Vehicle Communication Experiment Environment With MANET And NEMO
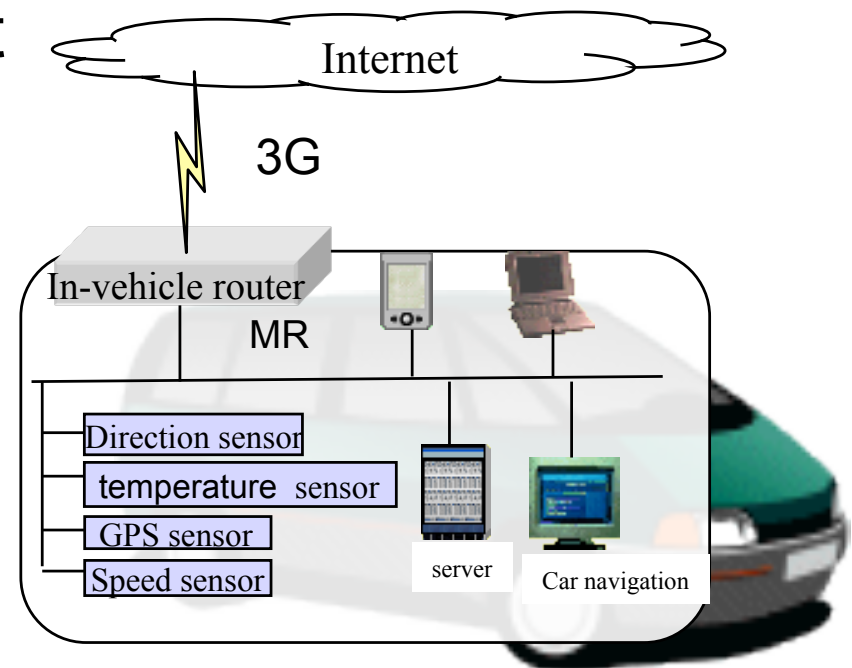
Manabu Tsukada

Thierry Ernst

2007/01/15

KEIO UNIVERSITY
CALAMVS GLADIO FORTIOR
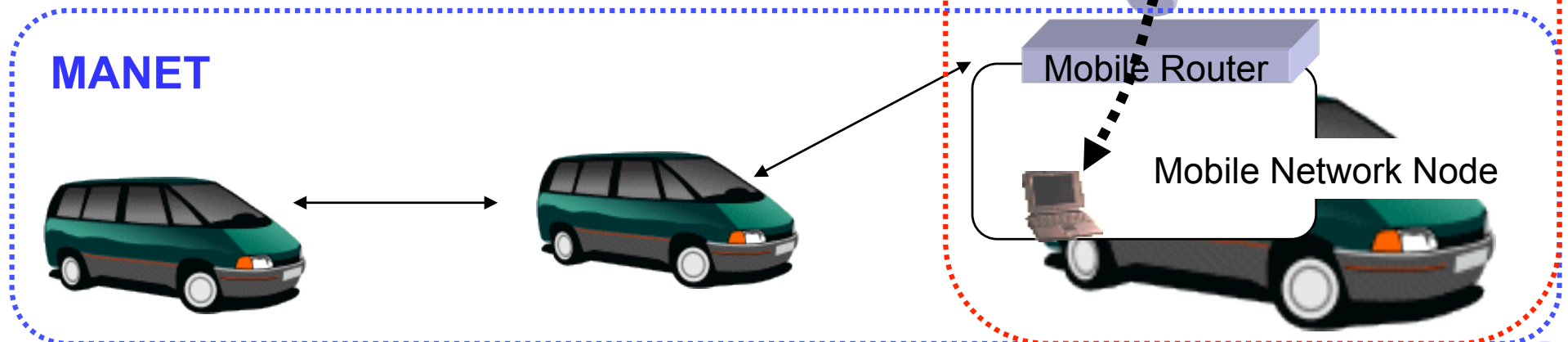1858

Nautilus6

IMARA

INRIA

Introduction

- Vehicle communication
- Intelligent Transportation System (ITS)
  - Solution for traffic control
    - Car position
    - Car speed
  - Solution for traffic accident
    - Car position
    - Rapid Brake activation

- Vehicle information sharing in IPv6

Internet

3G

In-vehicle router

MR

Direction sensor

temperature sensor

GPS sensor

Speed sensor

server

Car navigation

Technologies

- ## Network Mobility
  - ○ NEMO Basic Support protocol
  - ○ RFC3963
  - ○ Refer as Vehicle to Infrastructures (V2I)
- ## Mobile Adhoc Network (MANET)
  - ○ Optimized Link State Routing Protocol (OLSR)
  - ○ RFC3626
  - ○ Refer as Vehicle to Vehicle (V2V)

NEMO

Correspondent Node

Home Agent

Internet

IP in IP tunnel

X Care-of Address

Mobile Router

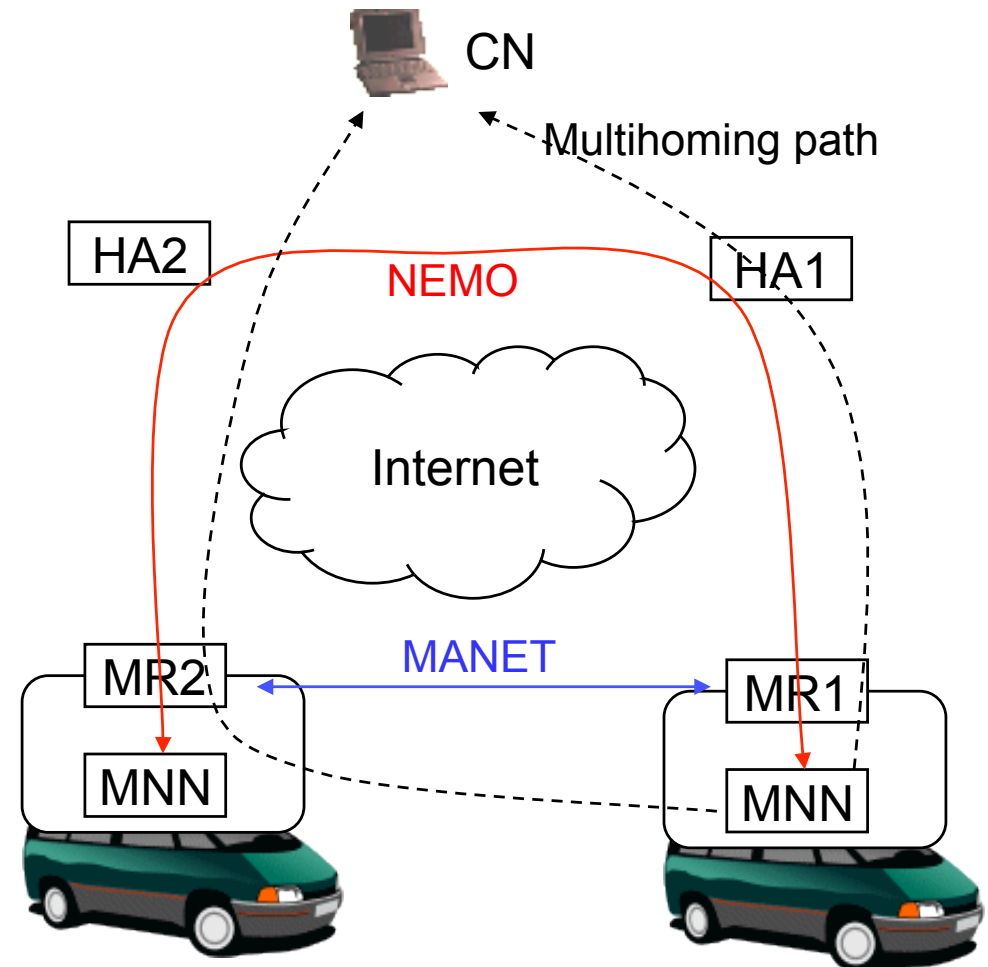Mobile Network Node

MANET

Objectives

- ## Investigate MANEMO (MANET + NEMO)
  - Route optimization
  - Multihoming

- ## Setup Real-field Testbed
  - Network performance Evaluation
  - Development environment
  - Demonstration

CN

Multihoming path

HA2

NEMO

HA1

Internet

MR2

MANET

MR1

MNN

MNN

MANEMO analysis

- **Same node**
  - Type 1

- **Separate node**
  - All node connect same network (1 case) — Type 2
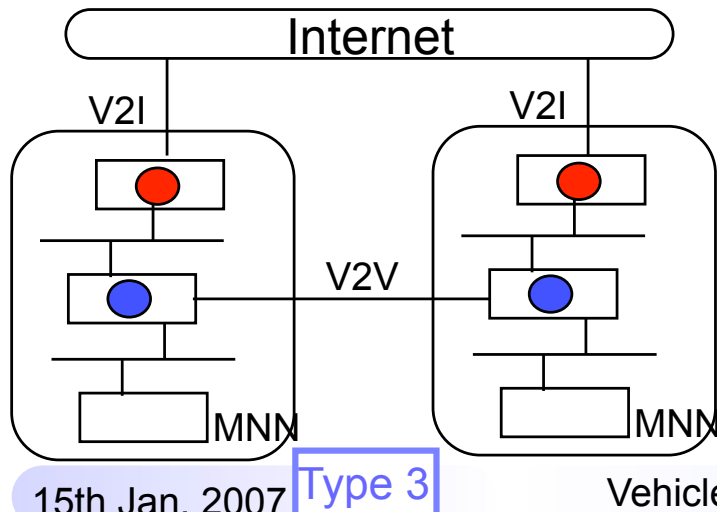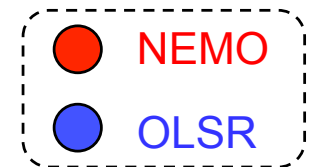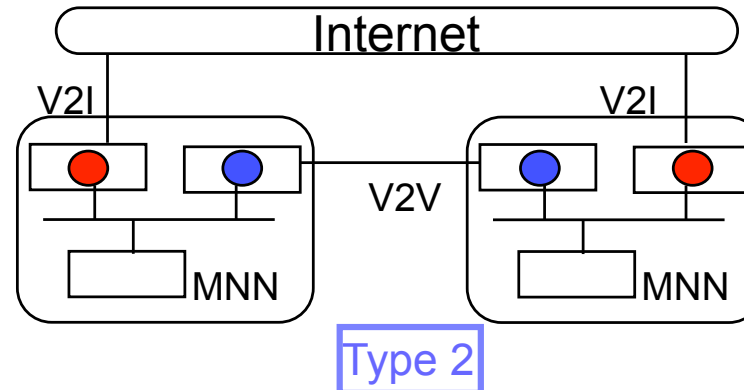 - Separated network (3 case) — Type 3 Type 4 Type 5

Type 1
Internet — V2I / V2V / MNN (NEMO, OLSR)

Type 2
Internet — V2I / V2V / MNN

Type 3
Internet — V2I / V2V / MNN

Type 4
Internet — V2I / V2V / MNN

Type 5
Internet — V2I / V2V / MNN

Legend:
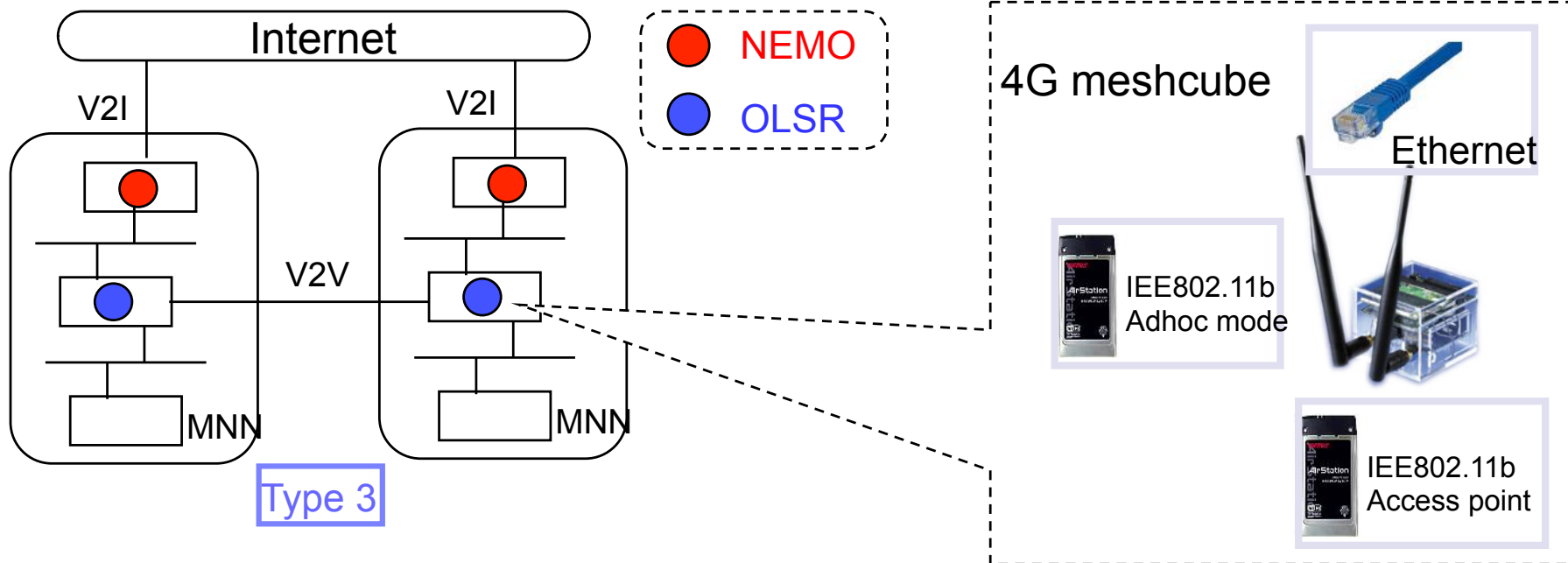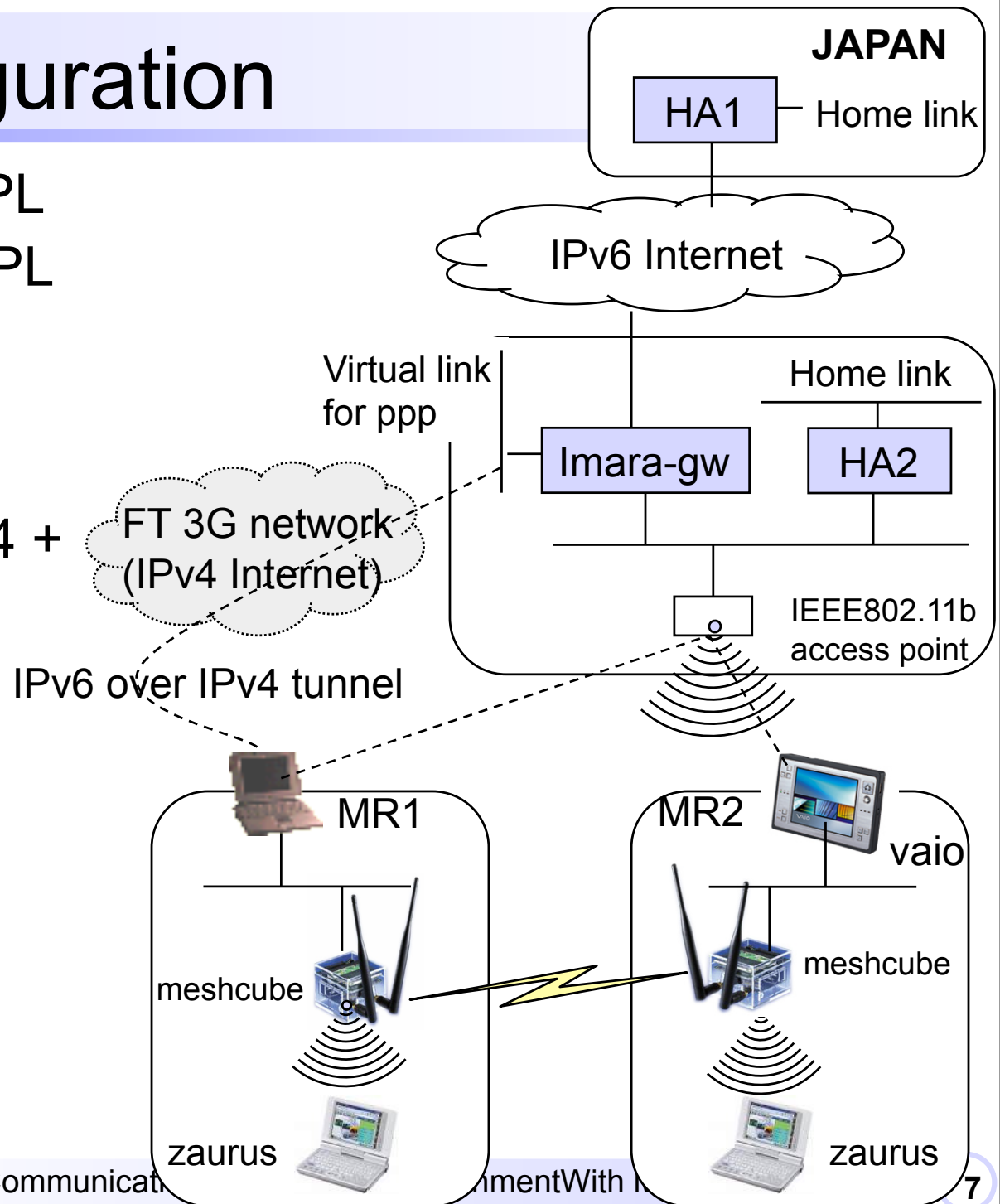- 🔴 NEMO
- 🔵 OLSR

Focus network

- ## Focus type 3
  - ○ Network reason
    - OLSR route is better than NEMO route (normally)
    - OLSR route should be checked first
  - ○ Equipment reason
    - 4G meshcube is used in demonstration
    - 4G meshcube has 3 interfaces (Ethernet, Wifi access point, adhoc mode)

Internet

V2I

V2I

V2V

MNN

MNN

Type 3

NEMO

OLSR

4G meshcube

Ethernet

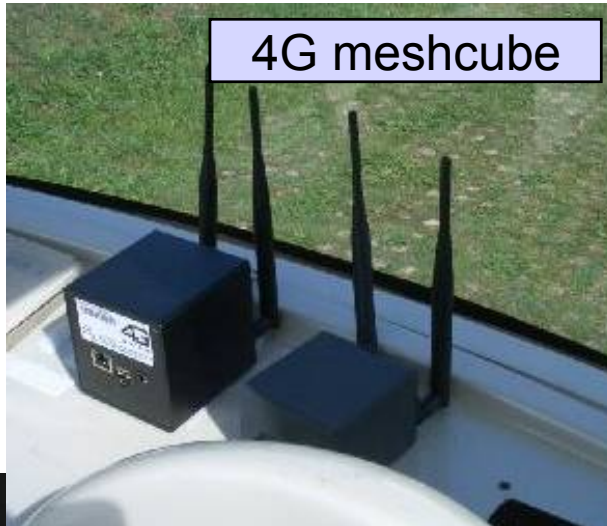IEE802.11b Adhoc mode

IEE802.11b Access point
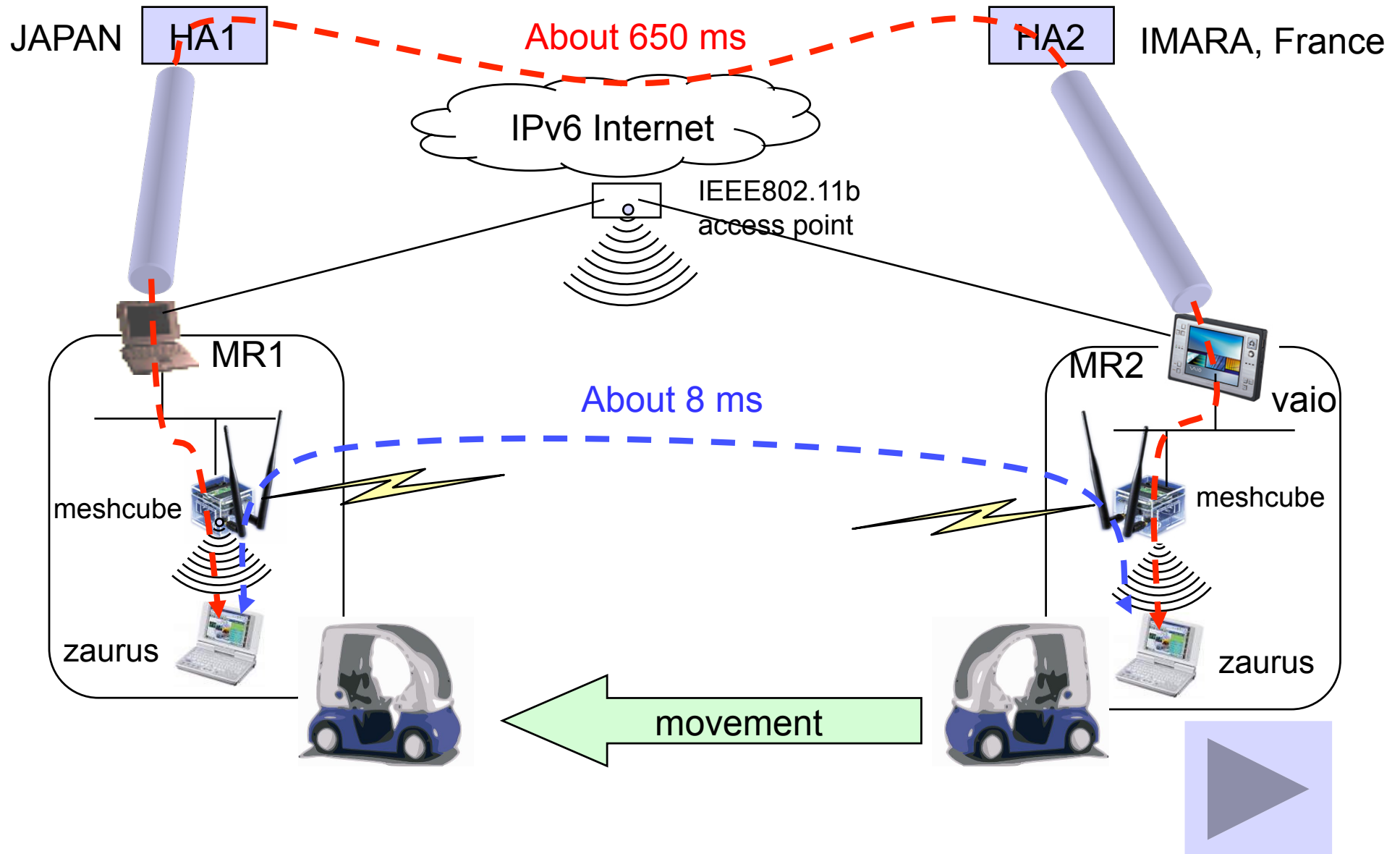
Testbed configuration

- HA: linux 2.6.15 + NEPL
- MR: linux 2.6.15 + NEPL
- Imara-gw
  - L2tp server
  - Access router
- Meshcube: linux 2.4.24 + olsrd
- Zaurus: linux 2.4.18

JAPAN

HA1 — Home link

IPv6 Internet

Virtual link for ppp

FT 3G network (IPv4 Internet)

Home link

Imara-gw   HA2

IEEE802.11b access point

IPv6 over IPv4 tunnel

MR1   MR2

vaio

meshcube   meshcube

zaurus   zaurus

devices

4G meshcube

CyCab

Vaio (MR)

Zaurus (MNN)

Demonstration

HA1 **About 650 ms** HA2 IMARA, France

IPv6 Internet

IEEE802.11b
access point

MR1

About 8 ms
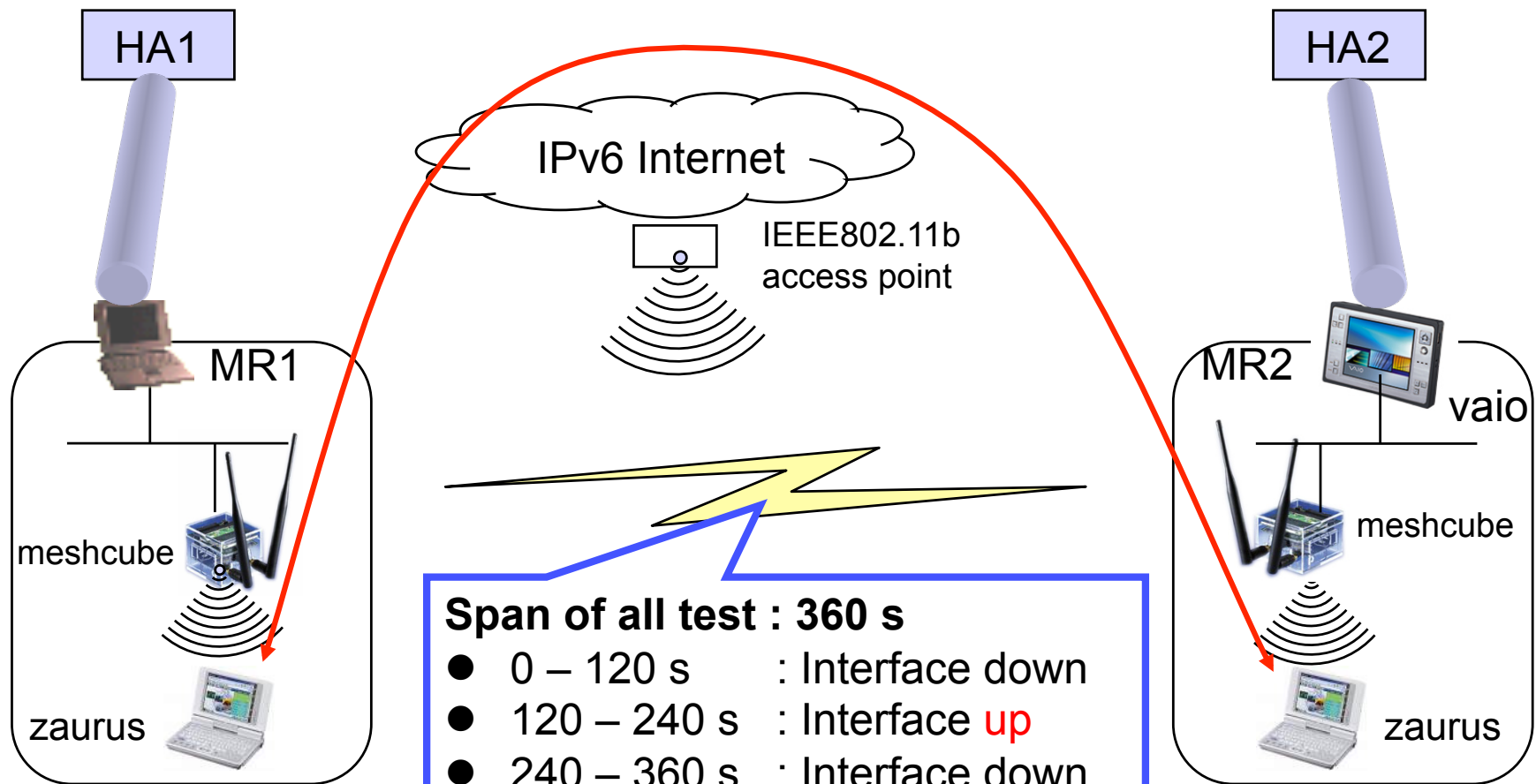
meshcube

MR2

vaio

meshcube

zaurus

zaurus

movement

Evaluation

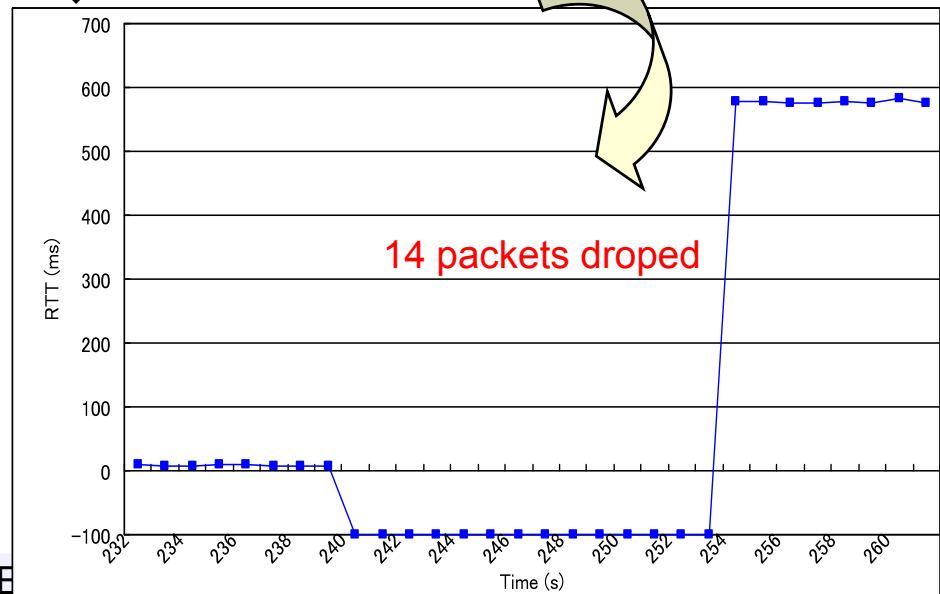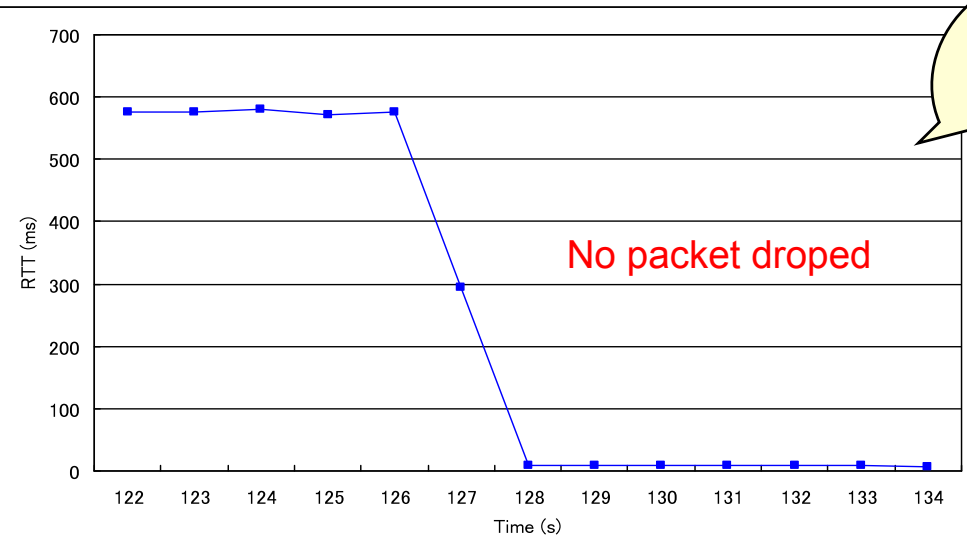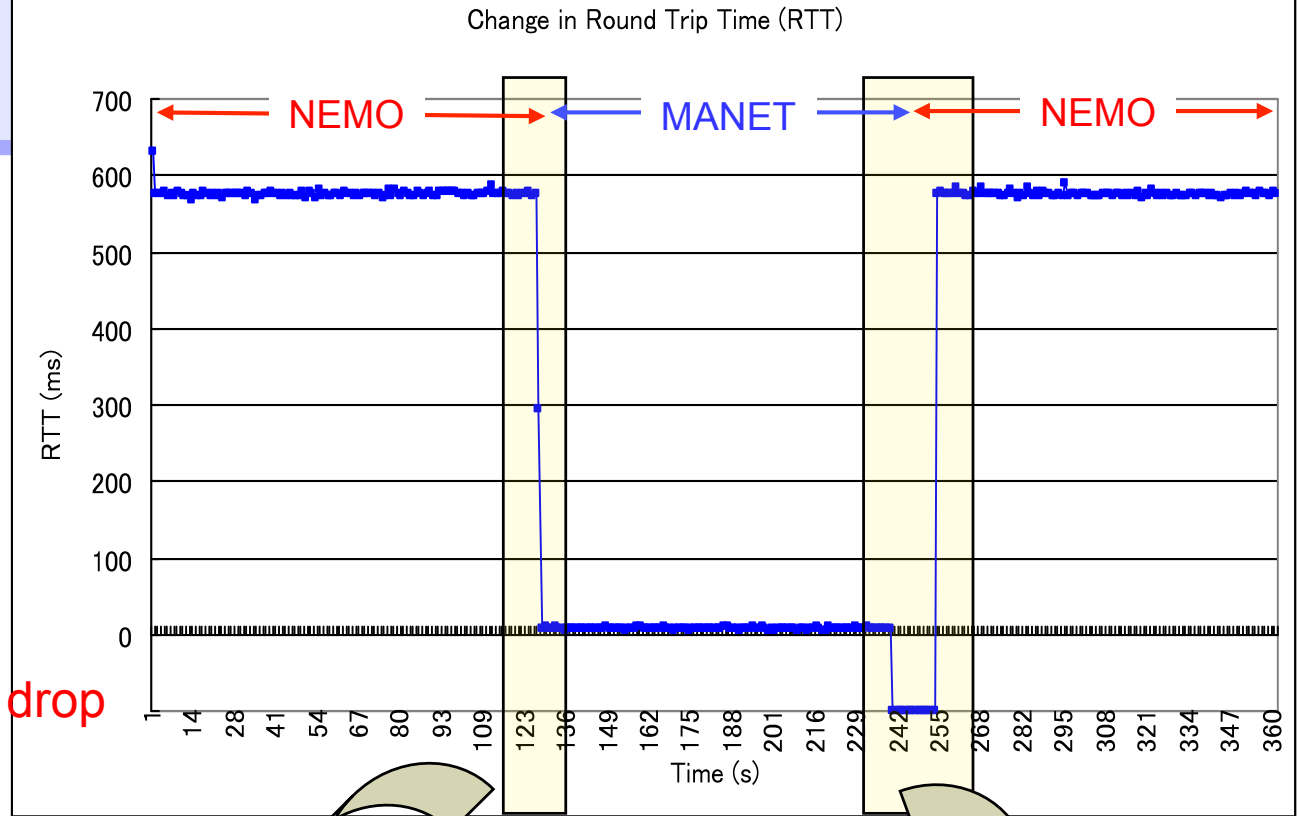- Evaluation 1
  - ○ HA1 in Japan
  - ○ NEMO route RTT 574 ms

- Evaluation 2
  - ○ HA1 in IMARA network
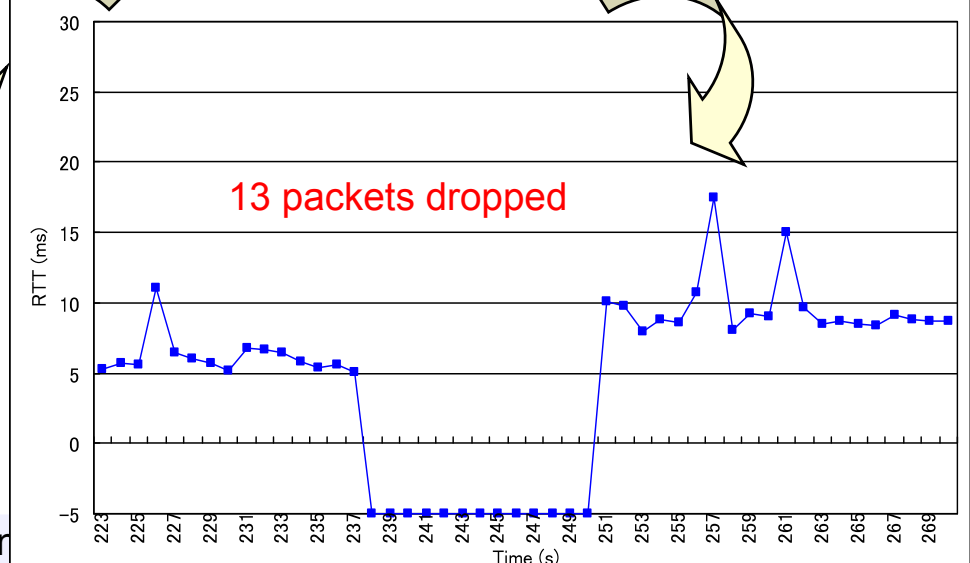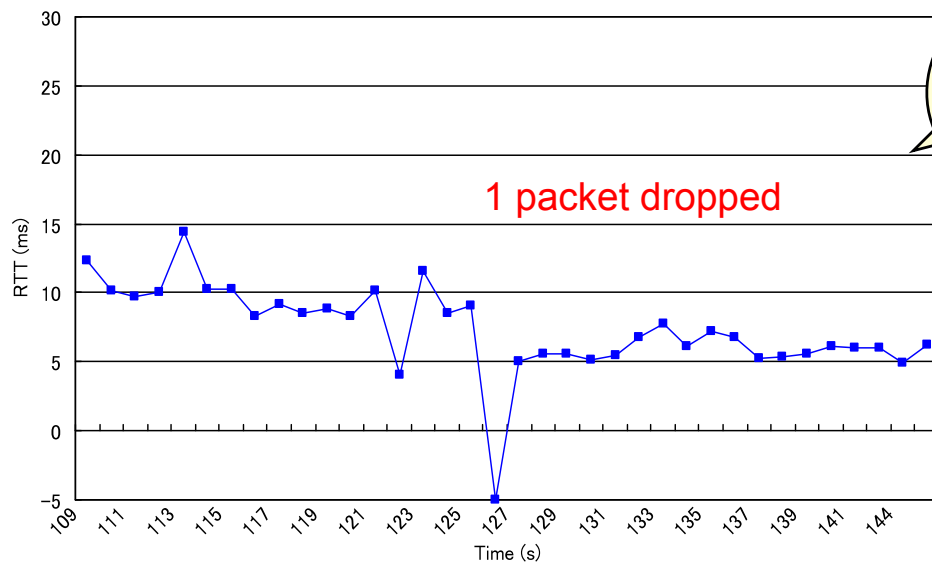 - ○ NEMO route RTT 9.06 ms

HA1

HA2

IPv6 Internet

IEEE802.11b
access point

MR1

MR2

vaio

meshcube

meshcube

zaurus

zaurus

Span of all test : 360 s
- 0 – 120 s   : Interface down
- 120 – 240 s   : Interface up
- 240 – 360 s   : Interface down
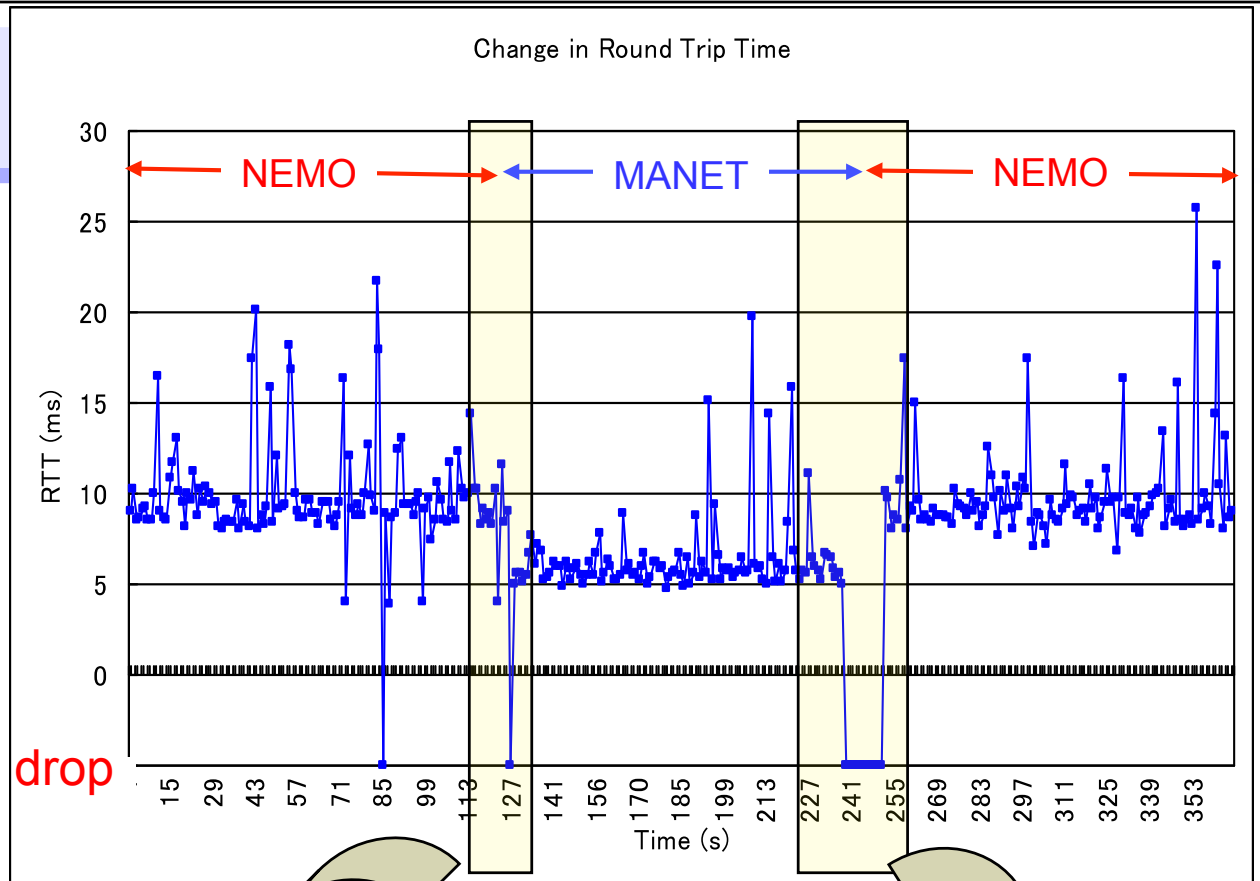
Vehicle Communication Experiment EnvironmentWith MANET And NEMO

Evaluation(1)

- HA in Japan

- Round Trip Time (RTT)
- NEMO route
  - 574 ms (average)
- MANET route
  - 7.63 ms (average)

Change in Round Trip Time (RTT)

drop

No packet droped

14 packets droped

Vehicle Communication E

Evaluation(2)

- HA in IMARA network

- Round Trip Time (RTT)
- NEMO route
  - 9.06 ms (average)
- MANET route
  - 7.11 ms (average)

Change in Round Trip Time

Conclusions and future works

- Conclusions
  - MANEMO can enhance network performance
  - Trade off to change MANET route
    - Some packet can be lost when the route change form MANET to NEMO
    - Few packet is lost from NEMO to MANET
- Future works
  - Multihop MANET evaluation
  - Hand over optimization
    - Parameters configuration (HELLO message interval, etc)
    - Wireless links aware
  - Multihoming
    - Multiple Care-of Addresses registration
    - draft-wakikawa-monami-multiplecoa-01.txt
  - Adaptive application

Fin

- Thank you for listening.
- Any Question?

- Graduate School of Media and Governance, Keio University

- http://www.nautilus6.org/   (Nautilus6 Project)

- IMARA

○ Manabu Tsukada <tu-ka@sfc.wide.ad.jp>
○ Thierry Ernst <thierry.ernst@inria.fr>