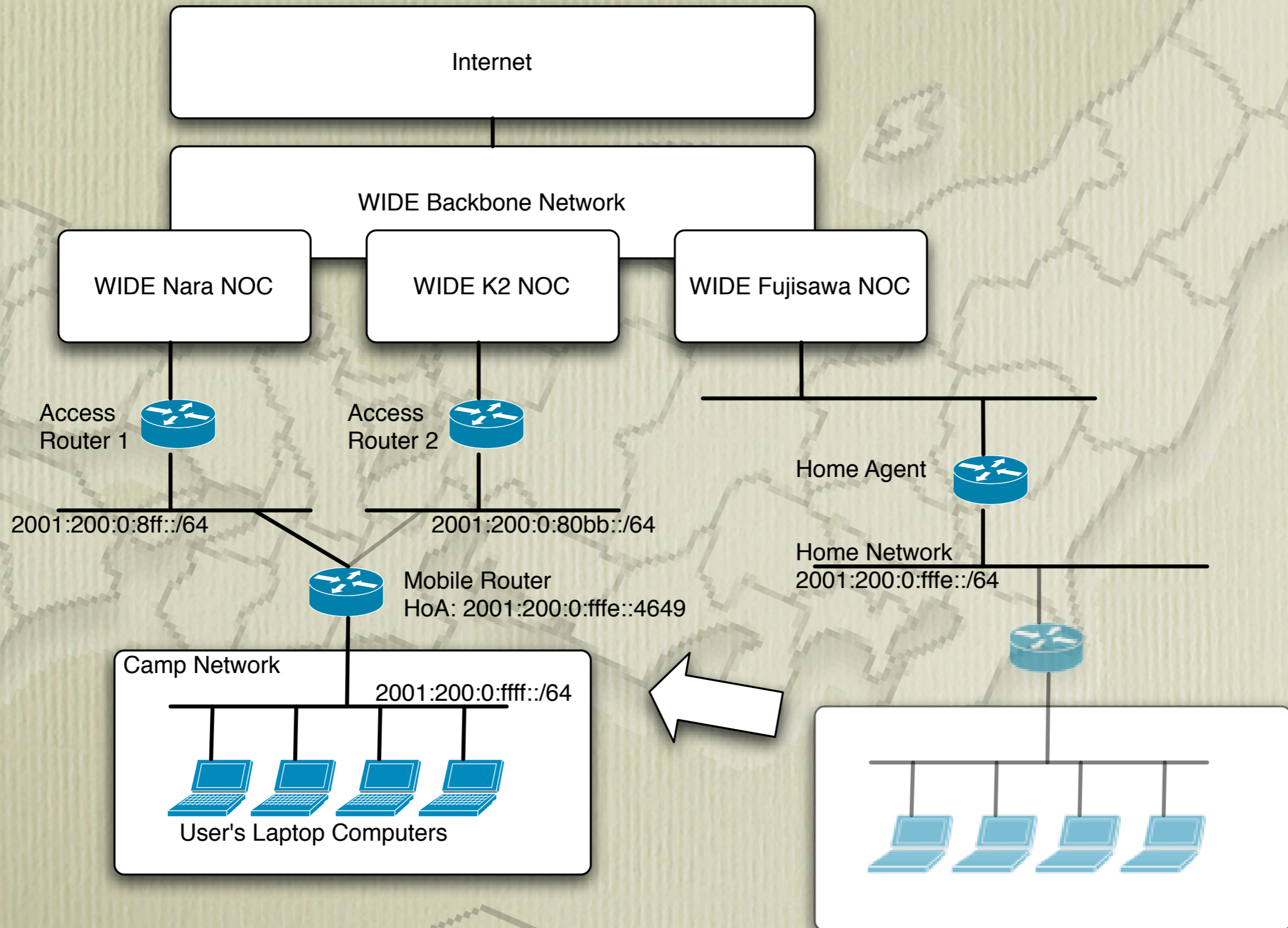
Requirements for Demo

- The conceptual image of the network is a large moving entity, like a train and its passengers
- Must contain a few hundred people in the network
 - We have to get people involved in the demo
- Must change the point of attachment of a mobile router periodically

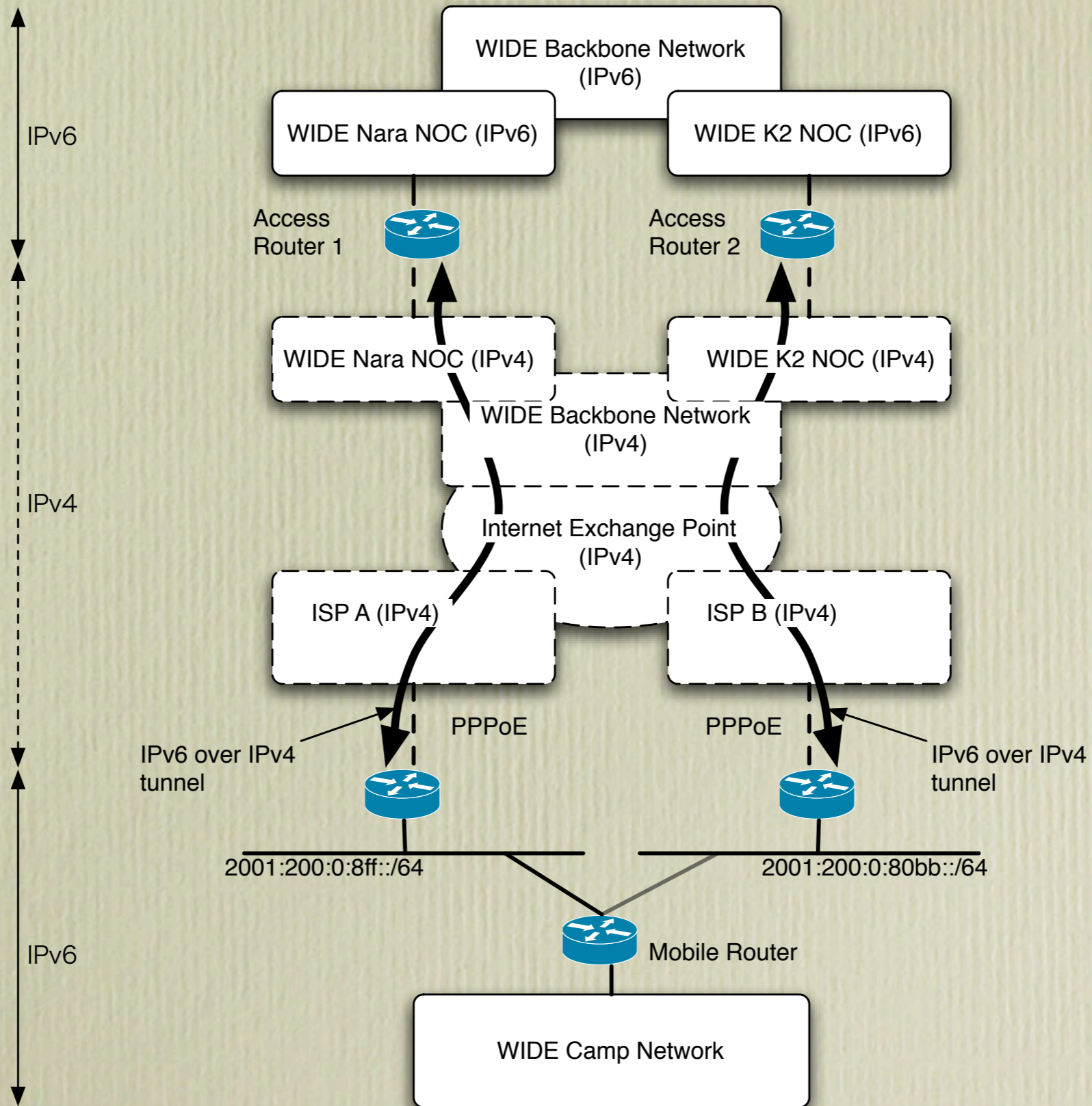
Network Topology for NEMO

- Provides two foreign networks for the mobile router on the edge
- The routes for the foreign networks should have different paths as much as possible

Network Topology (Logical)



Network Topology (Physical)



Equipments

- Mobile Router
 - FreeBSD5.4-RELEASE with KAME/
SHISA Mobile IPv6/NEMO protocol stack
- Home Agent
 - NetBSD2.0 with KAME/SHISA Mobile
IPv6/NEMO protocol stack
- IPv6 over IPv4 devices
 - FreeBSD5.4-RELEASE using gif interface
 - Hitachi GR-2000 (at K2), FreeBSD5.4-
RELEASE (at Nara)

Get people involved

- Usually it is hard to make people be involved in experiments
 - The interest of the organizer and participants usually differs
 - The user terminals / operating systems are not easy to change
- In NEMO case, it was quite easy
- To make people more interested, we also provided a simple interface to change the movement frequency

User Interface

The screenshot shows a web browser window with the title "The user feedback page for movement frequency determination". The address bar contains the URL "http://kirikae.camp.wide.ad.jp/speed/index.php". The browser's menu bar includes "Apple (40)", "Yahoo!", "Microsoft", "News (103)", "Kayak", "Shopping", "Money", "Gallery", "Dictionary", and "Travel". The page content features a large heading "IPv6 NEMO UI" and a sub-heading "Let's decide the speed of your mobile network". Below this, it states "Current speed: *Warp 2.00*". A section titled "Current voting status" shows two options: "less speed" with "0 votes" and "more speed" with "0 votes". A horizontal bar with a blue segment on the left and a red segment on the right represents the voting progress. Below the bar are two buttons: "Vote for less speed!" and "Vote for more speed!", connected by a dashed double-headed arrow. At the bottom, it says "Next speed change is planned at: *2005/09/6 13:20:00*".

The user feedback page for movement frequency determination

http://kirikae.camp.wide.ad.jp/speed/index.php

Apple (40) Yahoo! Microsoft News (103) Kayak Shopping Money Gallery Dictionary Travel

The user feedback page ... An operational demonstr... ページを開けませんでした

IPv6 NEMO UI

Let's decide the speed of your mobile network

Current speed: *Warp 2.00*

Current voting status

less speed
0 votes

more speed
0 votes

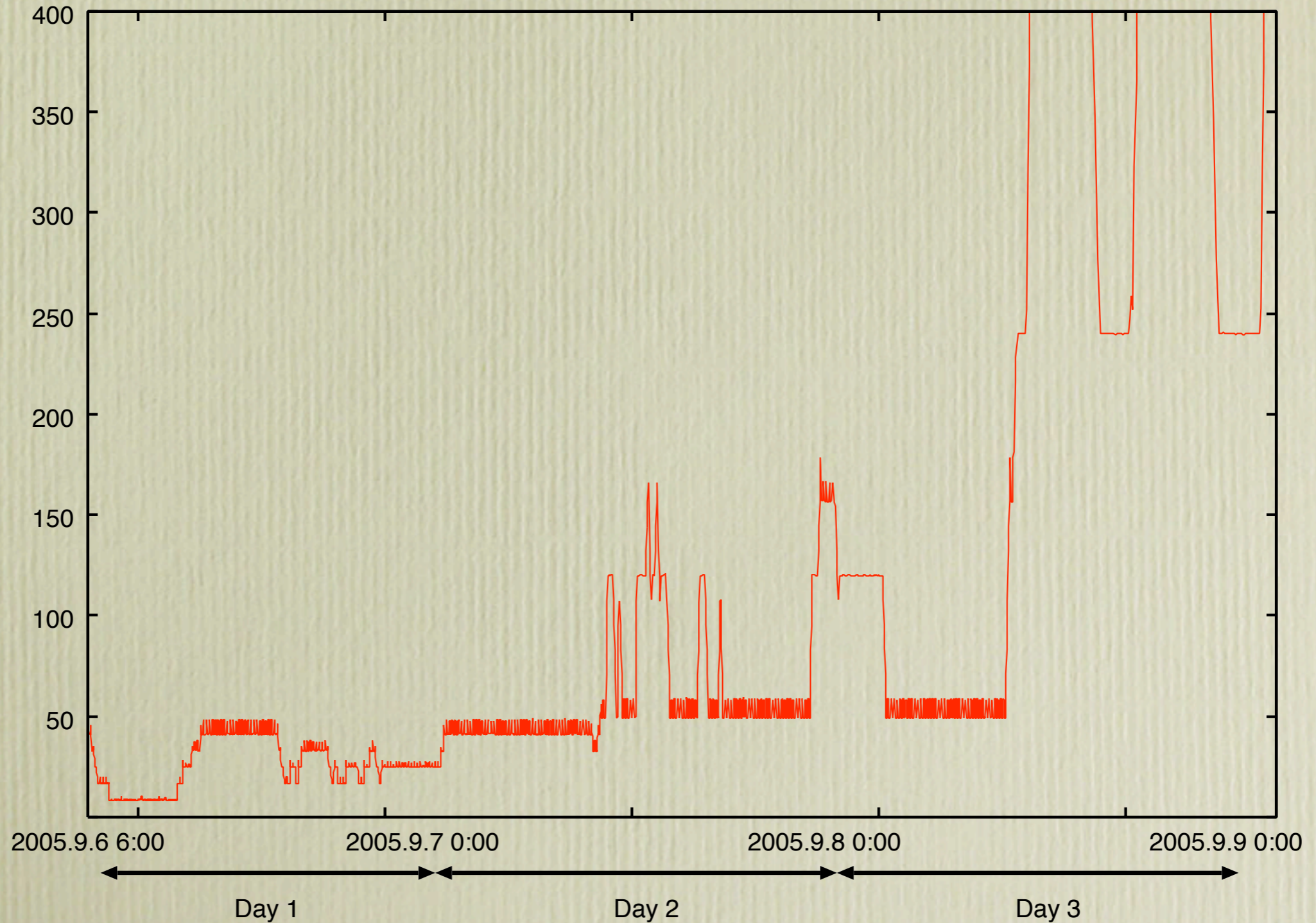
Vote for less speed! <-----> Vote for more speed!

Next speed change is planned at: *2005/09/6 13:20:00*

Results

Movement Frequency

Movement Interval
(seconds)



Results

Packet loss rate

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

Consideration of the Results

- The loss rate on the nodes inside the mobile network was much larger than that of the mobile router
- We have never seen the problem in our small testbed experiments
 - ?? Because the equipments used for the demonstration were different
 - ?? Because the number of participants were quite large

Next Plan of demo

- We will perform a similar demonstration in March with similar equipments used in this demonstration
 - In addition to BSD based MR, Linux based MR will be also tested
 - We can check if the problem is related to the equipments
- The service disruption cannot be avoided in theory as long as we only use one external connection
 - Using the Multiple Care-of Address Registration mechanism to reduce the disruption as much as possible

Conclusion

- We operated a NEMO network as an infrastructure network used by a meeting
- Making a network as a NEMO network is easy; that means there will not be big deployment problems
- We saw service disruption during handover of a mobile router
 - We will investigate the reason at the next experiment, and will try to operate an advanced function to reduce the disruption