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

Home Network

Home Agent (HA)

Mobile Node (MN)

Foreign Network

Internet

Move

Home Address (HoA)

Care-of Address (CoA)

Correspondent Node (CN)
MIPv6 operation
MIPv6 operation
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 extend SHISA to support DSMIPv6
- MIPv6/NEMO BS implementation for BSDs
- http://www.mobileip.jp/
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

- Requirement-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

![Diagram showing the process of receiving a BA and establishing a bi-directional tunnel]

IPv6 BA
From the Internet
IPv4 BA
Mobility Message via Mobility Socket
ioctl

MRD
bul_kick_fsm
mh_input
bul_reg_fsm
bul_fsm_back_reg
raw4_input_common
udp4_input_common

NEMONETD
nemo_setup_forwarding
nemo_tun_set
nemo_tun4_set
main:loop
mipsock_bul_request
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)

<table>
<thead>
<tr>
<th>proto\Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIPv6</td>
<td>819.077</td>
<td>1.612</td>
<td>0.232</td>
<td>1.101</td>
<td>0.234</td>
</tr>
<tr>
<td>DSMIPv6</td>
<td>1818.758</td>
<td>2.351</td>
<td>0.268</td>
<td>1.140</td>
<td>0.316</td>
</tr>
</tbody>
</table>

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 acknowledgement
## Performances

<table>
<thead>
<tr>
<th>CoA-CN \ case</th>
<th>RTT (msec)</th>
<th>TCP (up/down)</th>
<th>UDP (up/down)</th>
</tr>
</thead>
<tbody>
<tr>
<td>v6-v6</td>
<td>174.787</td>
<td>87Kbps /238Kbps</td>
<td>95.3Kbps /332Kbps</td>
</tr>
<tr>
<td>v6-v4</td>
<td>183.6</td>
<td>104.3Kbps /701Kbps</td>
<td>95.3Kbps /344.4Kbps</td>
</tr>
<tr>
<td>v4-v6</td>
<td>149.8</td>
<td>112Kbps /1.05Mbps</td>
<td>111Kbps /324Kbps</td>
</tr>
<tr>
<td>v4-v4</td>
<td>183.27</td>
<td>103.2Kbps /1.08Mbps</td>
<td>111Kbps /308.6Kbps</td>
</tr>
</tbody>
</table>
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?