Virtual Mobility Control Domain for Enhancements of Mobility Protocols

INFOCOM 2005

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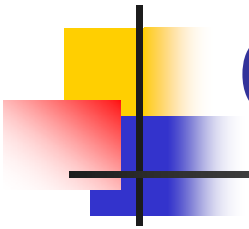
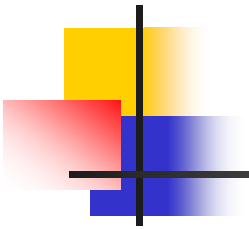


Outline

- Introduction
- Mobility Protocol and Their Weakness
- Concept of Virtual Mobility Control Domain
- System Approach
- System Evaluation
- Conclusion

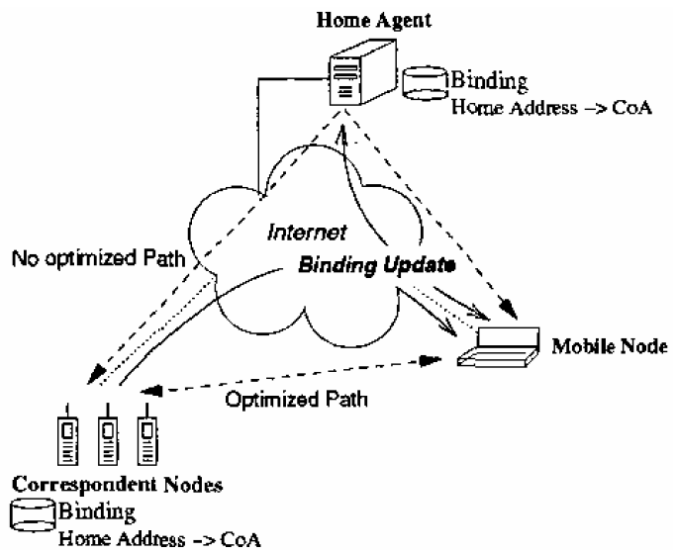


Introduction

- Mobility support is the key feature to realize the coming ubiquitous mobile internet.
- Mobile IPv6 and NEMO cannot fulfill service requirements when serving a large number of mobile nodes.
- This paper addresses issue of mobility protocols and proposes Virtual Mobility Control Domain (VMCD).

Mobility Protocol

- A home agent delegates one address from its home network to a mobile node as a permanent home address.
- The mobile node always communicates using the home address anywhere on the network.
- When the mobile node is attached to a new subnetwork, it first obtains a new care-of address on the visited link and registers binding information to its home agent.
- The binding information contains an association between the home address and the care-of address.



Weakness

- Mobile IPv6 and the basic NEMO protocol have a common weakness that both protocols completely depend on home agent availability.

1. Lack of Load Balancing and Single Bottleneck
2. Lack of Redundancy and Single Point of Failure
3. Redundant Route
4. Lack of Flexible Home Agent Selection
5. Lack of Serviceability

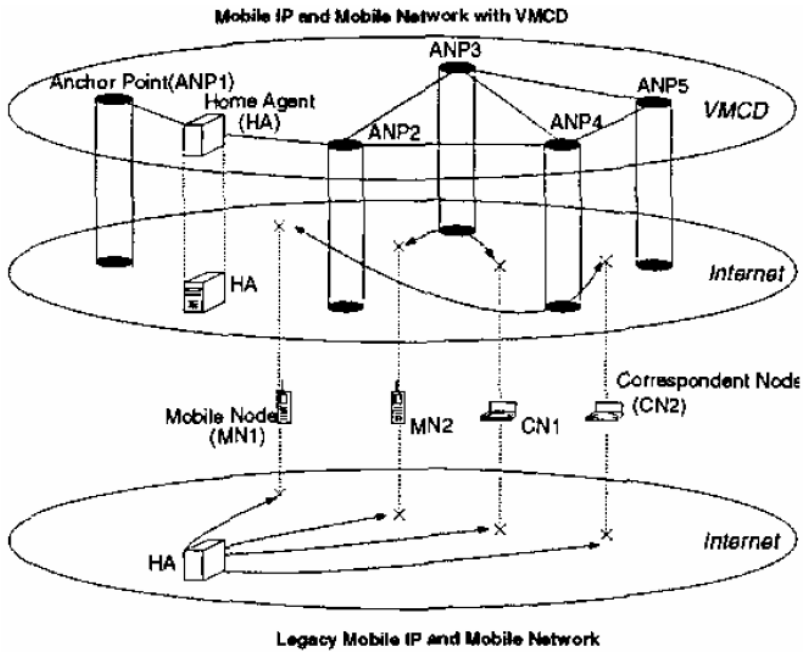
Concept of Virtual Mobility Control Domain

- VMCD is a distributed system that activates multiple anchor points managing binding information like a home agent.

- Each anchor point must be a router and capable of managing binding cache, intercepting packets, and tunneling packets to a mobile node according to binding cache.

Concept of Virtual Mobility Control Domain

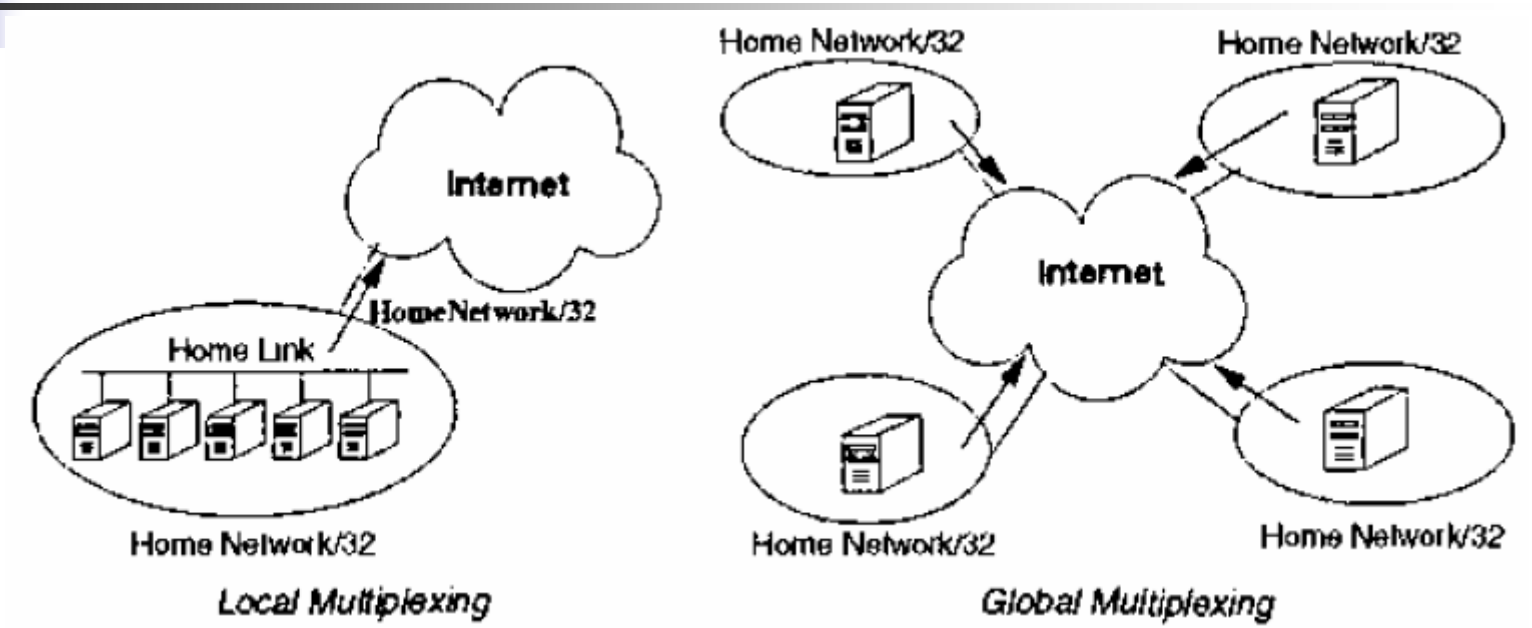
- A mobile node first reaches a correspondent node via its home agent like Mobile IPv6.
- A packet sent by a correspondent node is routed to a mobile node via the closest anchor point to the correspondent node.
- The closest anchor point is selected based on the internet routing.

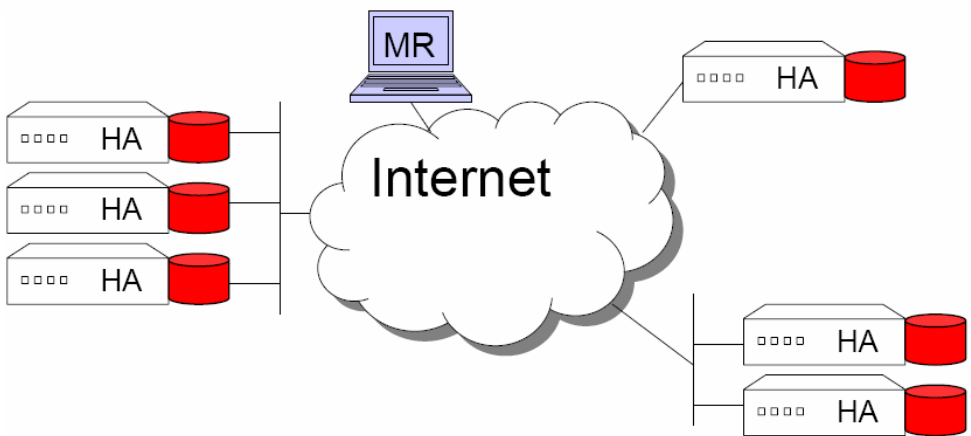


System Approach

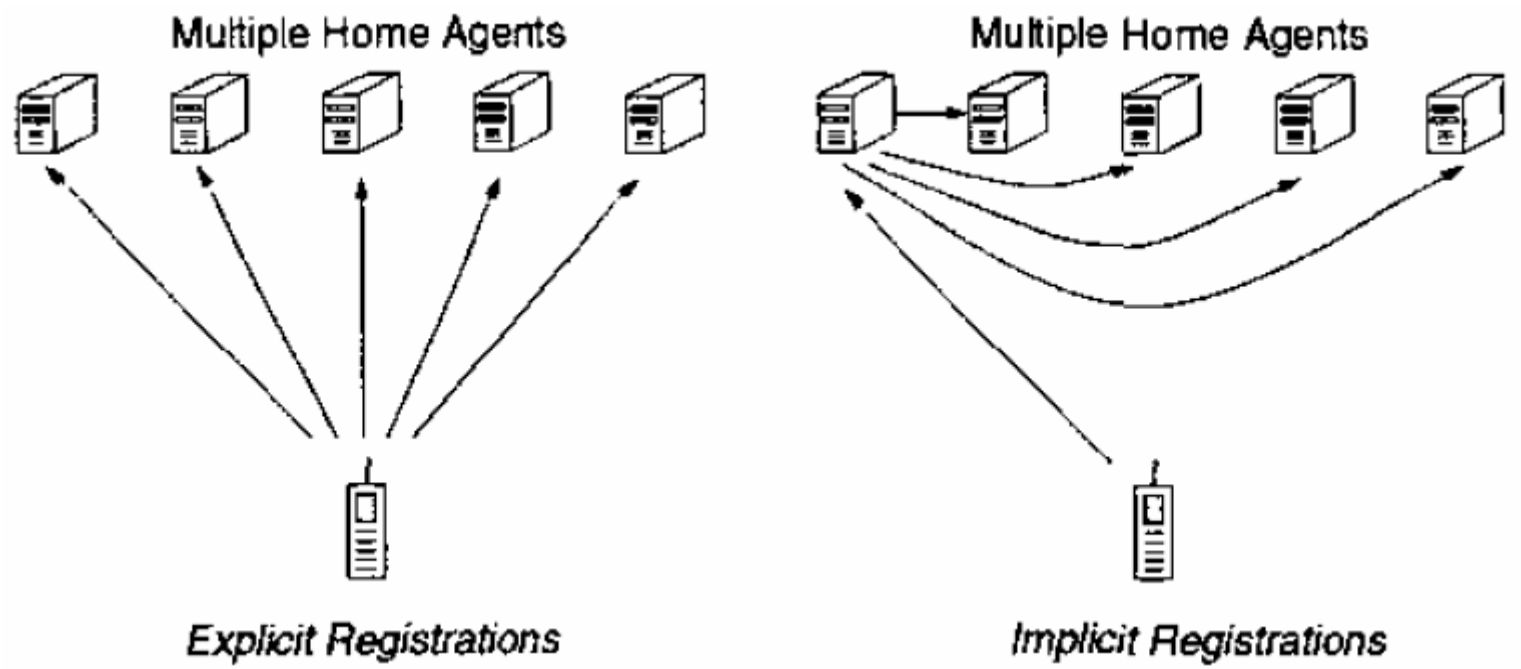
- How to distribute anchor points
  - Local Multiplexing
  - Global Multiplexing
- How to synchronize binding information among anchor points
  - Explicit Registrations
  - Implicit Registrations
- Inter Home Agent Protocol

System Approach





System Approach



Inter Home Agent Protocol

- The Inter Home Agent Protocol is used to maintain distributed anchor points globally and locally on backbone networks with implicit registration.

- Three mechanisms
  - Home Agent List management
  - Binding Synchronization
  - Home Agent Switching

Inter Home Agent Protocol

- Home Agent List management
  - It stores the home agents' data that service the same home network.
  - A home agent must periodically send a home agent HELLO message.
  - When its local information changes, it also sends a home agent HELLO message.
  - If the lifetime field is set to zero, the receiver must delete this home agent from the home agent list.
  - When a new home agent boots up, it should wait particular time to listen home agent HELLO message.

Inter Home Agent Protocol

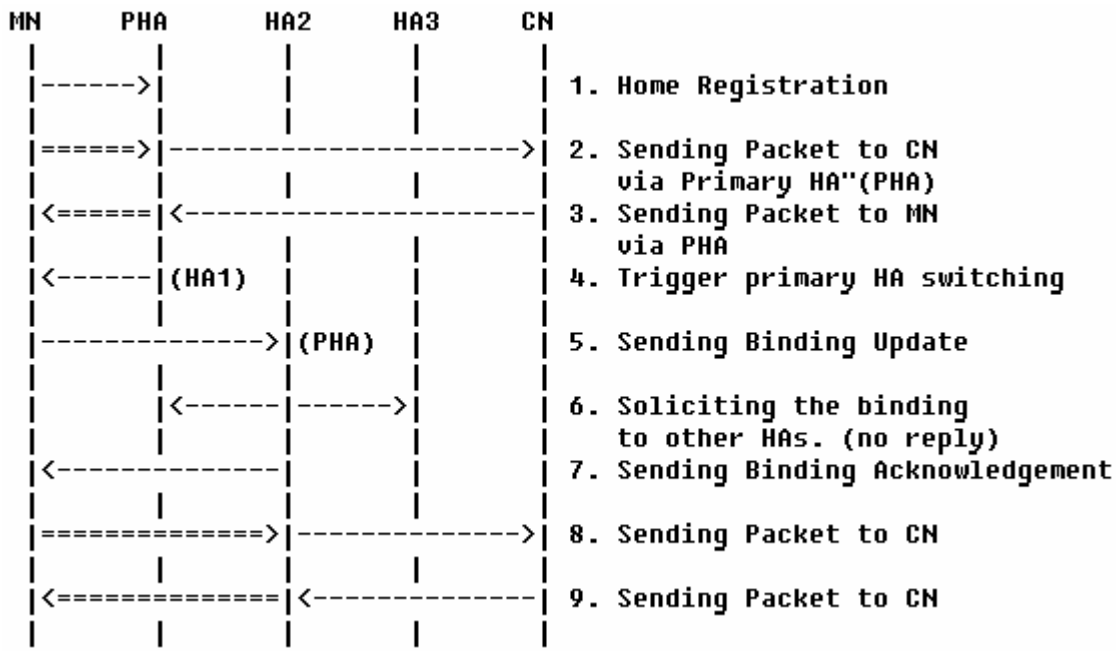
- Binding Synchronization
  - The primary home agent sends binding information update message when
    - It is solicited by binding information request message
    - It creates binding for a mobile node
    - It updates binding for a mobile node
  - The home agent must return a binding information acknowledgement message to the sender.
  - If the sender does not receive ACK, it must retry to send a binding information update message.

Inter Home Agent Protocol

- Home Agent Switching
  - Home agent initiated switching
    - The mobile node must immediately switch to the requested home agent by the home agent switch request if the home address is already known by the mobile node.
    - The mobile node must send a dynamic home agent discovery request message to the mobile IPv6 home agent anycast address if the requested home address is either unknown or empty.
  - Mobile node initiated switching
    - A mobile node selects the new home agent from its home agent list when it decides to change its primary home agent.

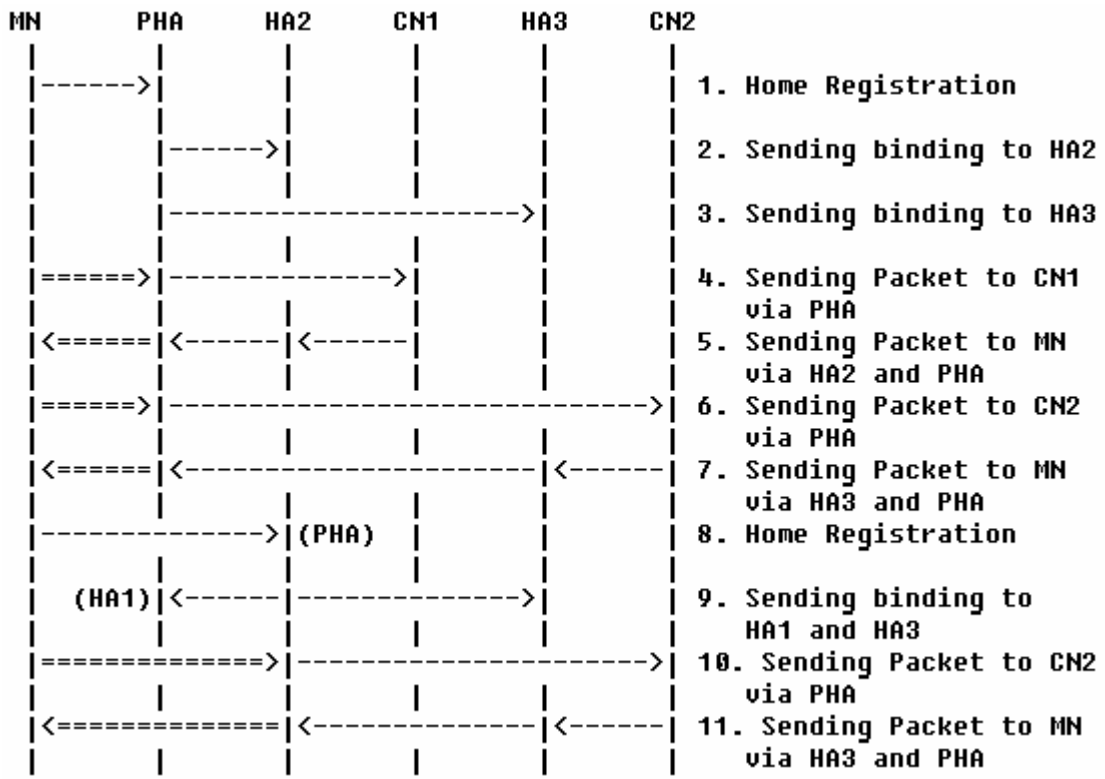
Inter Home Agent Protocol

- Single Home Agent Activation



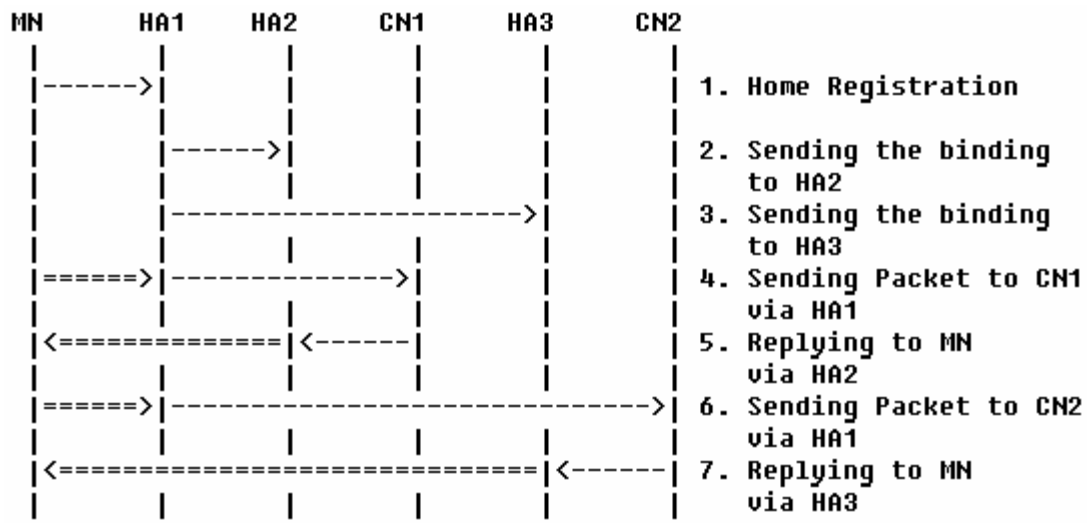
Inter Home Agent Protocol

- Multiple Home Agents with single bi-directional tunnel



Inter Home Agent Protocol

- Multiple Home Agents with multiple bi-directional tunnels



System Evaluation

- Scalability Consideration

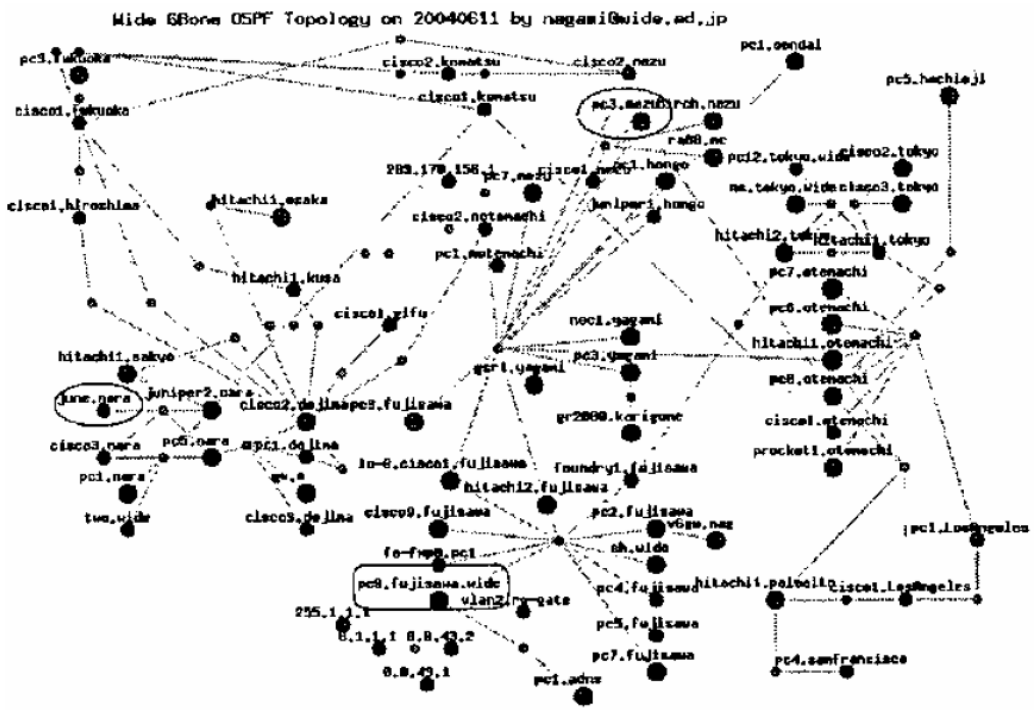
$$P_{ha} = P_{rbmn} \times N_{mn} \times \frac{T}{I_{bu}}$$

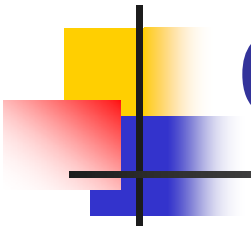
$$P_{vmcd} = P_{rbmn} \times N_{pmn} \times \frac{T}{I_{bu}} + P_{sb} \times (N_{anp} - 1) \times \frac{T}{I_{bu}} + P_{rb} \times (N_{mn} - N_{pmn}) \times \frac{T}{I_{bu}}$$

- Each mobile node sends binding update to its primary home agent every I_{bu} seconds during the test (T sec)
- N_{anp} : number of anchor point
- N_{mn} : number of mobile node
- N_{pmn} : number of mobile node that select the target anchor point as the primary home agent
- $P_{\tau bmp}$: processing cost for receiving a binding update from a mobile node
- P_{sb} : processing cost for sending a copy of a binding to another anchor point
- $P_{\tau b}$: processing cost for receiving a copy of a binding from a primary home agent
- P_{ha} : binding cache management cost for time T sec when a legacy home agent is operated for N_{mn} mobile node
- P_{vmcd} : management cost when binding information is sychronized

System Evaluation

- Average latency : 5.96 sec (Standard Deviation : 5.05)
- Minimum latency : 0.619 sec
- Maximum latency : 18.9 sec





Conclusion

- VMCD enhance Mobile IP and Mobile Network.
- VMCD provides robustness and route optimization to mobility protocols without any assistance of correspondent nodes.