Implementation and Evaluation of the Dual Stack Mobile IPv6

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Outline

- Motivation
- DSMIPv6 operation
- Design & Implementation
- Evaluation
- Conclusion

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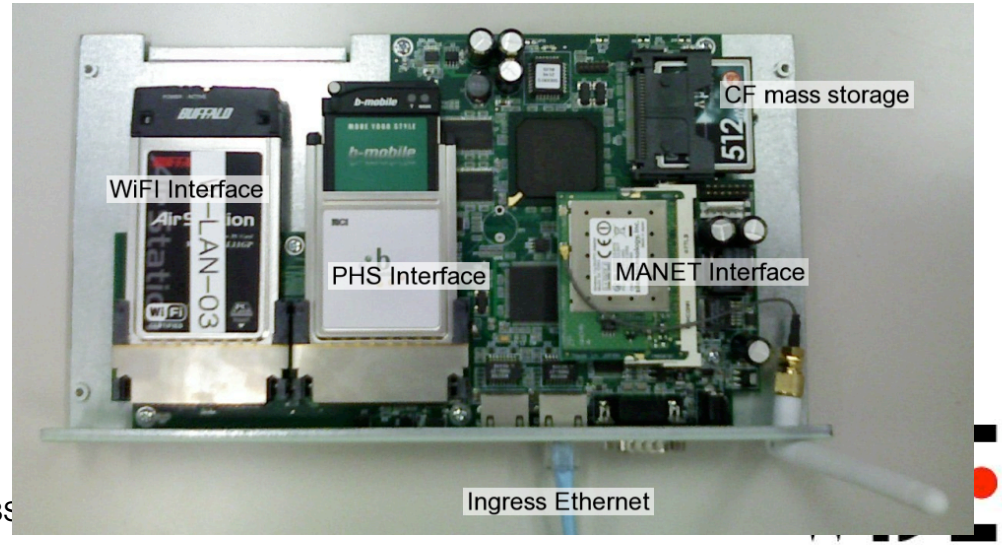
Background

- IPv6 is deployed
- IPv6 involves vast number of non-PC nodes
  - cellular phones, automobiles, sensor devices, etc.
- Mobility is a key feature
- MIPv6(RFC3775), NEMO BS(RFC3963) have been standardized
- However we are still living on:
  - IPv4 access network
  - IPv4 application

Example Configuration of current MIPv6 experiments

- No IPv6 wireless network access unless you made it by yourself
- Many IPv6 applications
  - DNS servers, some WWWs, Mail servers, VoIP, Video Streaming
- Still many IPv4 only application
  - Major WWWs, IMs

InternetCAR
in-vehicle router →



DSMIPv6

- Dual Stack
  - support both IPv6 and IPv4
- An extension of MIPv6/NEMO BS to support
  - IPv4 Care-of Address
  - IPv4 Home Address/Mobile Network Prefix
- "MIPv6 + its extension" is lower cost than "MIPv4 + MIPv6"
  - We will use MIPv6 in the near future
  - We will stop to use MIPv4 in the near future

Purpose

- DSMIPv6 spec. is under development
- Specification Validation:
  - Confirm it can be implemented
  - Confirm it can work as expected

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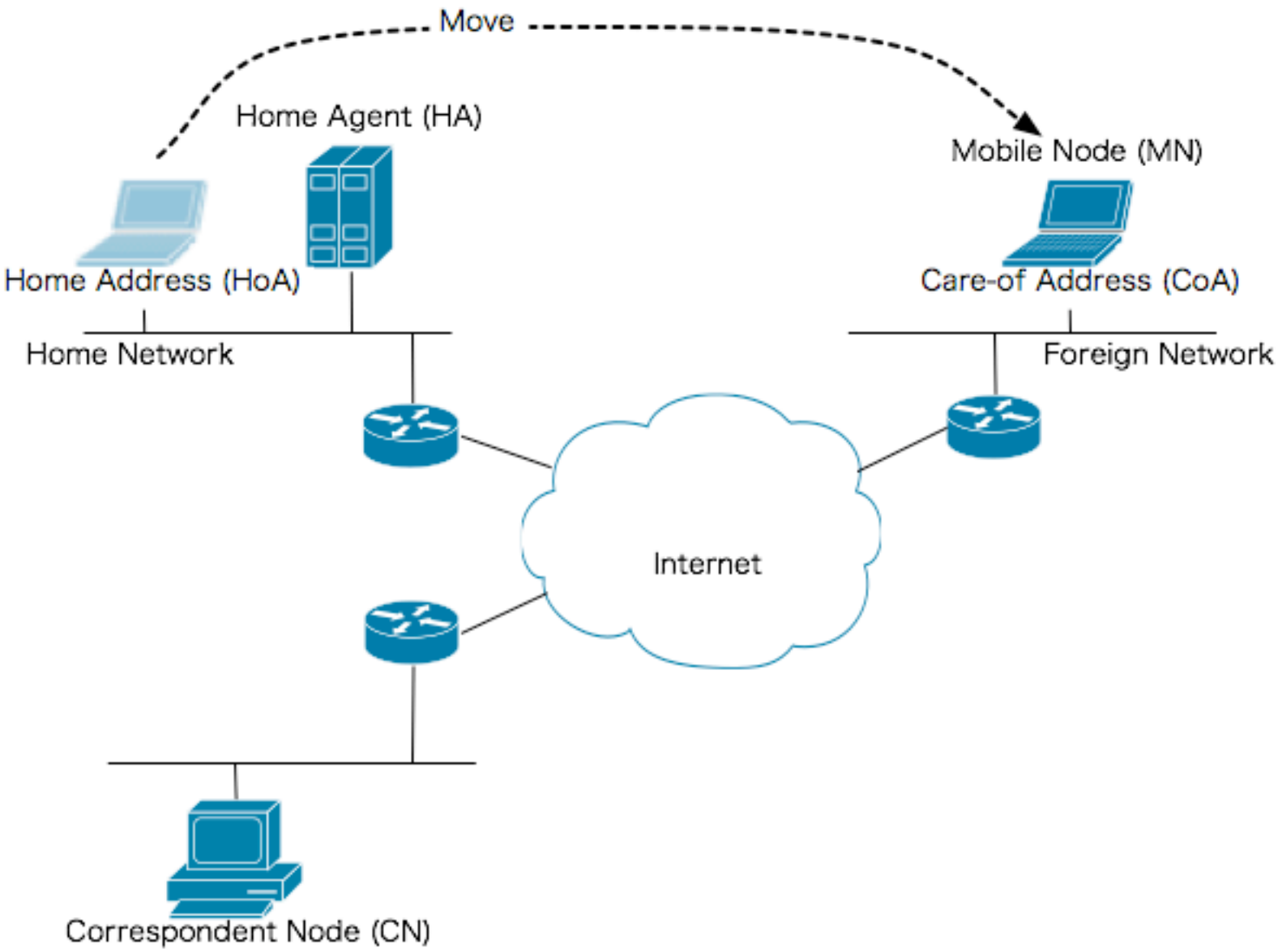
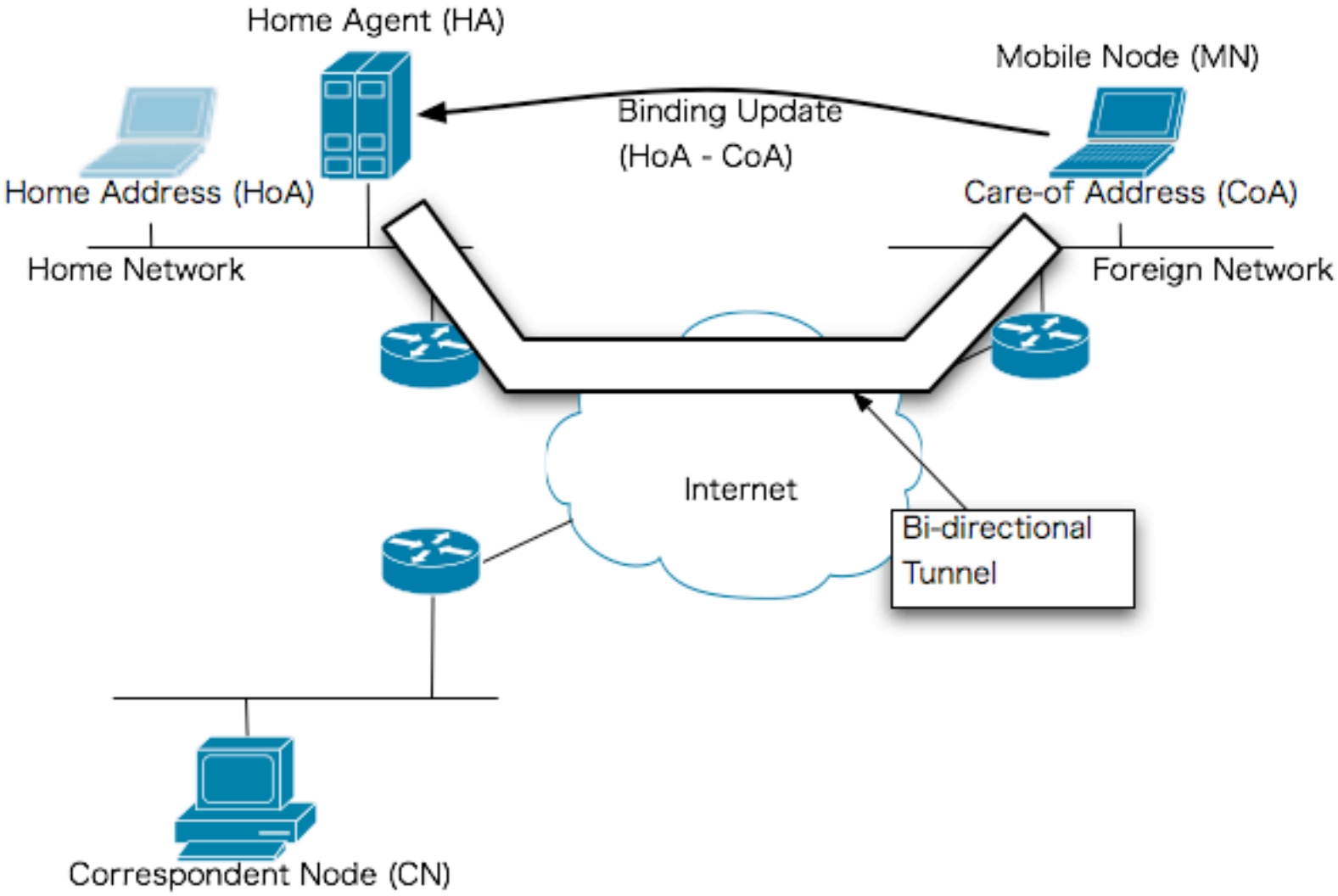
MIPv6 operation



MIPv6 operation



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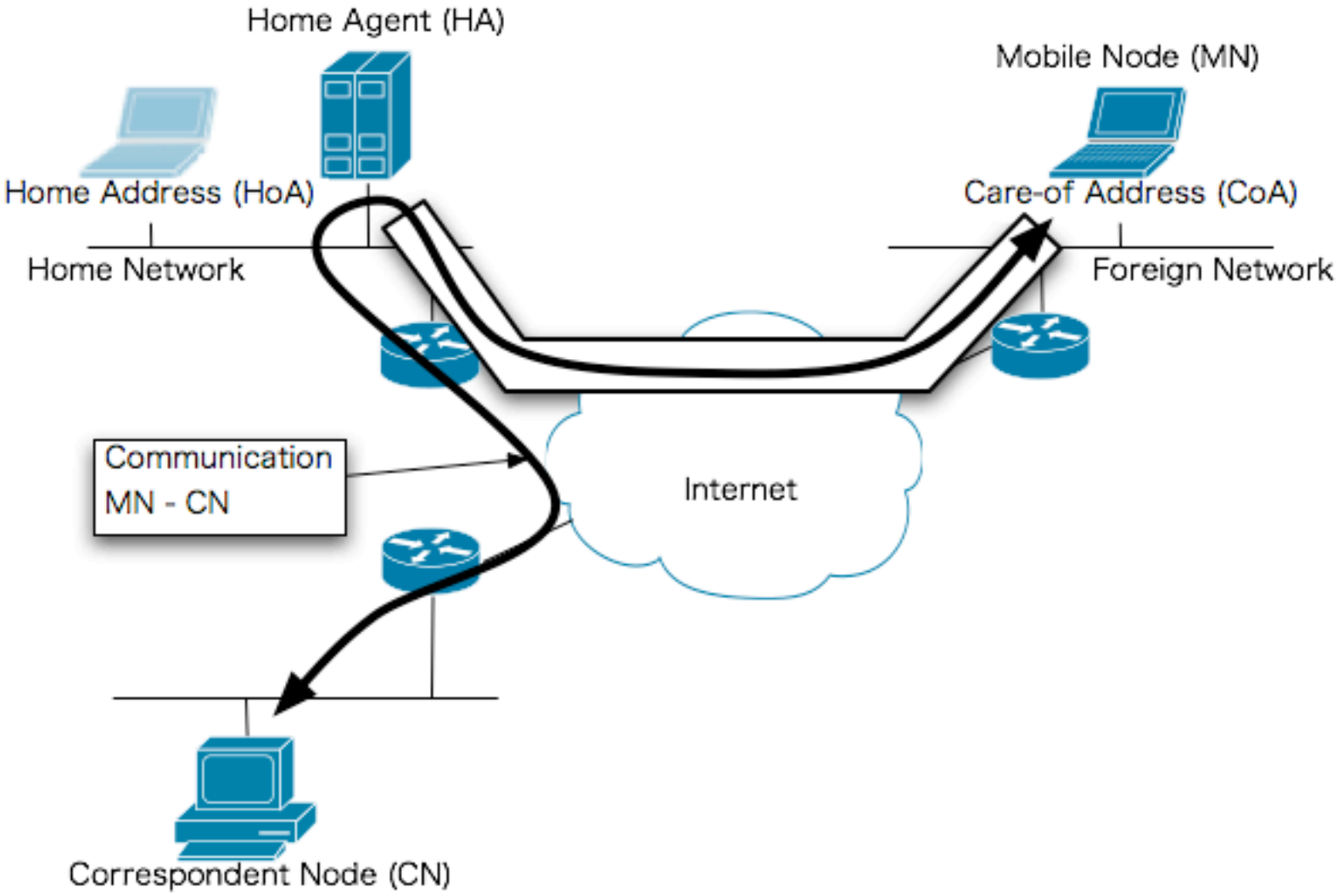
MIPv6 operation



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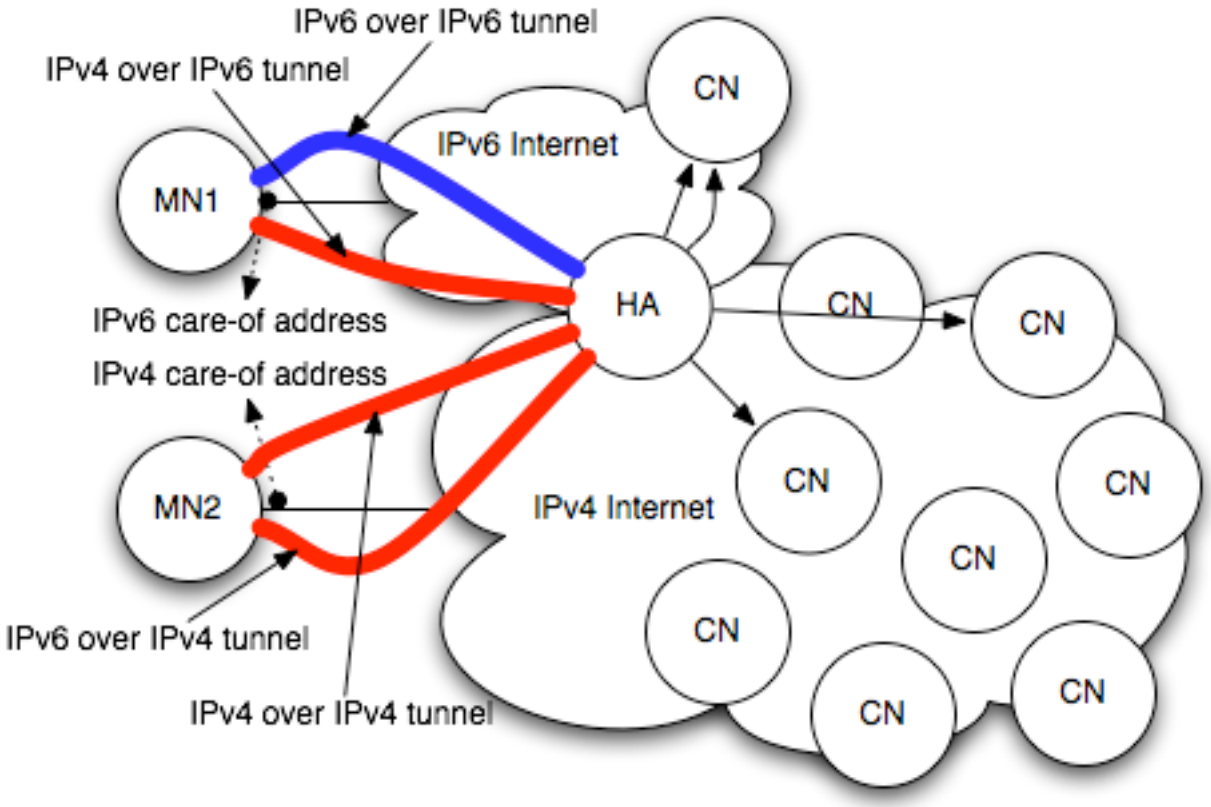
DSMIPv6 concept



MIPv6 provides IPv6 over IPv6 tunnel (blue line)
DSMIPv6 provides other tunnels (red line)

Binding Management

- Including IPv6 and IPv4 home addresses
- Creating binding cache entries for both home addresses
- Sending/Receiving packets
  - The format is varies depending on the visited network
    - IPv6 global network
    - IPv4 global network
    - IPv4 private network

Visiting IPv6 foreign network

- MIPv6 BU:

  IPv6 header (src=V6CoA, dst=V6HA)

  Destination option (V6HoA)

  Mobility header (BU)

- DSMIPv6 BU:

  IPv6 header (src=V6CoA, dst=V6HA)

  Destination option (V6HoA)

  Mobility header (BU)

  [IPv4 home address option]

Visiting IPv4 only foreign network

IPv4 header (src=V4CoA, dst=V4HA)

UDP header

IPv6 header (src=V4MAPPED, dst=V6HA)

Destination option (HoA)

Mobility header (BU)

[IPv4 home address option]

Functional Requirements

1. Extending Binding Management
   - to handle IPv4 care-of address and IPv4 home address
2. Detecting IPv4 care-of address
3. Sending & Receiving binding update messages
   - via IPv4
   - IPv4 home address option
4. Sending & Receiving binding acknowledgment messages
5. Establishing(Configuring) bi-directional tunnels
   - (IPv6-IPv6) IPv4-IPv6, IPv6-IPv4 , and IPv4-IPv4
6. Processing bi-directional tunneled packets

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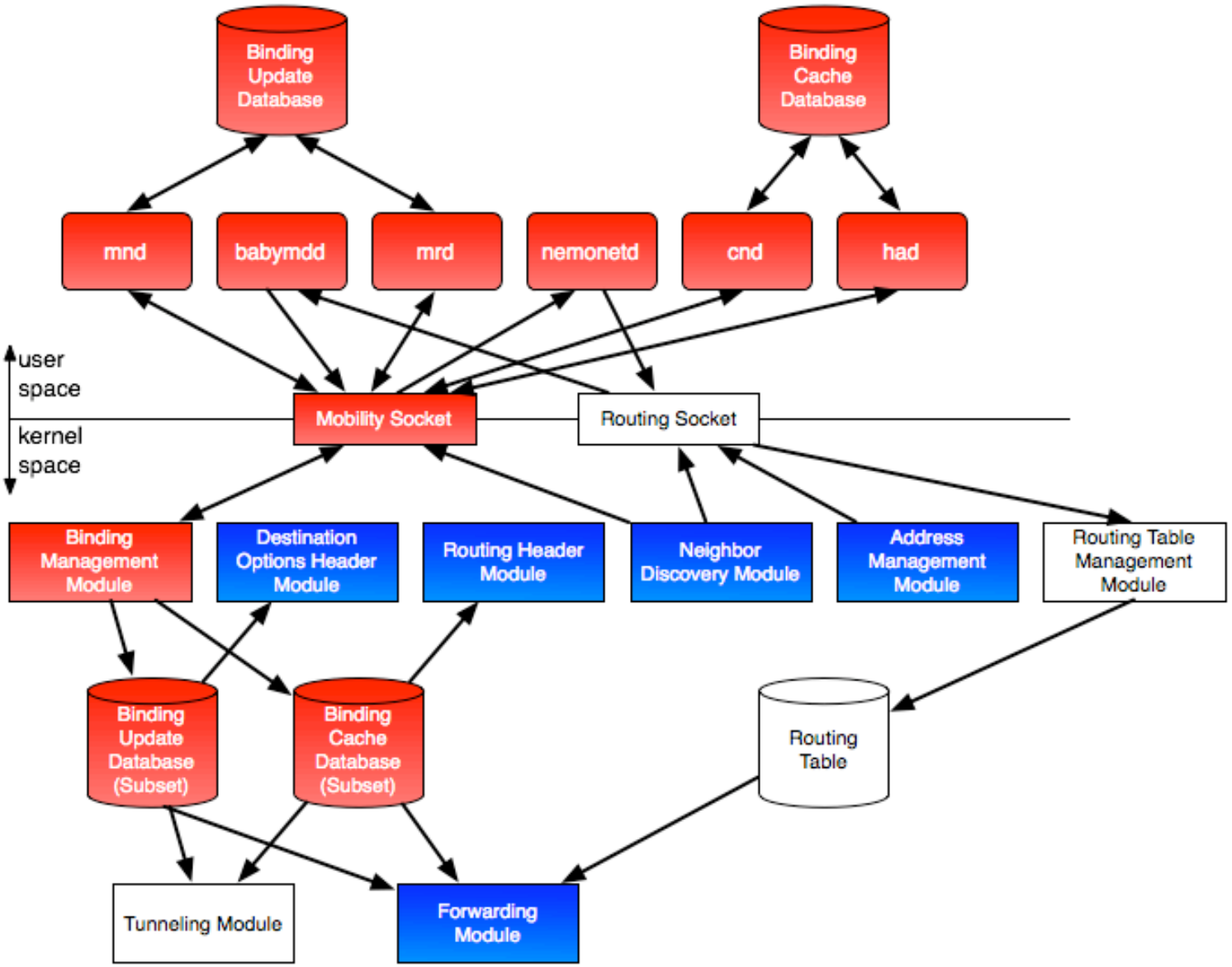
MIPv6/NEMO Implementation

- We extends SHISA to support DSMIPv6
- MIPv6/NEMO BS implementation for BSDs
- http://www.mobileip.jp/

SHISA modules



Binding Management

- (To solve Requirement-1,) reuse the existing Binding module by
  - storing IPv4 addresses as IPv4-mapped IPv6 address format
  - checking it is IPv4 or IPv6 wherever an address is referred. According to the address family, the correspondent function is called

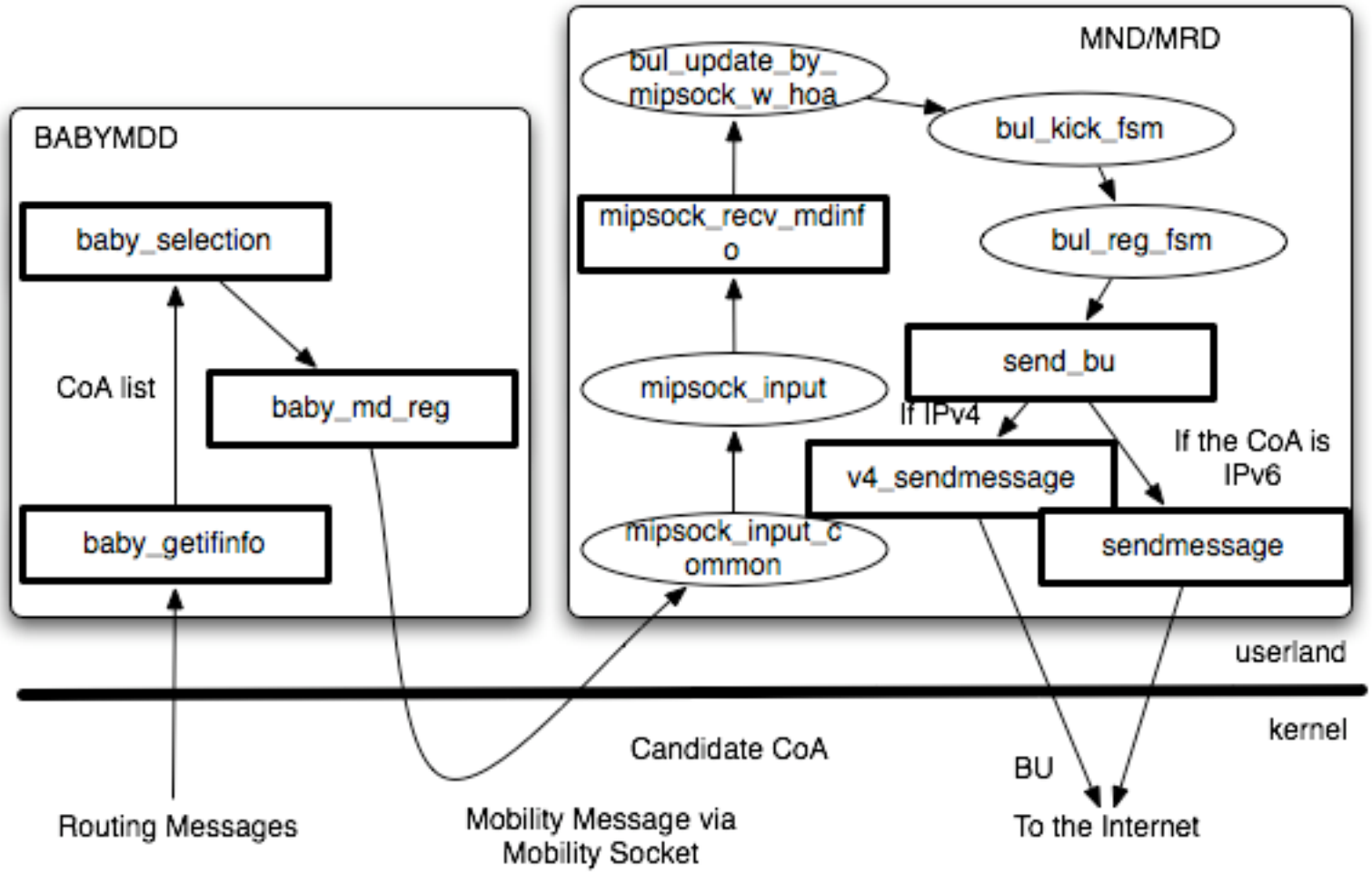
Newly Defined IPv4 functions

- Sending/Receiving DSMIPv6 signaling
  - Requirement-3 and Requirement-4 are implemented at the user land space like what SHISA did for IPv6 signaling message
- Configuring a bi-directional tunneling (Requirement-5)
  - the kernel already provides various type of IP-in-IP tunnels (Requirement-6)
  - just prepare a function to configure tunnels from the user land space.

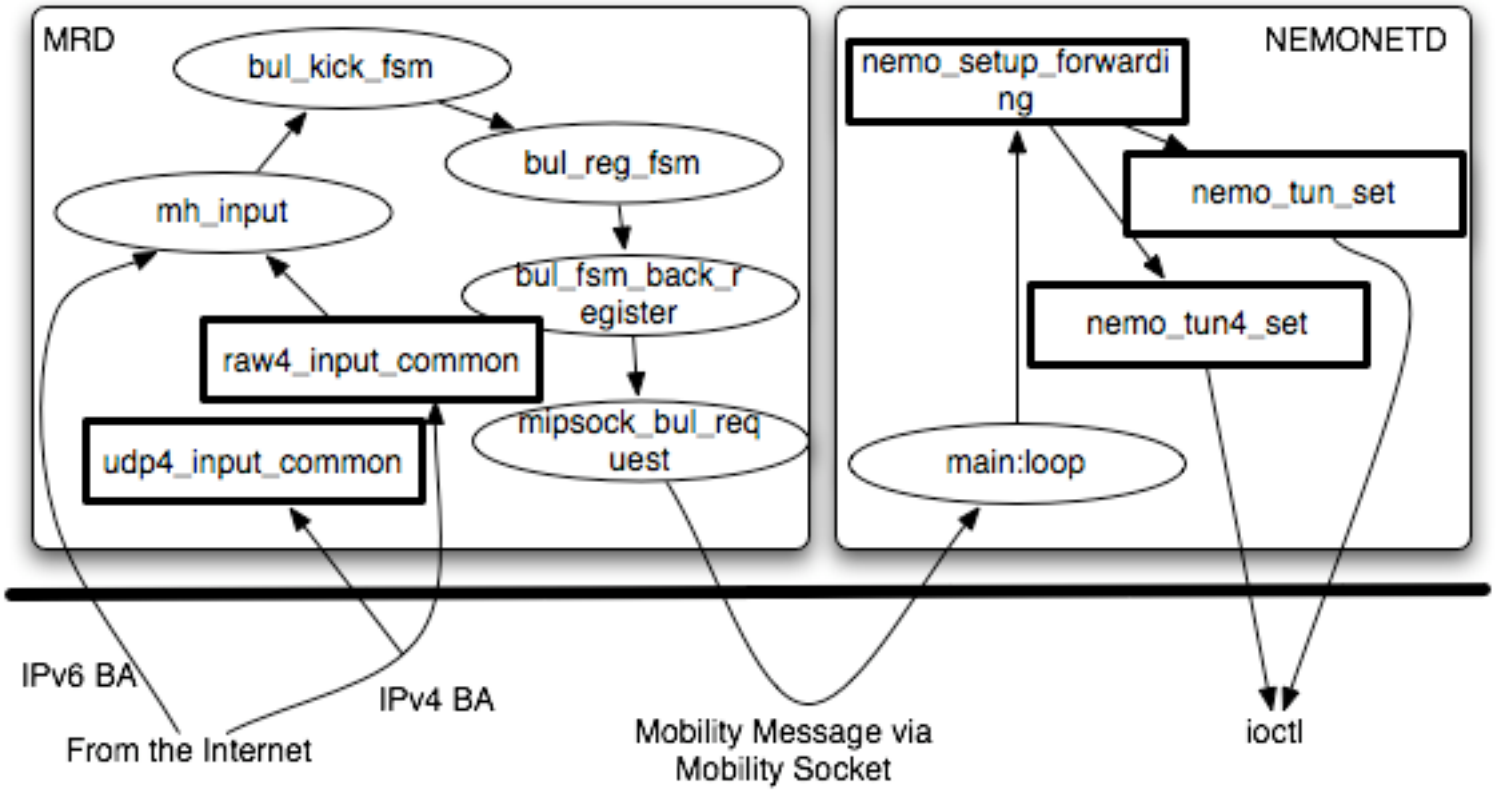
V4 Address Detection

- Requiremet-2
  - lunch dhclient when a link became up
  - terminate the dhclient when the link became down
- Modify *BABYMDD* to monitor both IPv6 and IPv4 address

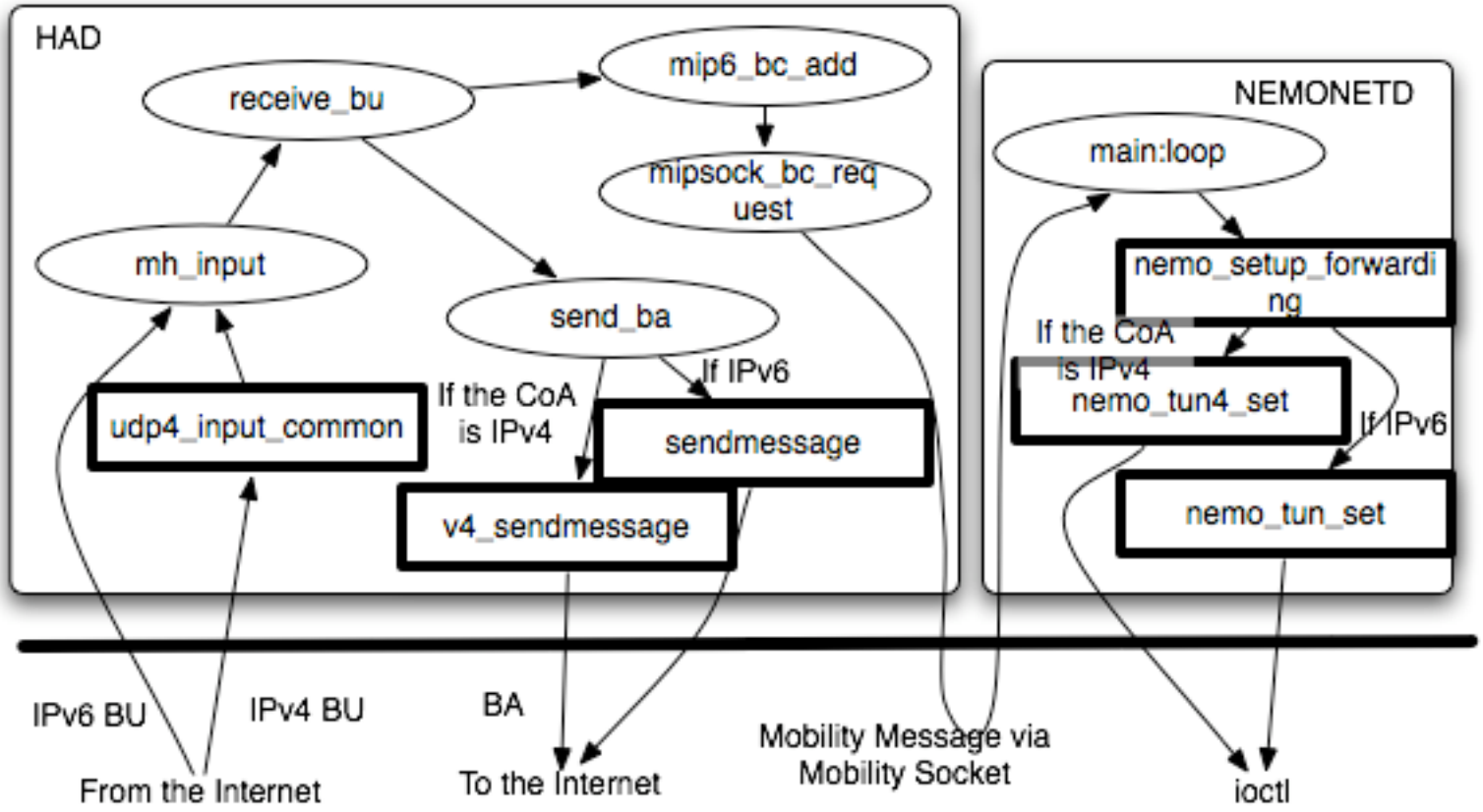
Detecting IPv4 care-of address and Sending a BU



Receiving a BA and Establishing a Bi-directional tunnel



Receiving a BU, Establishing a tunnel, and Sending a BA



Usage

- configure SHISA
  - http://www.kame.net/newsletter/20050707/
- Mobile Node:
  - # ifconfig mip0 <your IPv4 home address> home
  - specify IPv4 home agent address with the "-H" arg when you run MND/MRD
- Home Agent:
  - specify a range of IPv4 address which can be used by MNs in the configuration file

Demonstration

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Signaling Costs(msec)

proto\Item	1	2	3	4	5
MIPv6	819.077	1.612	0.232	1.101	0.234
DSMIPv6	1818.758	2.351	0.268	1.140	0.316

1. Detecting a care-of address
2. Sending a binding update
3. Receiving a binding update
4. Sending a binding acknowledgement
5. Receiving a binding acknowledgment

Performances

CoA-CN \ case	RTT (msec)	TCP (up/down)	UDP (up/down)
v6-v6	174.787	87Kbps /238Kbps	95.3Kbps /332Kbps
v6-v4	183.6	104.3Kbps /701Kbps	95.3Kbps /344.4Kbps
v4-v6	149.8	112Kbps /1.05Mbps	111Kbps /324Kbps
v4-v4	183.27	103.2Kbps /1.08Mbps	111Kbps /308.6Kbpsd

Considerations

- Works fine!
- UDP header in a binding acknowledgment
- Uses of the IPv4-mapped IPv6 address

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Summary

- DSMIPv6 extends MIPv6 to support IPv4 care-of address and IPv4 home address
- We extends SHISA, an open source MIPv6 implementation on BSDs, for DSMIPv6 support
- It works and the extension was small, as expected

Next Step

- NAT Traversal Support
- v4 address management/DNA
- Dynamic Home Agent Discovery

- Follow the next version of the draft
- Integration to SHISA

Acknowledgement

- KDDI R&D Laboratories
- KDDI
  - providing the experiment environment
  - confirming the protocol specification through interoperability testing

Thank you for listening!

Any question?

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