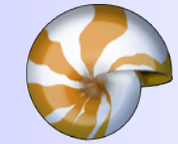

Dynamic Management of Multiple Mobile Routers

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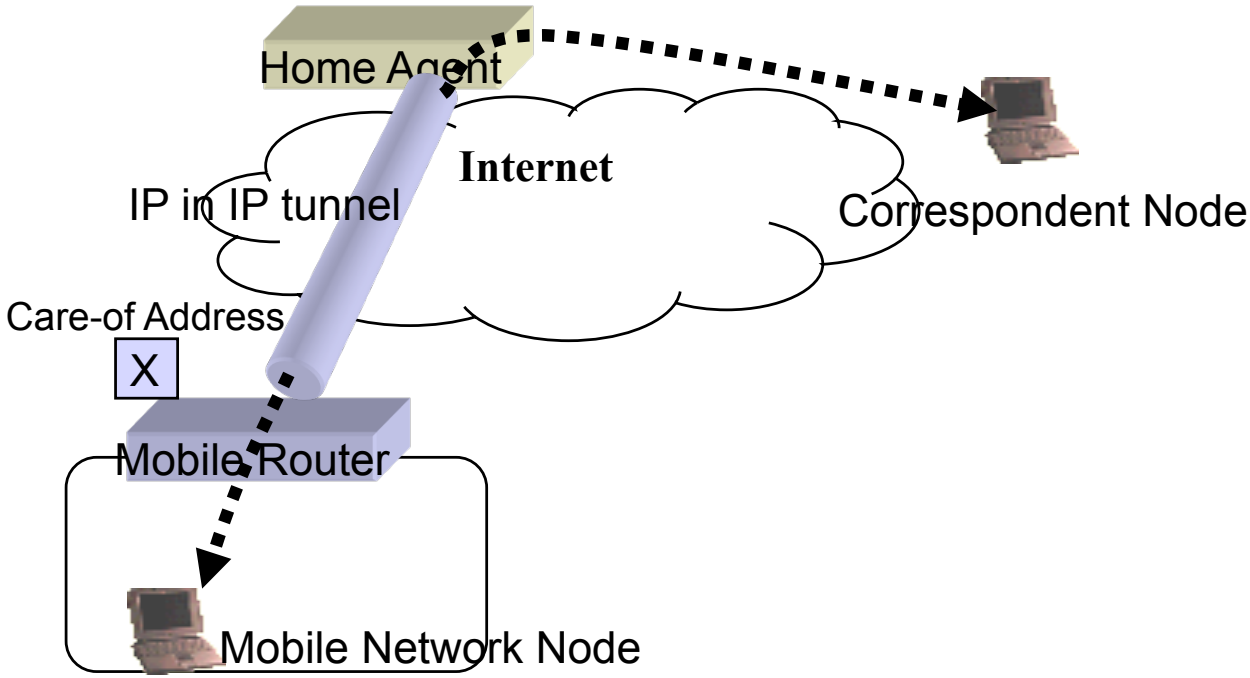
IEEE Malaysia International Conference on Communications
and IEEE International Conference on Networks (MICC & ICON 2005),
Kuala Lumpur, Malaysia, 11th November 2005

Introduction

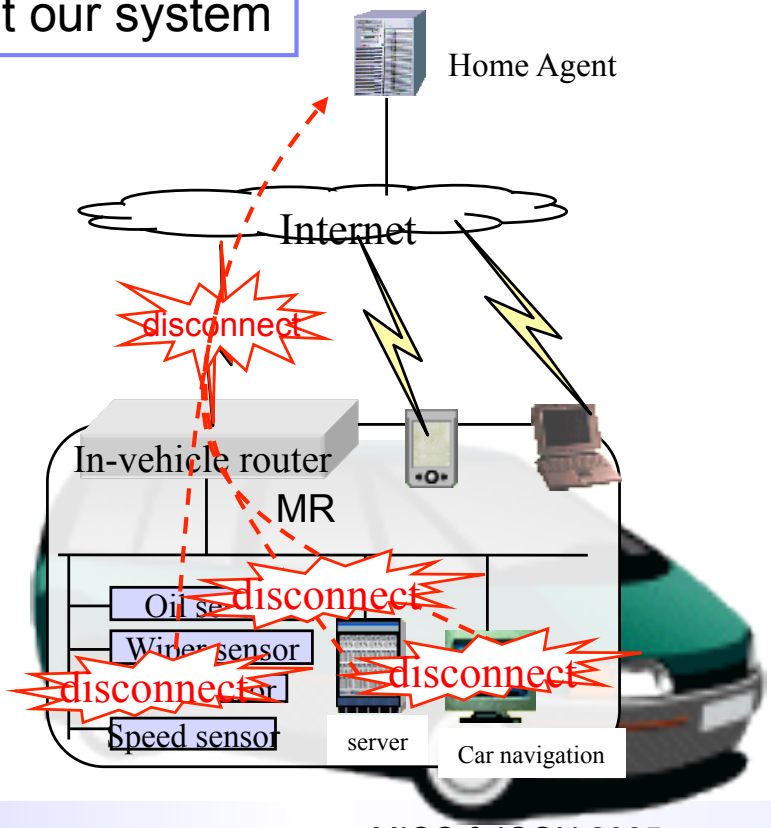
- Need for Network Mobility
  - Vehicle network,
    Personal Area Network (PAN)
- Network Mobility
  - NEMO Basic Support protocol at IETF
  - RFC3963



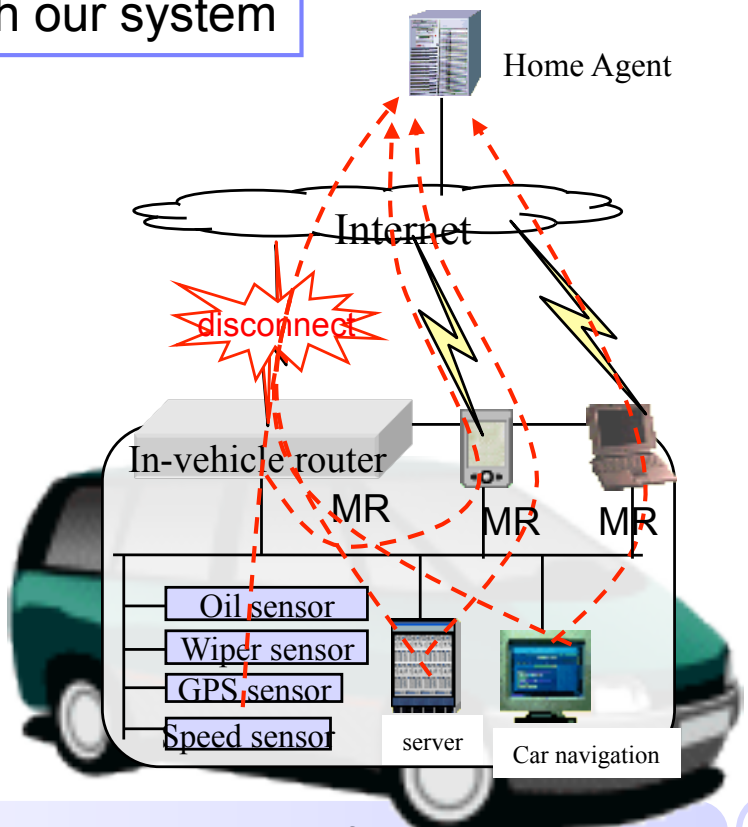
Objective

- There are a lot of computers in mobile network
  - In-vehicle router, PCs, PDAs, moble phones and sensors
  - Some have Internet connectivity and the other don't
- It is useful to share the connectivity

Without our system



With our system



Issues of multiple MRs with NEMO basic support

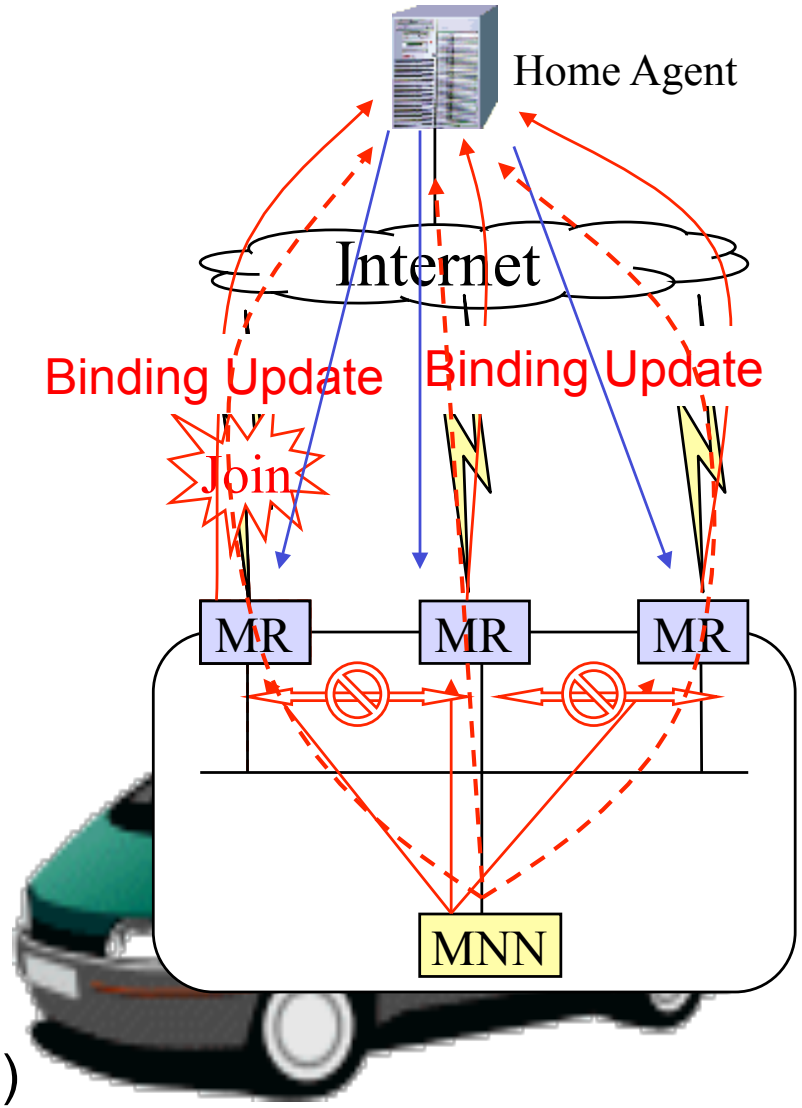
[Issue 1] Multiple Path Establishment
- HA can not bind several MRs to same mobile network prefix

[Issue 2] Path Selection
- Flow from MNNs can not be distributed

[Issue 3] Dynamic State Sharing
- MR join and leave dynamically
- Lack of mechanism to share state of MRs

[Issue4] Session Preservation
- Without breaking on-going sessions
- Without changing Address of MNNs

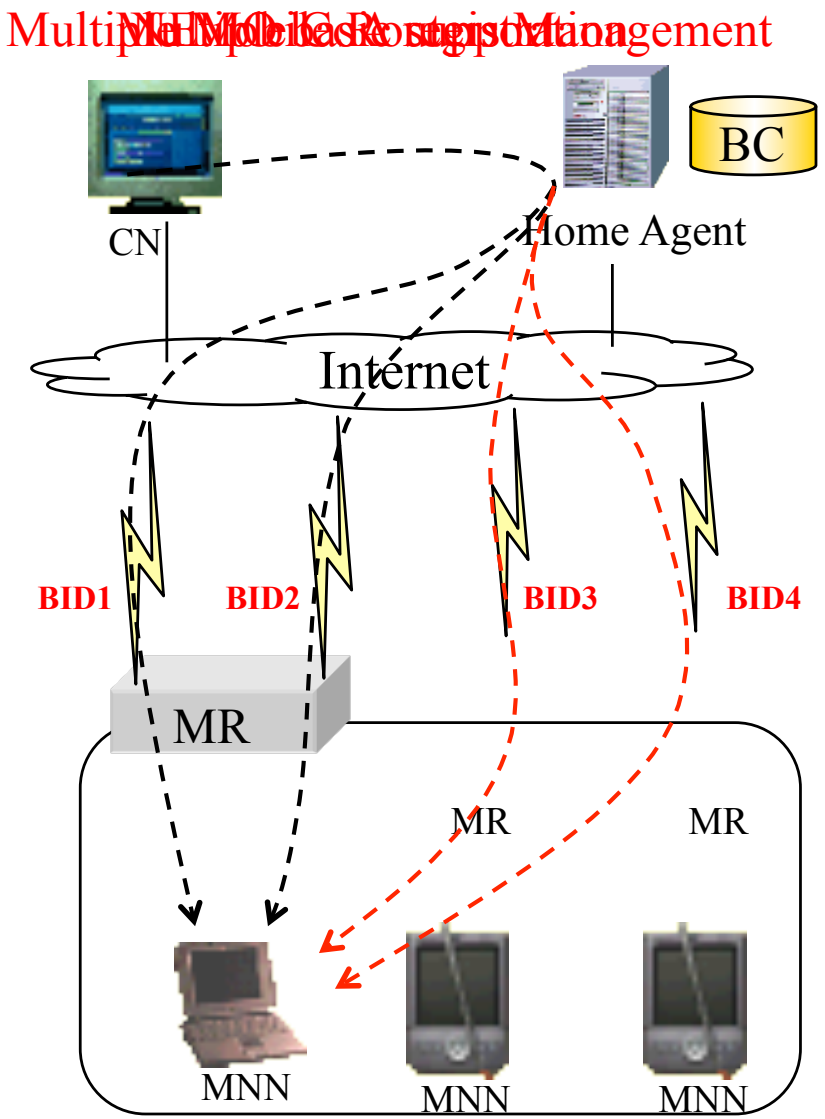
⇒Proposition of
Multiple Mobile Routers Management (MMRM)



Approach for Issue 1

Multiple Paths Establishment

- Multiple CoA Registration (work in progress)
  - to register multiple CoAs aquired by a single MR
  - Multiple Bindings are distinguished by BID
- Extension to multiple CoA registration for multiple MRs



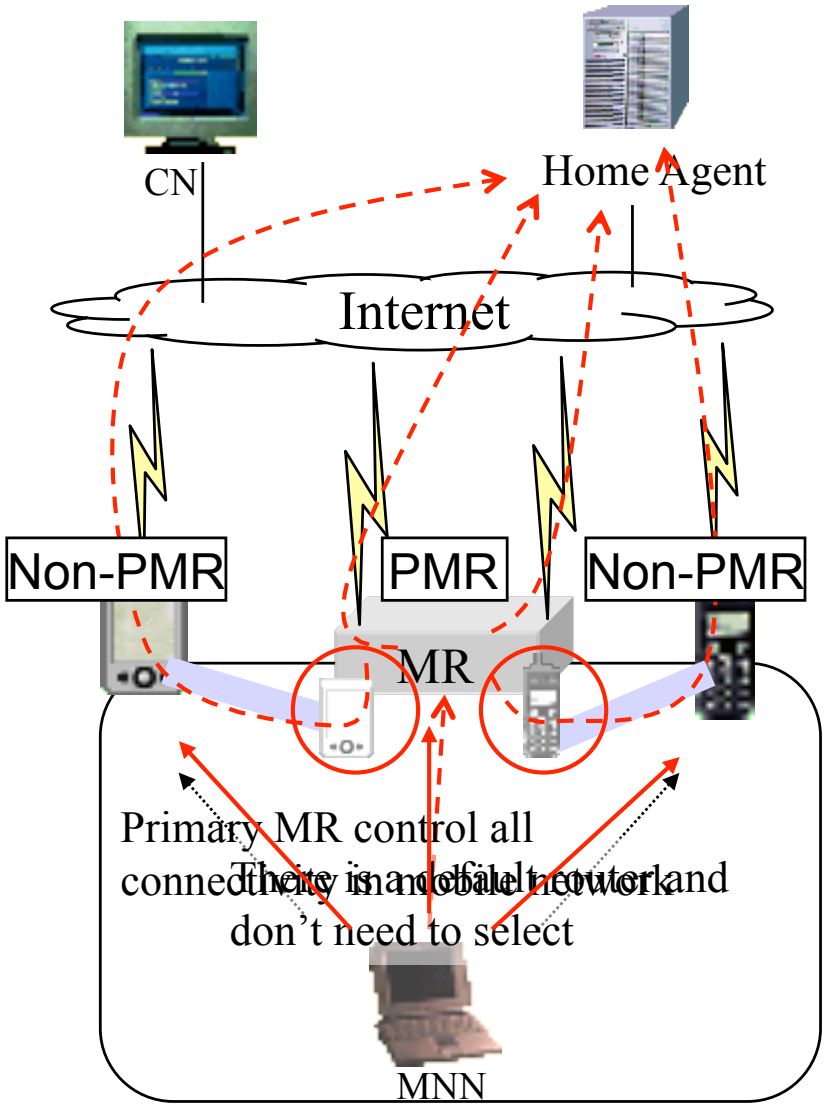
Approach for Issue 2

Path Selection

- Usual approach using default router selection
  - MNNs need additional selection mechanism to select path according to preferences
  - Replacement can be costly for low performance
- Our approach with virtual interface addition model
  - MNNs do not need more function than usual IPv6 nodes

Primary MR(PMR) :
MR fixed in the mobile network

Non-Primary MR (non-PMR) :
MR dynamically join and leave to mobile network

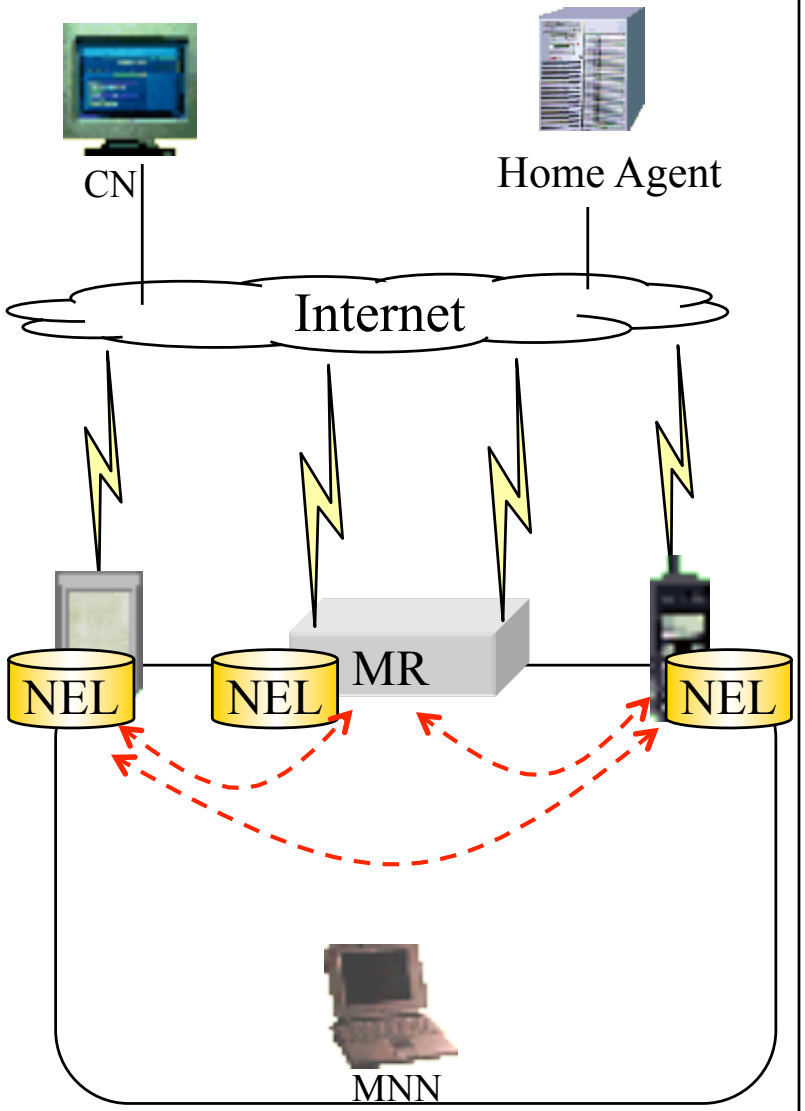


Approach for Issue 3

- Dynamic State Sharing

Neighbor Egress interface List (NEL) :
Database include binding information of the other MRs

NEL Advertisement :
Advertisement to notify binding information MRs have.



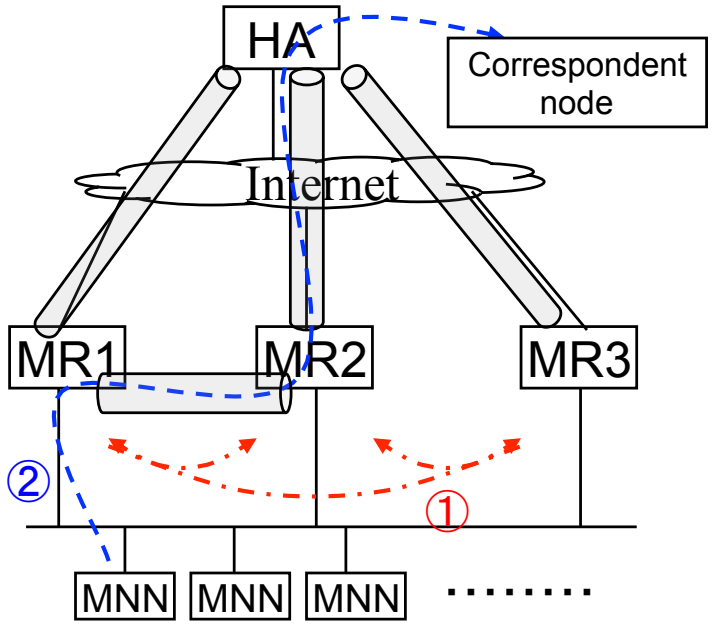
- Messages are periodically exchanged
- Neighbor MRs can detect joining / leaving MR

Summary of MMRM

1. Exchange binding information
2. Primary MR (PMR) is a default router of MNNs, and PMR transfer packets based on the user policy

Format which exchange each MRs

Destination : ff02::1(all node multicast)	**Port:** 11233
component	format
Action	NEL_ADD or NEL_REMOVE
Binding Unique Identification number (BID)	Integer
Home Address	IPv6 address
Care of Address	IPv6 address
Global Address of MR's ingress IF	IPv6 address
Lifetime	Integer

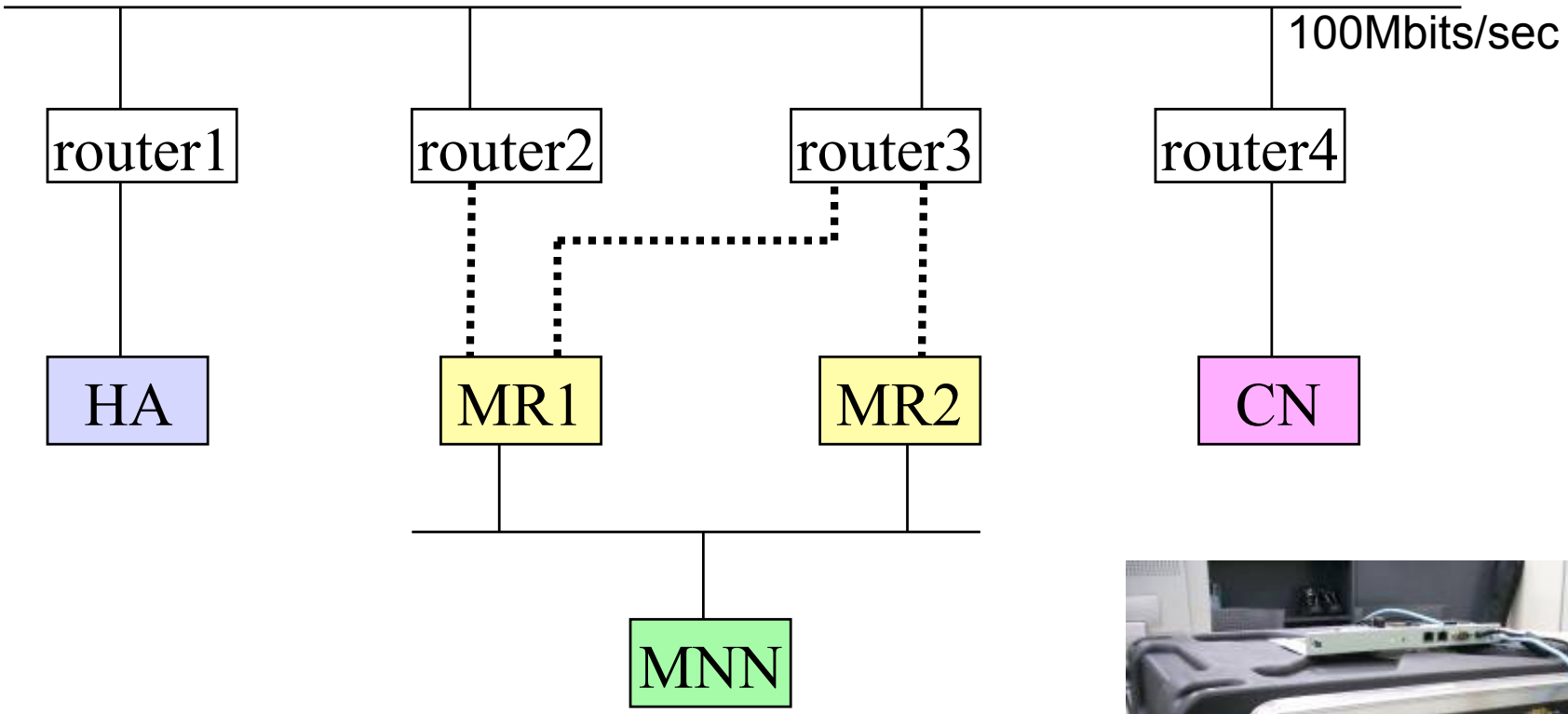


(Issue 4 is also solved)

Implementation

- NetBSD 1.6.2
- KAME (SHISA)
- Add new daemon
  - Multiple Mobile Routers Management Daemon

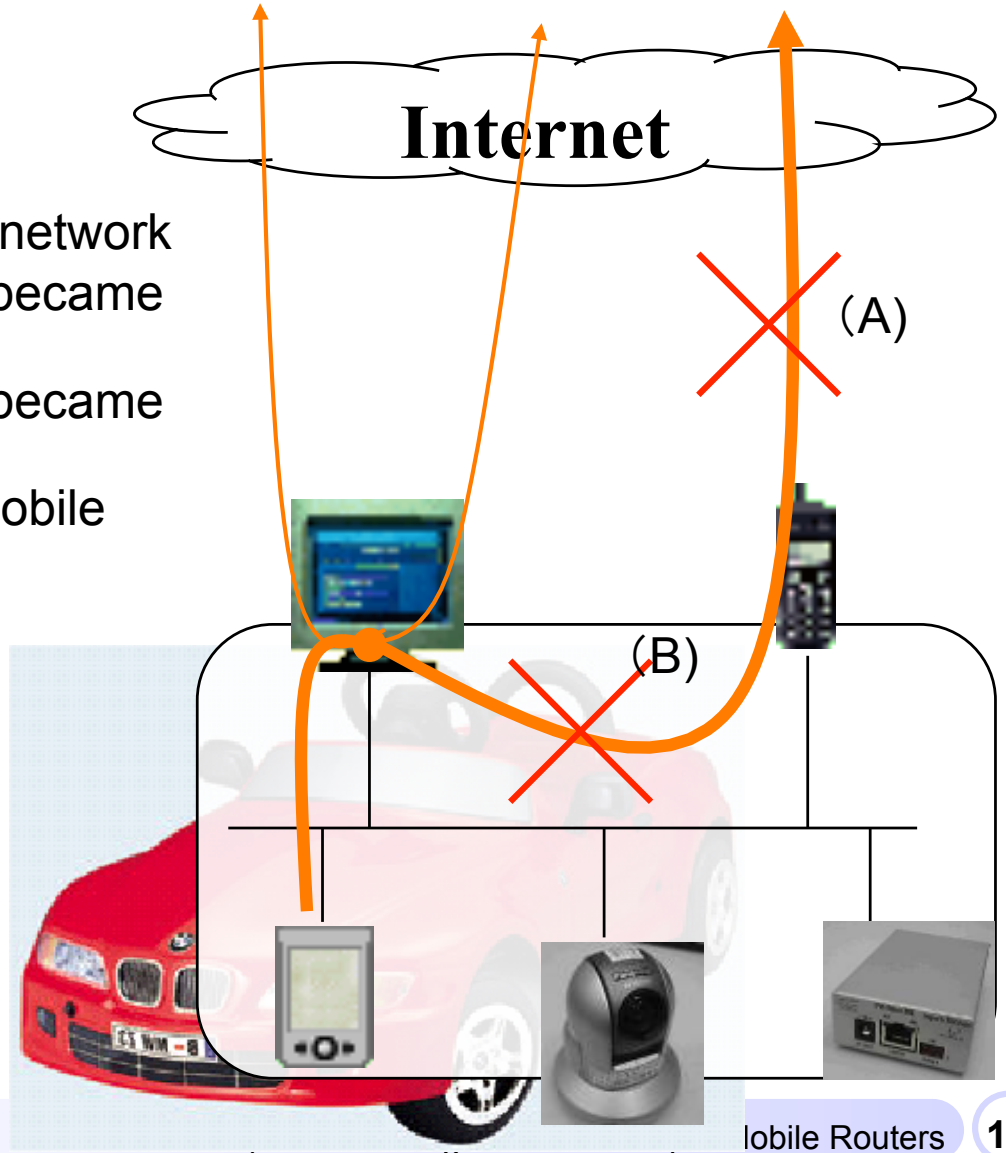
Evaluation environment



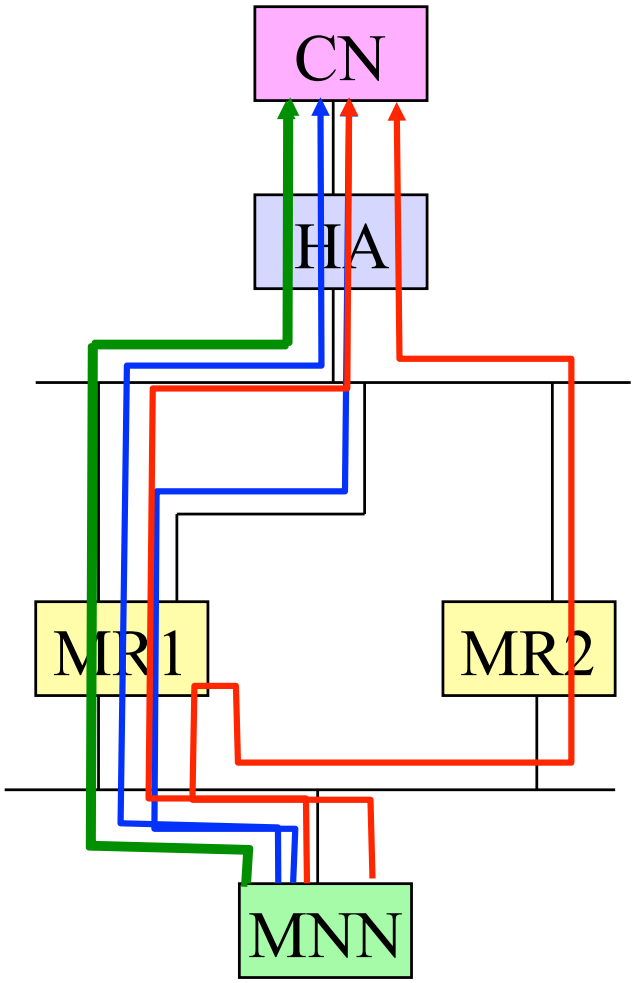
- Limitation on dotted line under 1.2 Mbps
  - Dotted lines are usually wireless
  - To avoid the bottleneck at HA or CN

Demonstration

- Scenario
  1. A mobile phone join to mobile network
  2. Wireless of the mobile phone became not available
  3. Wireless of the mobile phone became available
  4. The mobile phone leave the mobile network

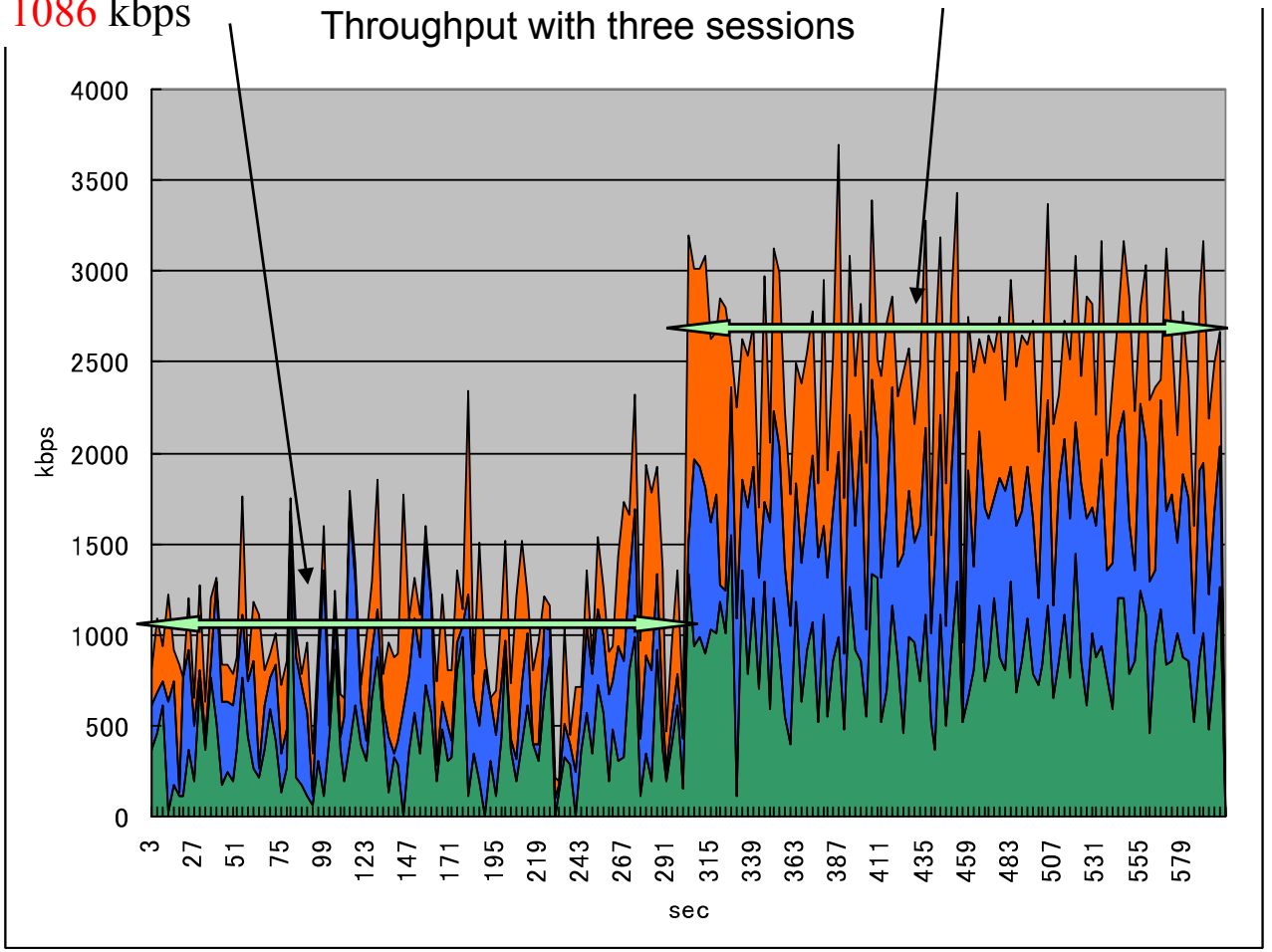


Throughput measurement



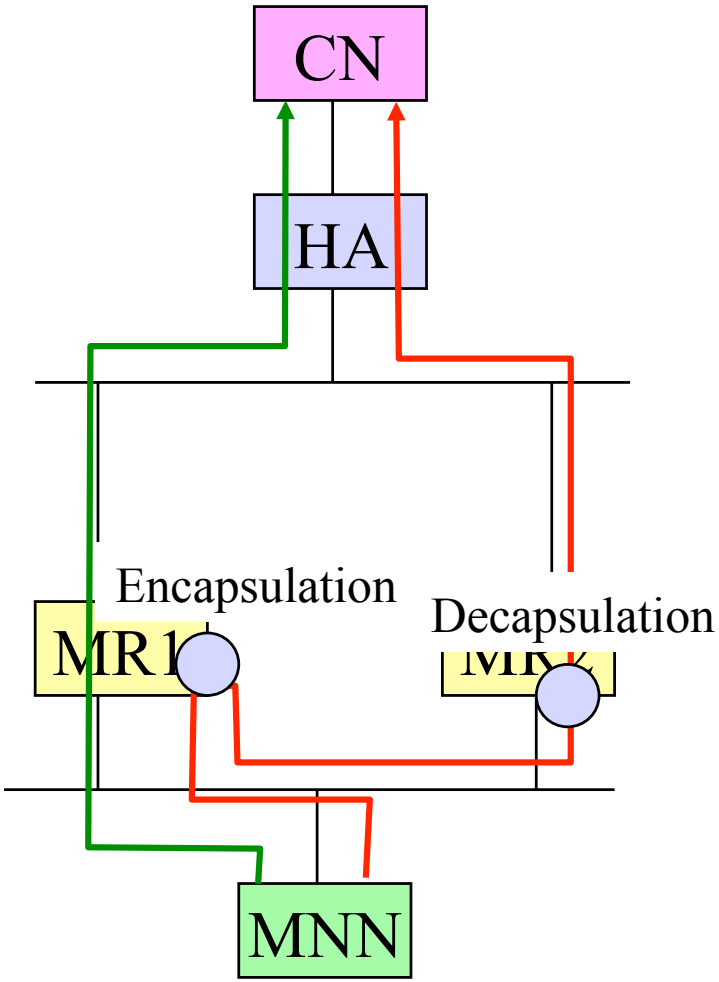
From 0 sec to 300 sec, total of three sessions is 1086 kbps

From 300 sec to 600 sec, total of three sessions is 2586 kbps



Overhead measurement

- What is overhead?
  - Encapsulation at MR1 and decapsulation at MR2
  - Increasing one hop
- RTT (average of 100 pings)
  - 2.38 ms
  - 2.86 ms (0.479ms much)
- Throughput (average of 300 sec)
  - 1071 kbps
  - 991 kbps (80kbps less)



Conclusion

- We propose Multiple Mobile Routers Management

Issue	Solution
Multiple paths establishment	Extension of Multiple Care-of Address Registration
Path selection	Virtual interface addition model
Dynamic state sharing	Neighbor Egress interface List
Session preservation	(Solved with above solutions)

- All access technologies in mobile network became available for all nodes
  - Increase redundancy and bandwidth
  - In addition, overhead is little compare with benefits

- Future works
  - Primary MR replacement
  - Security issue (MR-MR, MR-HA, MR-MNN)

Fin

- Thank you for listening.
- Any Question?

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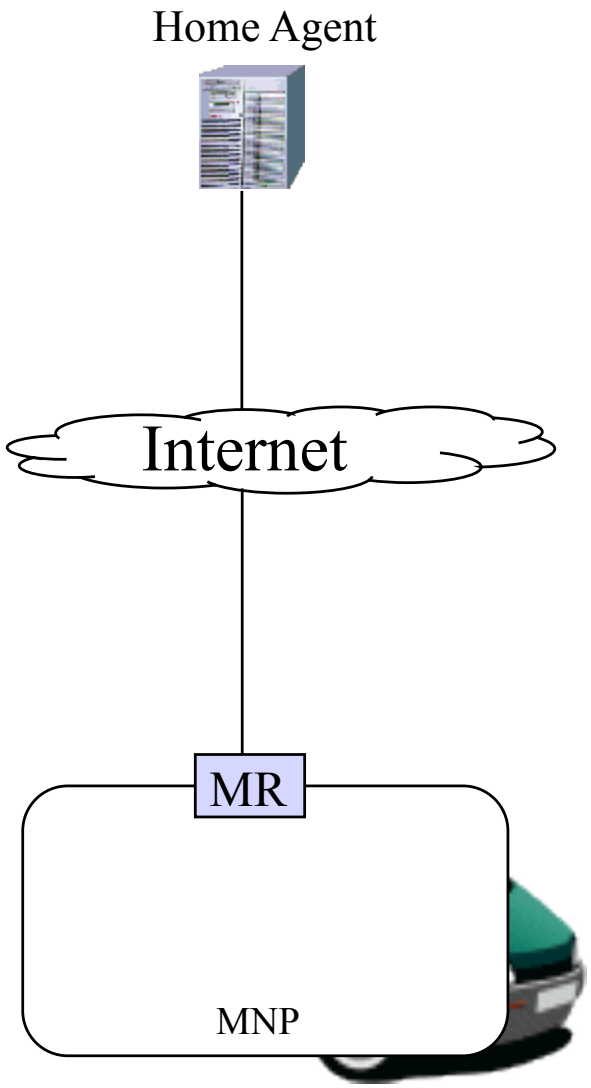
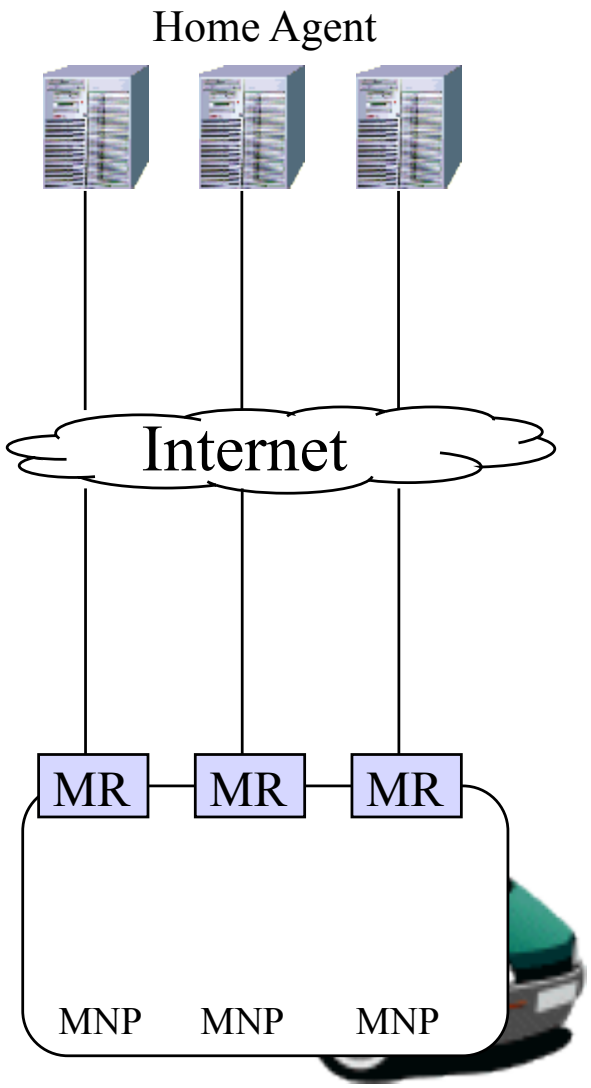
- Thierry Ernst <ernst@sfc.wide.ad.jp>
- Ryuji Wakikawa <ryuji@sfc.wide.ad.jp>
- Koshiro Mitsuya <mitsuya@sfc.wide.ad.jp>

Actual state



- Network Mobility basic support
  - Single MR, Single HA, Single MNP
- Network Mobility extended support
  - multihoming
    - Multiple MR
    - Multiple HA
    - Multiple MNP
  - Draft
    - draft-ernst-generic-goals-and-benefits-01
    - draft-ietf-nemo-multihoming-issues-02
- Proposal in this study
  - NEMO Basic support ←→ Multiple MR
  - Dynamic joining and leaving for mobile network
  - Case (n, 1, 1) or case (n, n, n)
  - Multiple Mobile Router Management (MMRM)

Actual state



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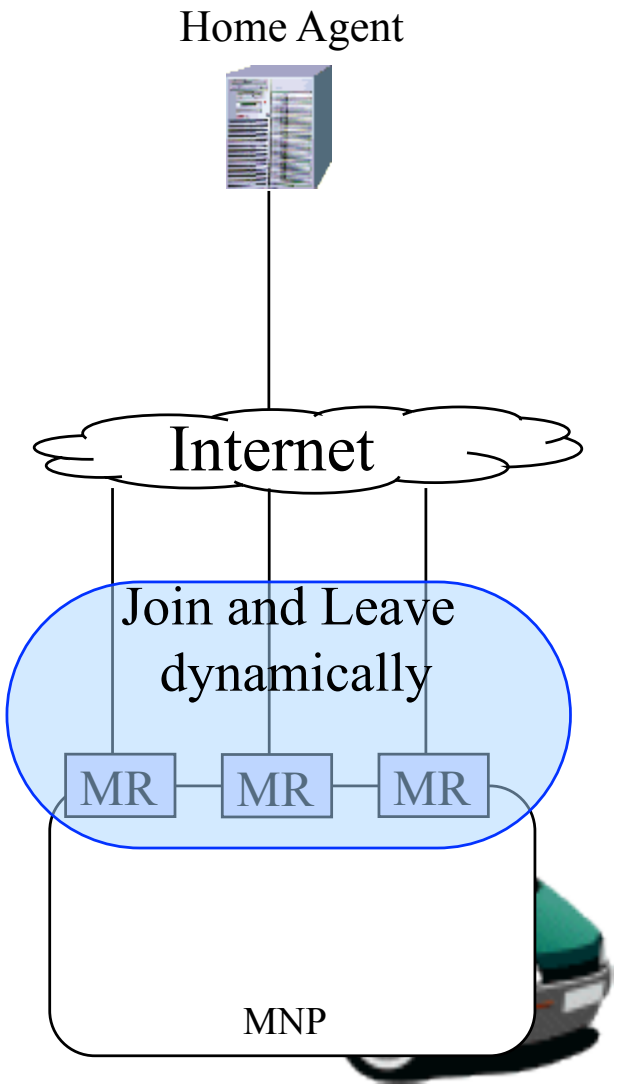
Target of this study



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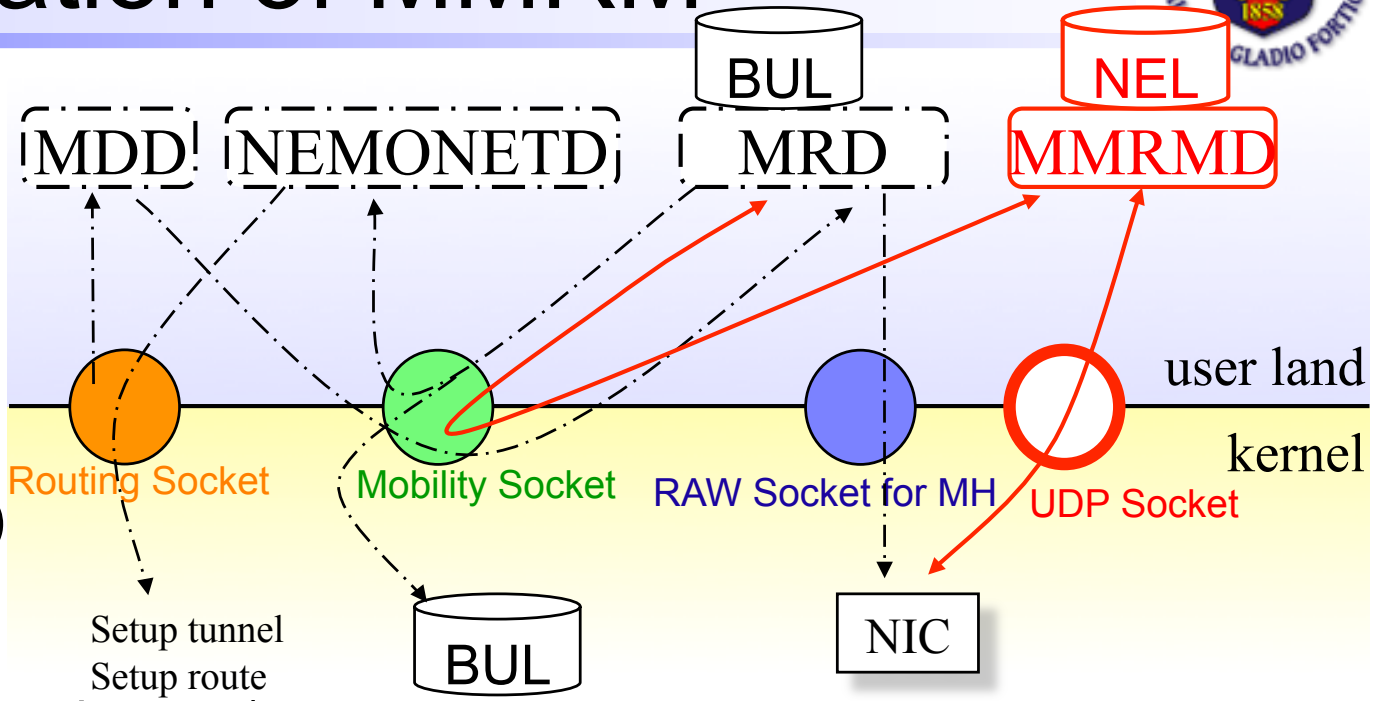
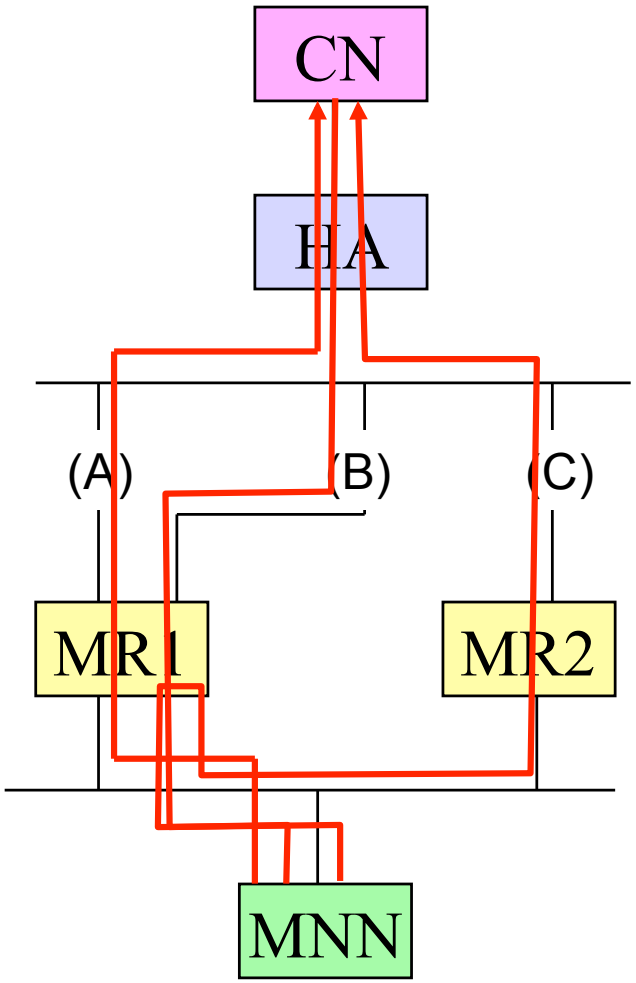
  - Multiple Mobile Router Management (MMRM)

Implementation of MMRM



- NetBSD 1.6.2
- SHISA (WIDEMIP)
- Extension
  - MRD (mobile router daemon)
    - Control binding
  - MDD (movement detection daemon)
    - Movement detection and interaction with Kernel
  - NEMONETD (NEMO network daemon)
    - Control routing and tunnels
  - MMRMD (multiple mobile router management daemon)
    - NEL synchronization between MRs and routing control

1. Check if all connectivity are available



Only Ethernet (A) is connected

```
MNN# traceroute6 2001:4::4
traceroute6 to 2001:4::4 (2001:4::4) from 2001:1:0:1:20d:5eff:fe48:2b9d,
64 hops max, 12 byte packets
 1  2001:1::1111  1.062 ms  0.527 ms  0.501 ms                  (MR1)
 2  2001:1::a00:1fff:feb1:3865  1.657 ms  1.436 ms  1.383 ms   (HA)
 3  2001:1::1  1.769 ms  1.856 ms  1.752 ms                    (router)
 4  2001::4  2.445 ms  2.347 ms  2.332 ms                      (router)
 5  2001:4::4  2.345 ms  2.428 ms  2.273 ms                    (CN)
```

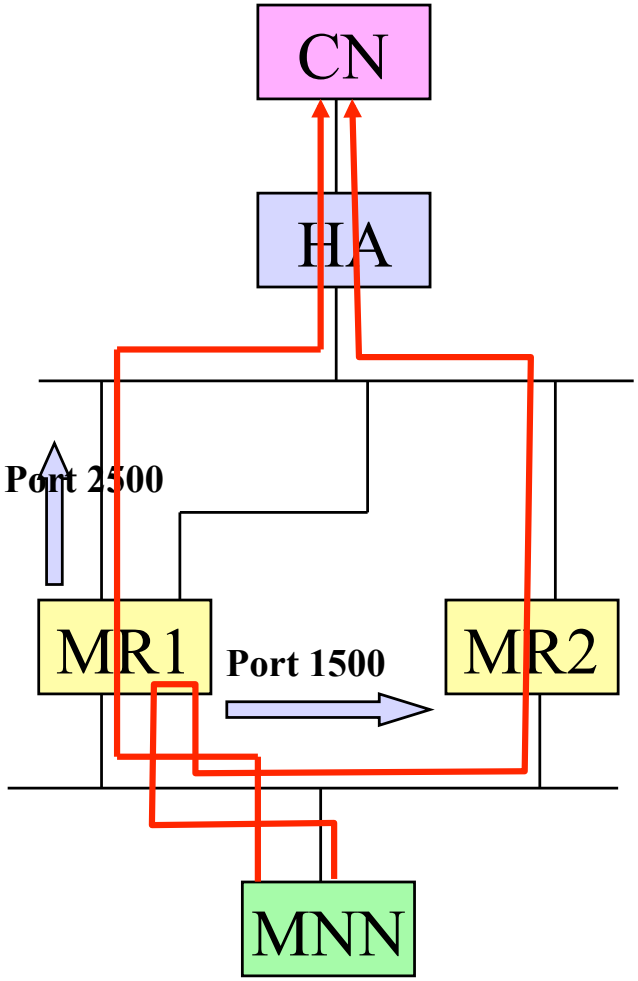
Only Ethernet (B) is connected

```
MNN# traceroute6 2001:4::4
traceroute6 to 2001:4::4 (2001:4::4) from 2001:1:0:1:20d:5eff:fe48:2b9d,
64 hops max, 12 byte packets
 1  2001:1::1111  1.02 ms  0.498 ms  0.49 ms                   (MR1)
 2  2001:1::a00:1fff:feb1:3865  2.12 ms  2.002 ms  1.832 ms   (HA)
 3  2001:1::1  2.483 ms  2.461 ms  2.255 ms                    (router)
 4  2001::4  2.968 ms  2.896 ms  2.789 ms                      (router)
 5  2001:4::4  2.86 ms  2.847 ms  2.82 ms                     (CN)
```

Only Ethernet (C) is connected

```
MNN# traceroute6 2001:4::4
traceroute6 to 2001:4::4 (2001:4::4) from 2001:1:0:1:20d:5eff:fe48:2b9d,
64 hops max, 12 byte packets
 1  2001:1::1111  0.556 ms  0.621 ms  0.494 ms                  (MR1)
 2  2001:1::1111  1.444 ms  1.021 ms  0.962 ms                  (MR2)
 3  2001:1::a00:1fff:feb1:3865  2.163 ms  2.179 ms  2.119 ms   (HA)
 4  2001:1::1  2.594 ms  2.598 ms  2.545 ms                    (router)
 5  2001::4  3.129 ms  3.129 ms  3.108 ms                      (router)
 6  2001:4::4  3.147 ms  3.173 ms  3.101 ms                    (CN)
```

2. Check if policy based routing is available



(a) Port 1500

```
MNN# traceroute6 -p 1500 2001:4::4
traceroute6 to 2001:4::4 (2001:4::4) from 2001:1:0:1:280:45ff:fe45:d1ab,
 30 hops max, 12 byte packets
 1  2001:1::1111  0.623 ms  0.495 ms  0.487 ms                  (MR1)
 2  2001:1::1111  1.012 ms  0.954 ms  0.951 ms                  (MR2)
 3  2001:1::a00:1fff:feb1:3865  2.096 ms  1.820 ms  1.827 ms   (HA)
 4  2001:1::1  2.260 ms  2.274 ms  2.212 ms                    (router)
 5  2001::4  2.861 ms  2.749 ms  2.756 ms                      (router)
 6  2001:4::4  2.834 ms  2.834 ms  2.826 ms                    (CN)
```

(b) Port 2500

```
MNN# traceroute6 -p 2500 2001:4::4
traceroute6 to 2001:4::4 (2001:4::4) from 2001:1:0:1:280:45ff:fe45:d1ab,
 30 hops max, 12 byte packets
 1  2001:1::1111  0.546 ms  0.493 ms  0.488 ms                  (MR1)
 2  2001:1::a00:1fff:feb1:3865  1.816 ms  1.357 ms  1.289 ms   (HA)
 3  2001:1::1  1.765 ms  1.722 ms  1.782 ms                    (router)
 4  2001::4  2.368 ms  2.265 ms  2.291 ms                      (router)
 5  2001:4::4  2.401 ms  2.315 ms  2.343 ms                    (CN)
```