ENSC 835-3: High-Speed Networks

Comparison of Route Optimization and Reverse Routing for Mobile IP Over IPv4

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November 27, 2003

Roadmap

- **Introduction**

- **Mobile IP Overview**

- **Implementation**

- **Results & Analysis**

- **Conclusion**

- **References**

Introduction: Motivation

- **Popularity of wireless communications and portable devices**

- **The Internet Engineering Task Force (IETF) introduced Mobile IP (MIP) to support mobile IP addresses**

- **Route Optimization in Mobile IP (ROMIP) – address efficiency**

- **Reverse Routing (RRMIP) – message simplification**

Introduction: Project Objective

- **Complete Route Optimization in NS-2 started by Leo Chen in Spring 2002**

- **Provide a quantitative efficiency evaluation between MIP and ROMIP**

- **Implement an alternate route optimization – Reverse Routing**

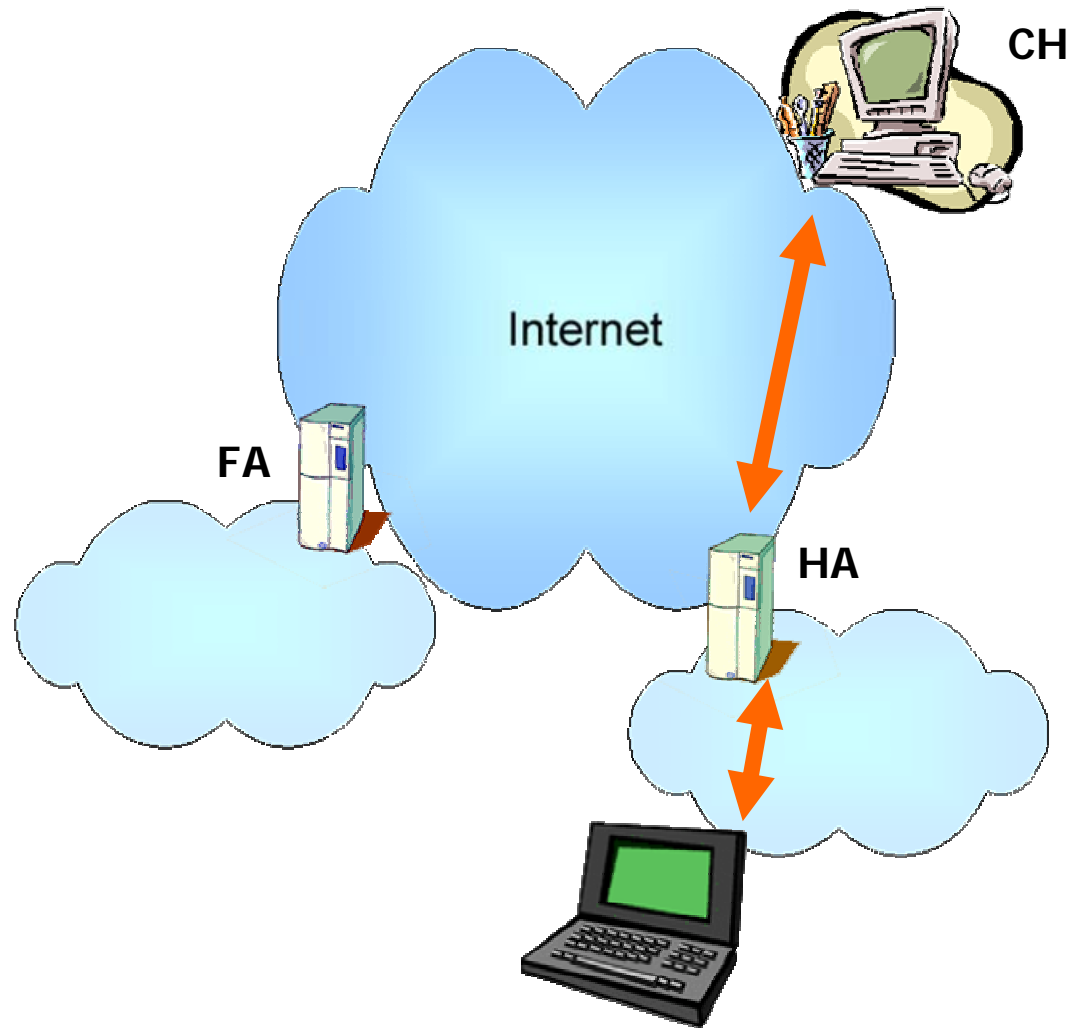- **Compare performance between the two protocols**

Mobile IP Overview

- **What is Mobile IP?**

  - Provides continuous Internet connectivity to the mobile user

  - Terminologies:
    - *Home Agent (HA) / Foreign Agent (FA)*
    - *Mobile Host (MH)*
    - *Corresponding Host (CH)*
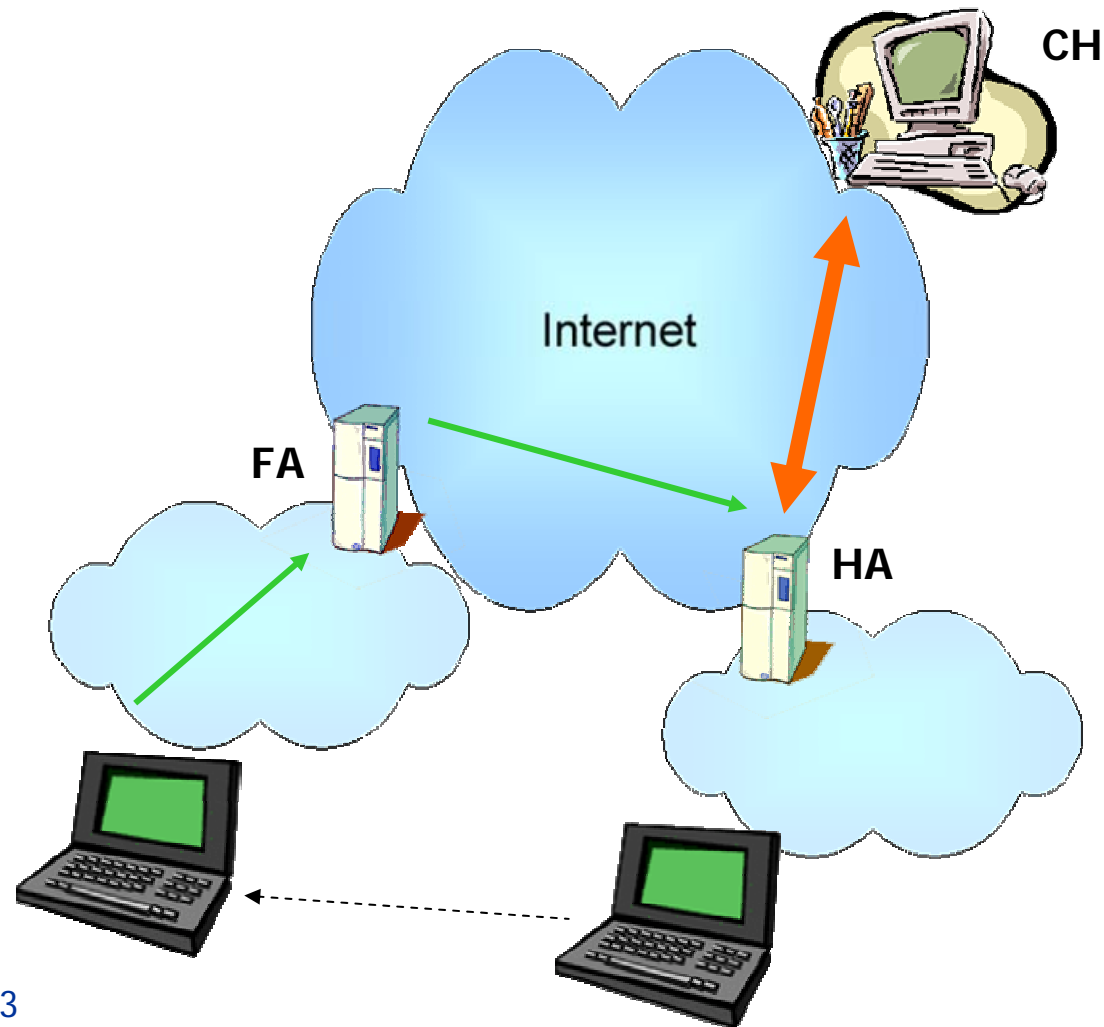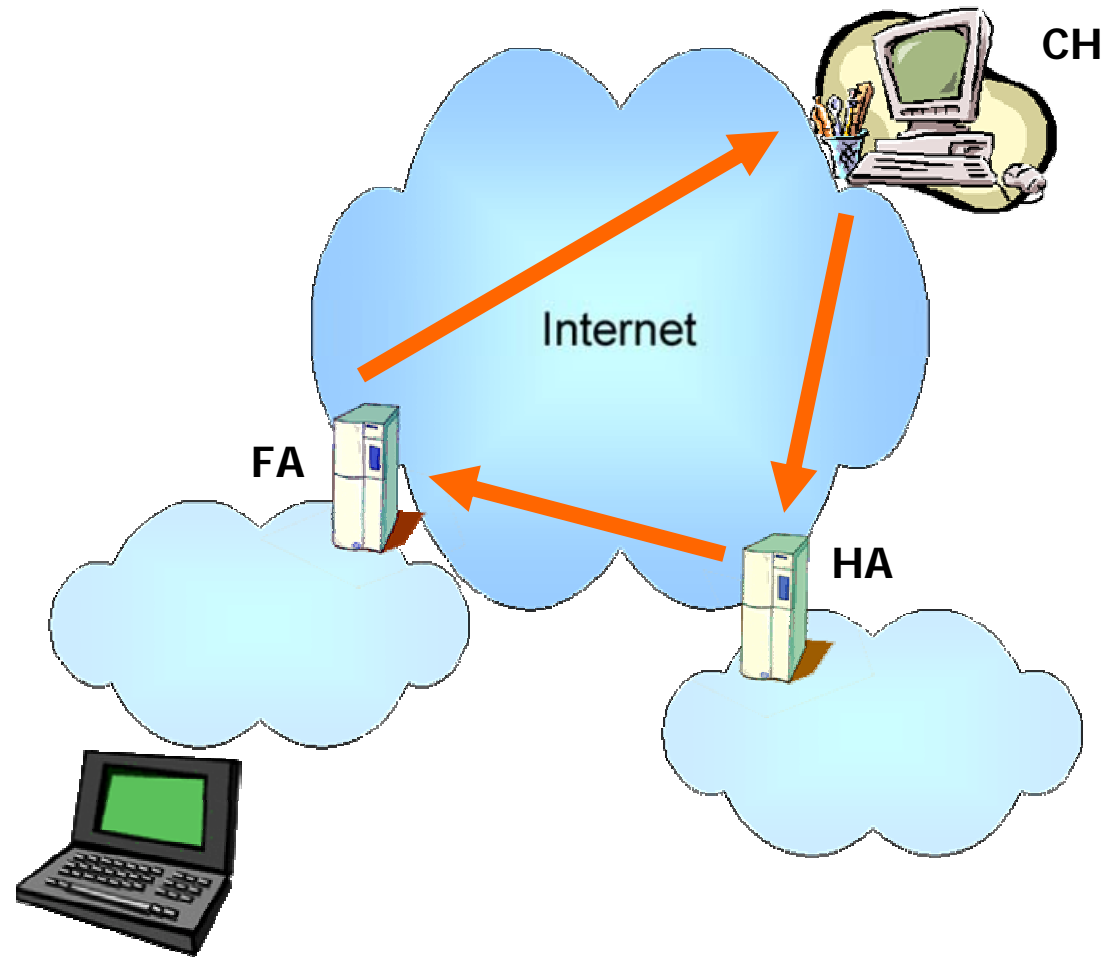   - *Care-Of-Address (COA)*

Mobile IP Overview

Mobile IP Overview

Mobile IP Overview

Mobile IP Overview

- **Problem: Triangle Routing**

  - MIP allows transparent inter-operation between MH and CH

  - Indirect routing – non-efficient use of routing packets

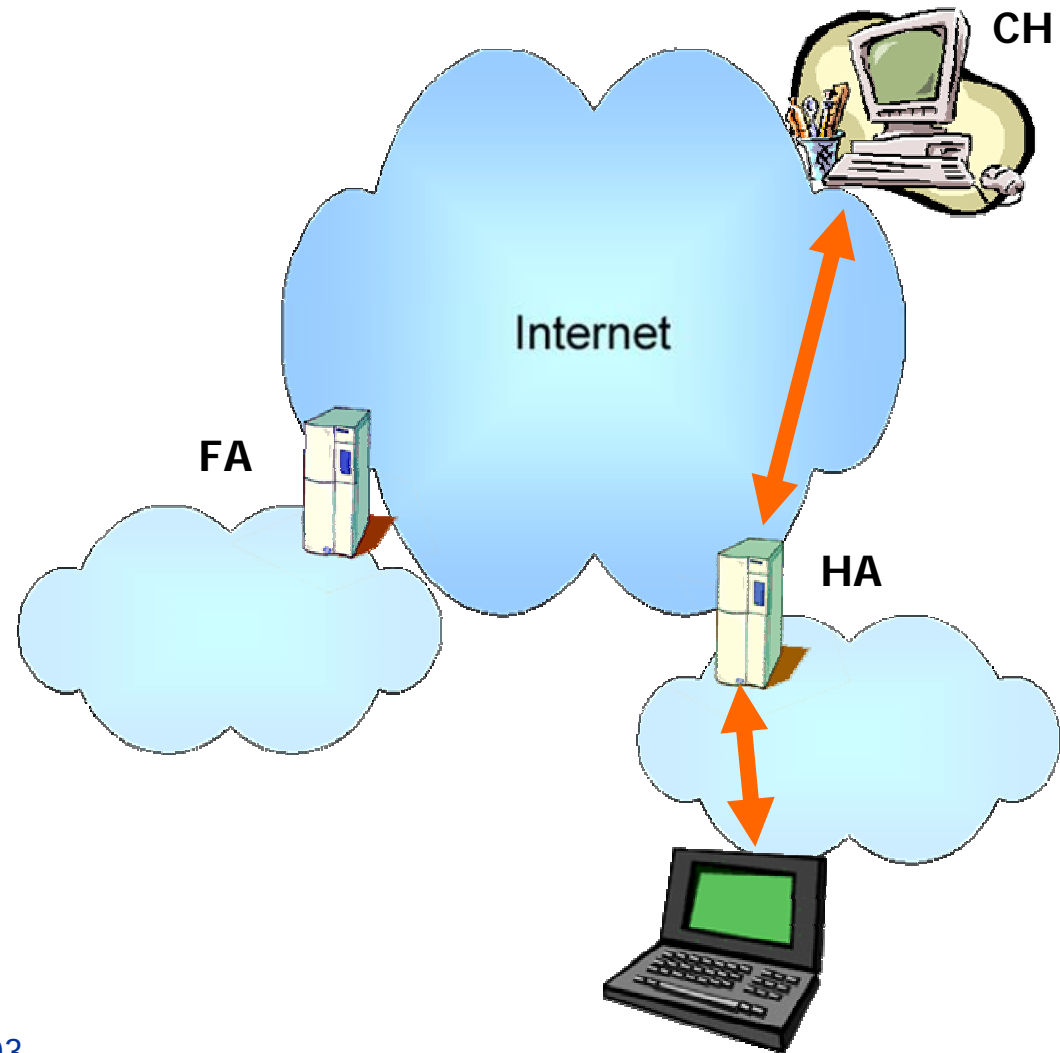# MIP Overview: Route Optimization

- **Binding Cache**

  - Allow packets to be sent directly to the MH, bypassing the HA

  - Use 4 messages:

    - *Binding Update (BU)*

    - *Binding Acknowledge (BA)*

    - *Binding Warning (BW)*
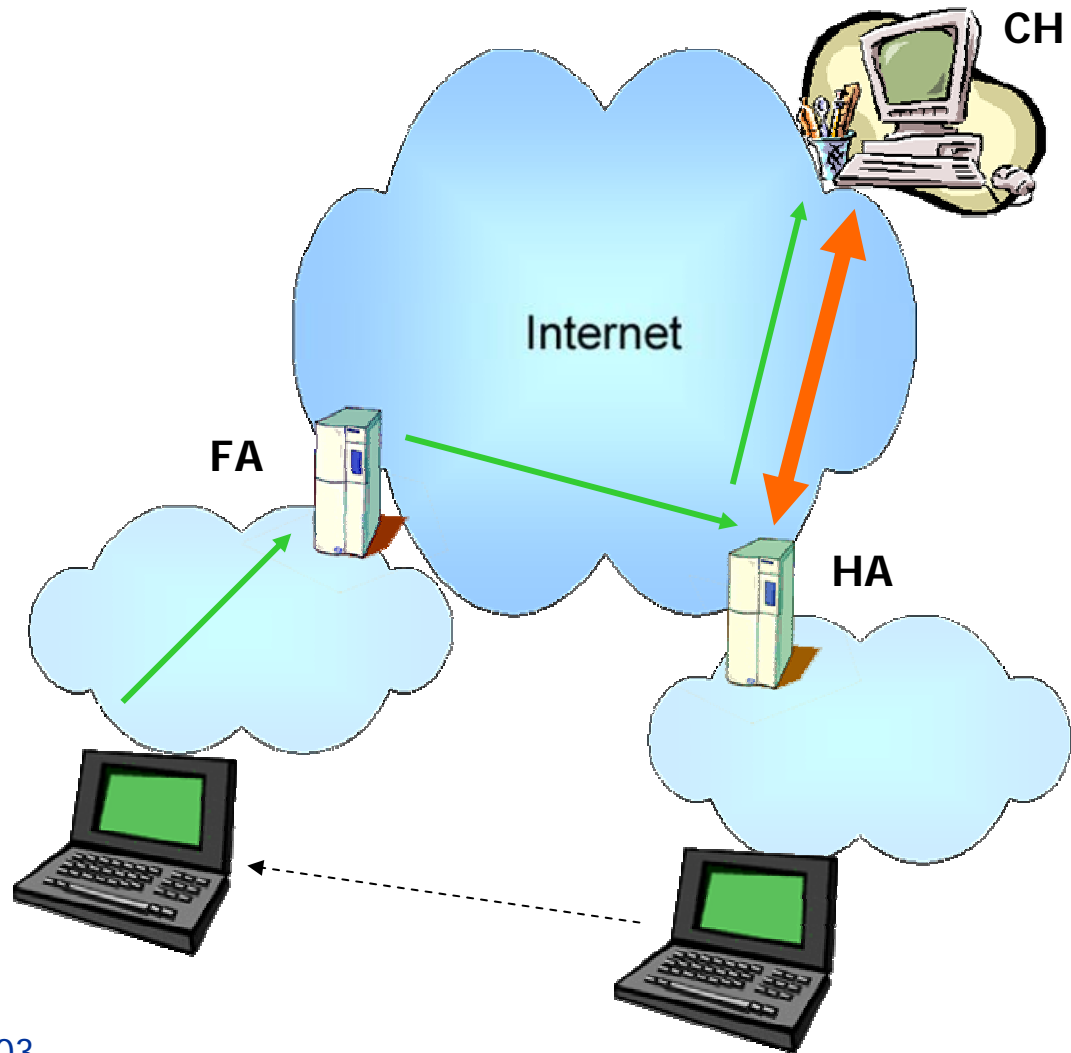
    - *Binding Request (BR)*

MIP Overview: Route Optimization
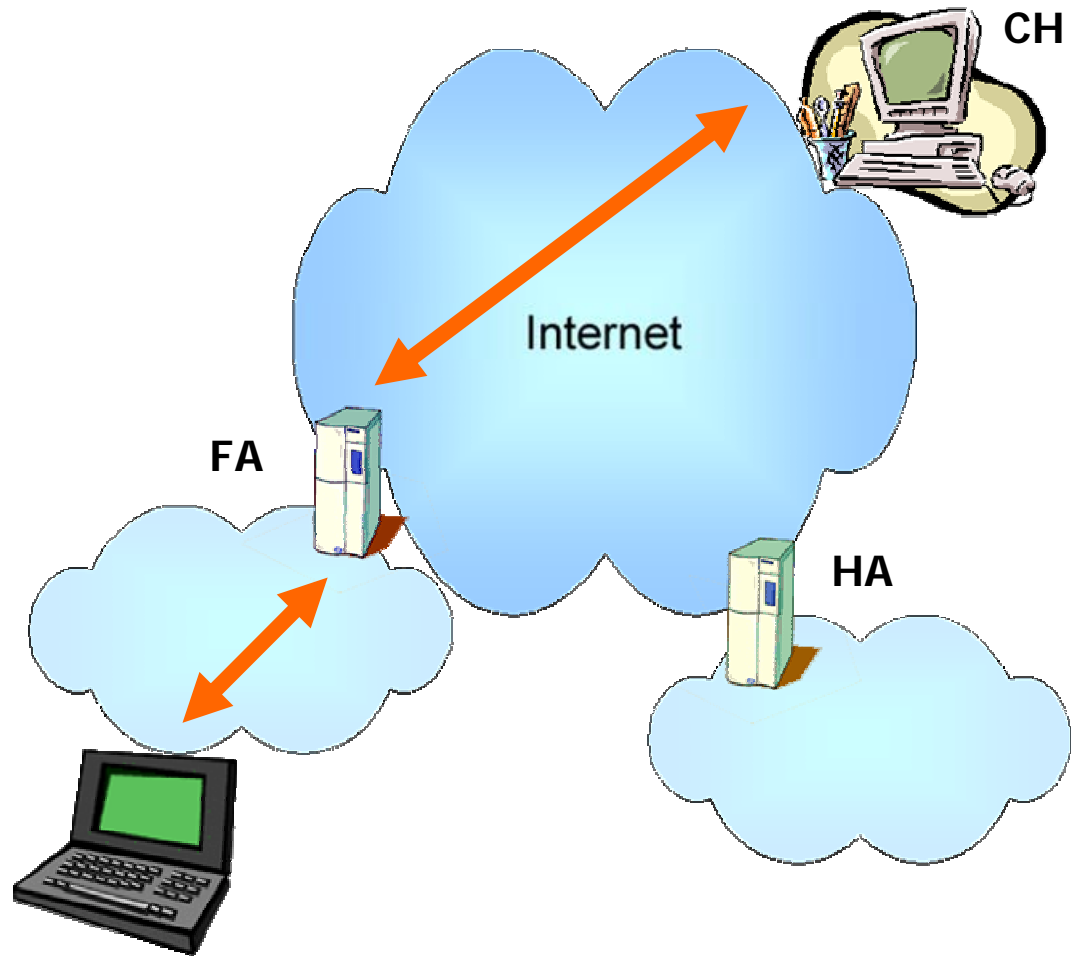
# MIP Overview: Route Optimization

MIP Overview: Route Optimization

MIP Overview: Route Optimization

- **Route Optimization: Smooth handoff**

  - Datagrams in flight to the MH are lost during a transition period between different FA's

  - MH informs the previous FA of the new MH address

  - Creates a temporary binding cache to address in-flight packets

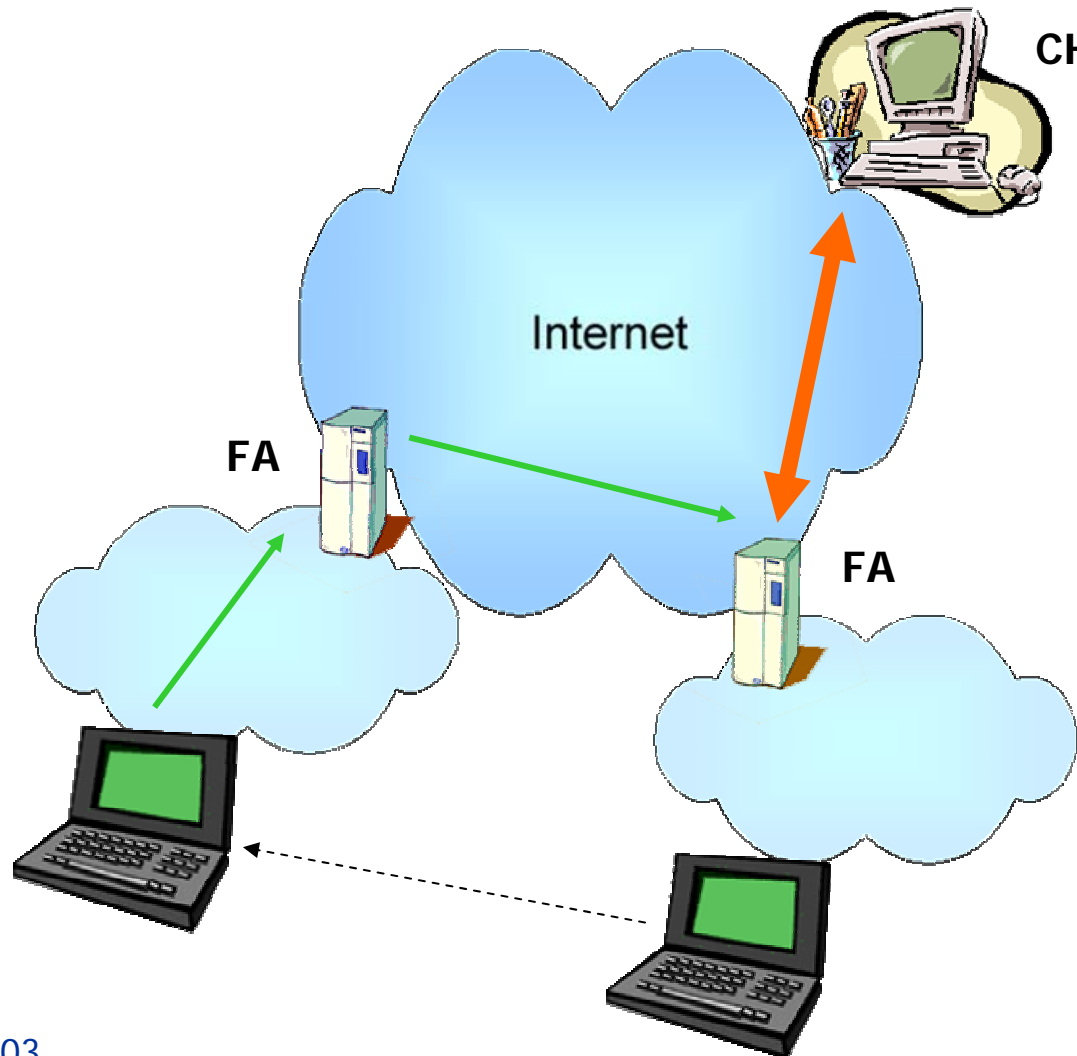 - MH needs to retransmit BU messages to the previous FA until a BA is received
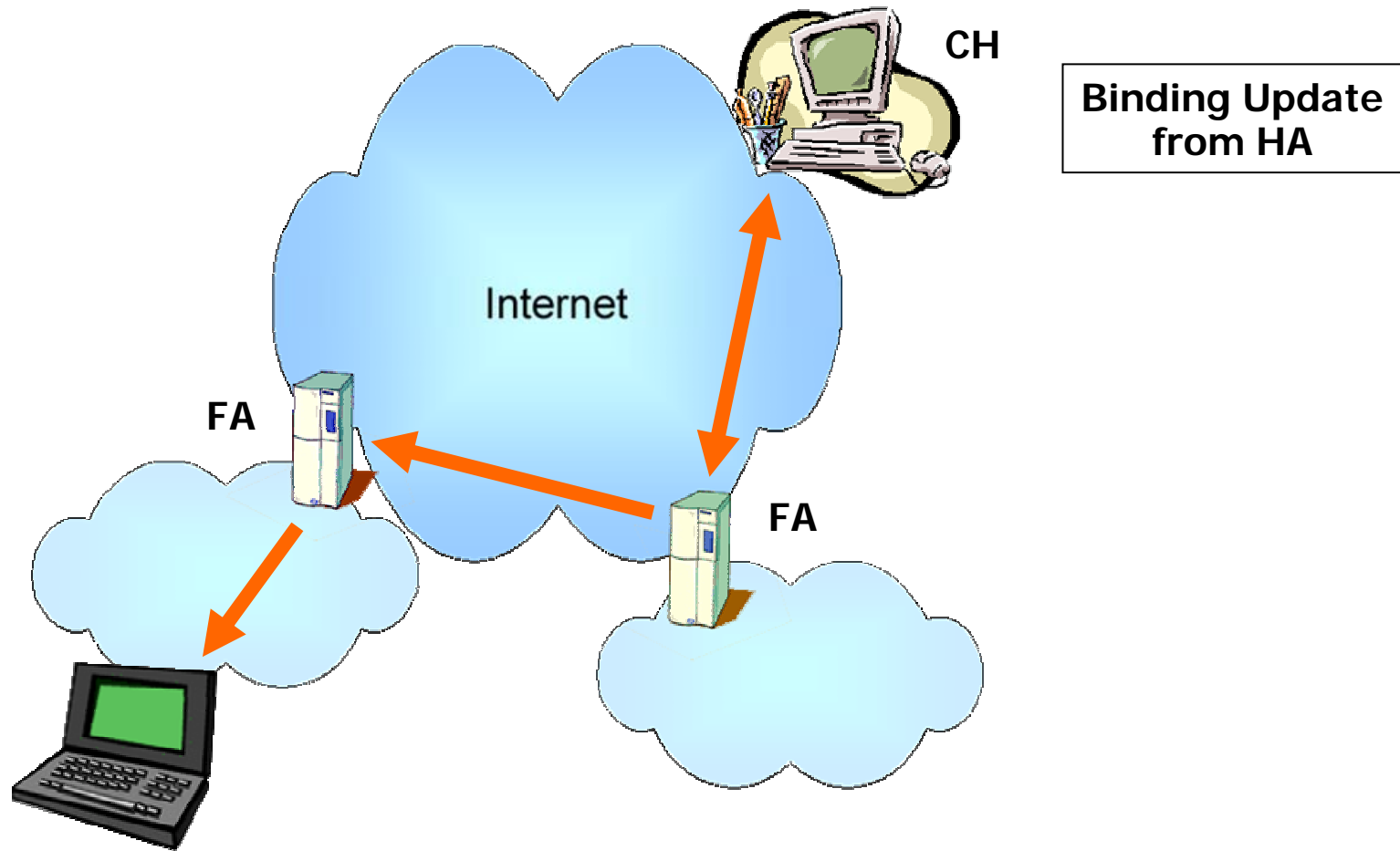
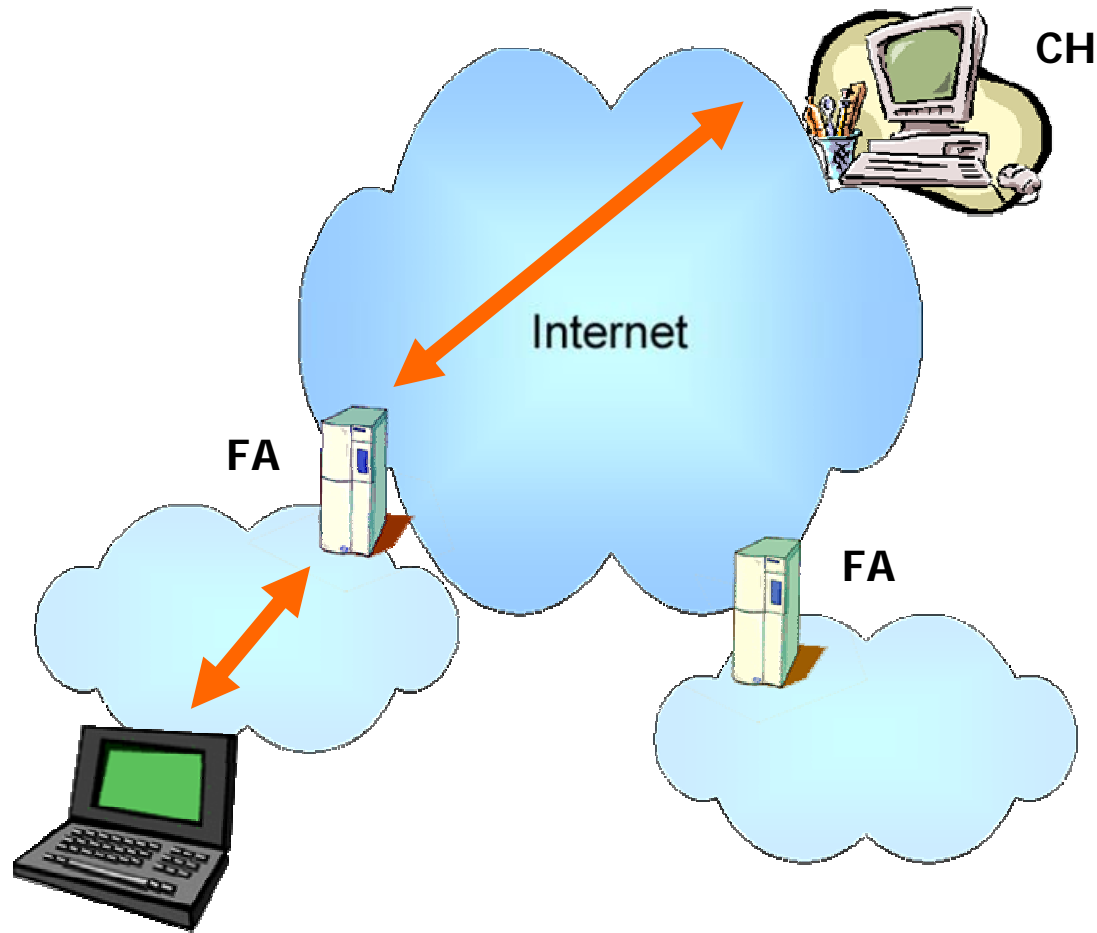# MIP Overview: Smooth Handoff
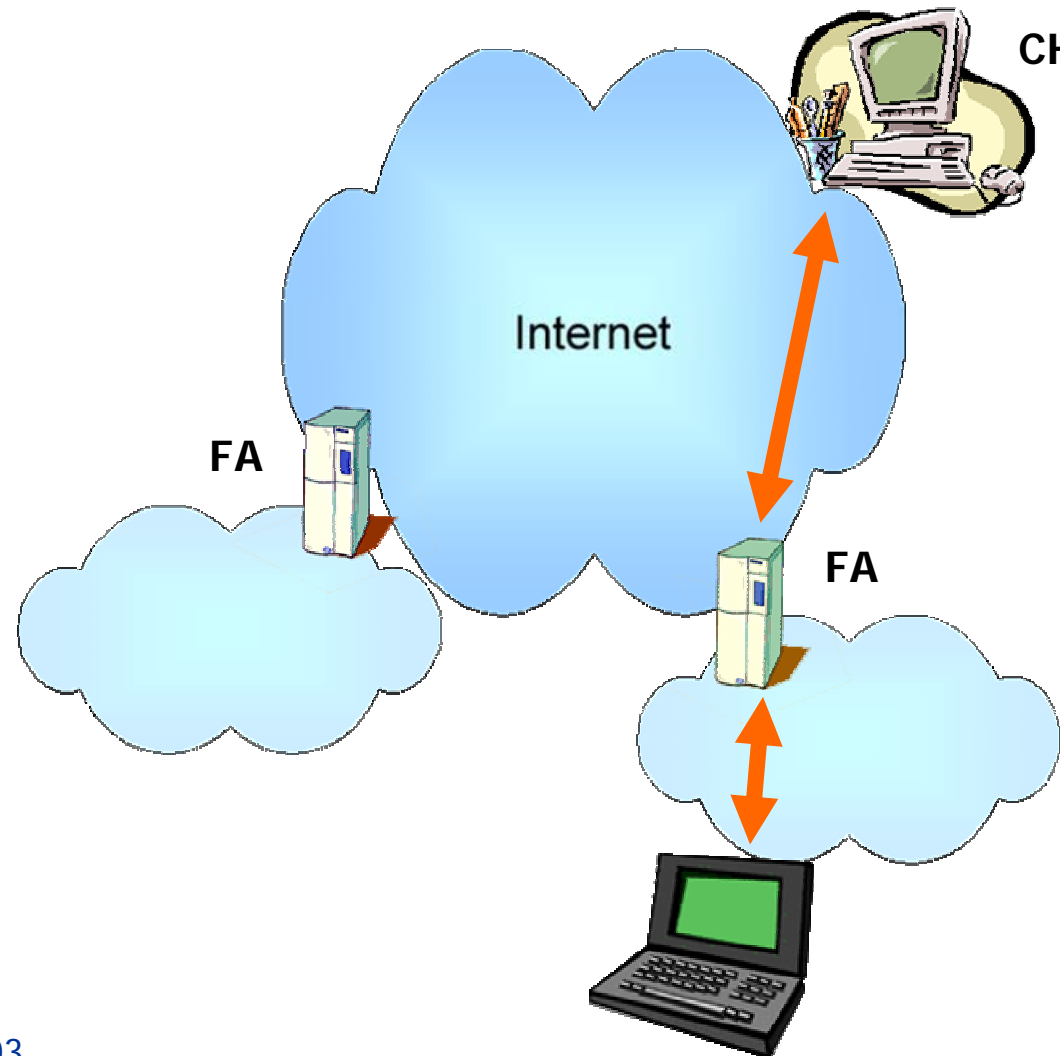
MIP Overview: Smooth Handoff

MIP Overview: Smooth Handoff

CH

Binding Update
from HA

Internet

FA

FA

MIP Overview: Smooth Handoff

MIP Overview: Reverse Routing
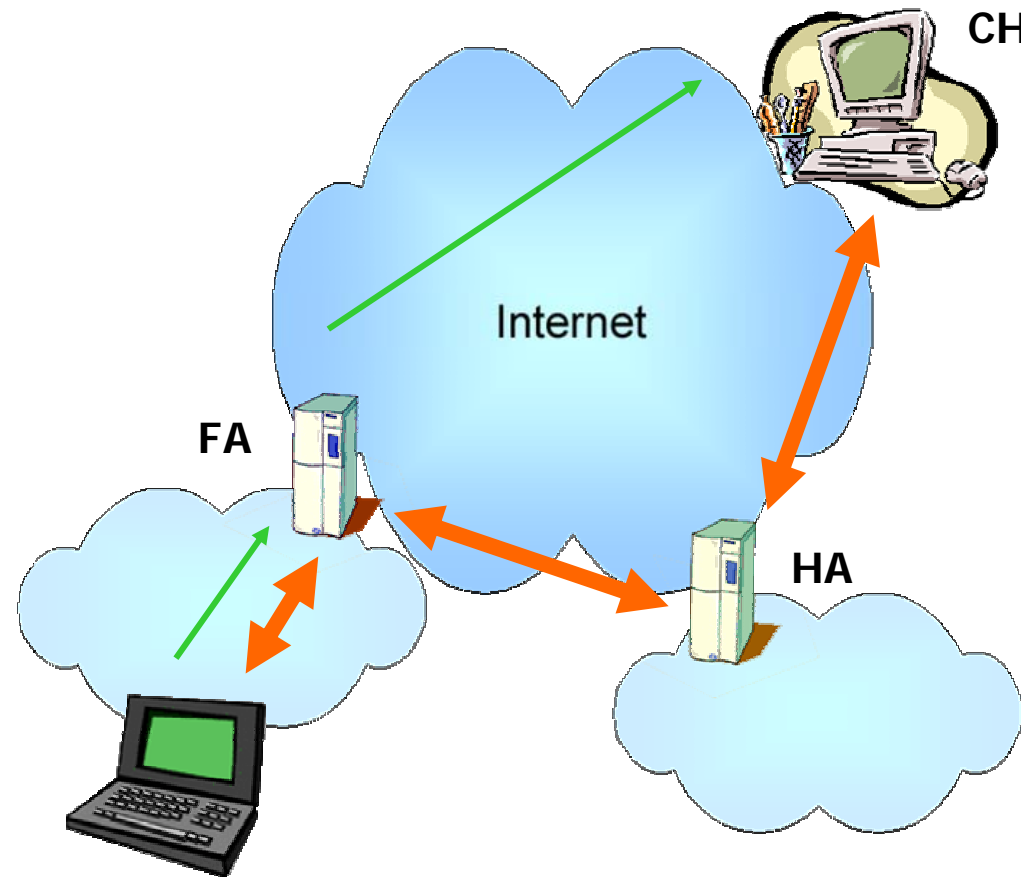
- **Why Reverse Routing?**
  - ROMIP – complex protocol and inconsistent cache mobility binding
  - Offers simplicity of MIP and direct routing of ROMIP

- **Overview**
  - MH sends new COA directly to the CH via a registration message
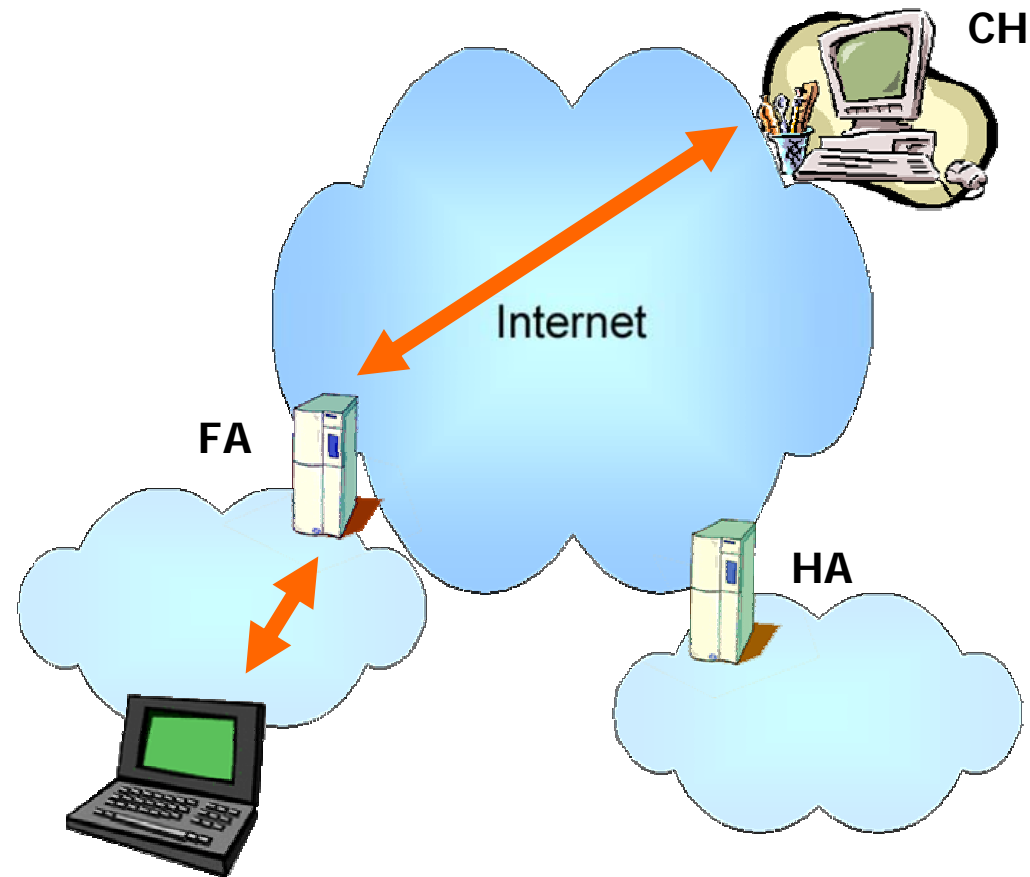 - CH router updates its routing table so that packets for MH are routed directly to the new COA

MIP Overview: Reverse Routing

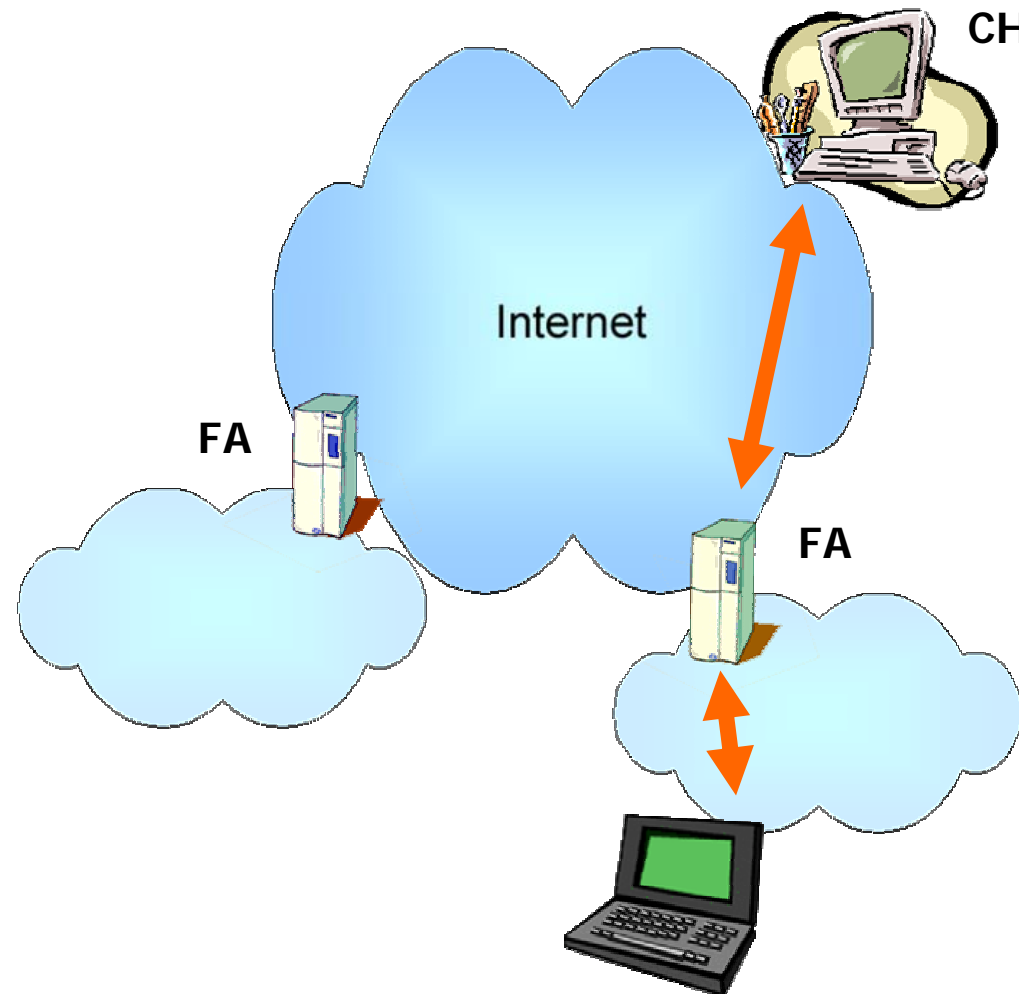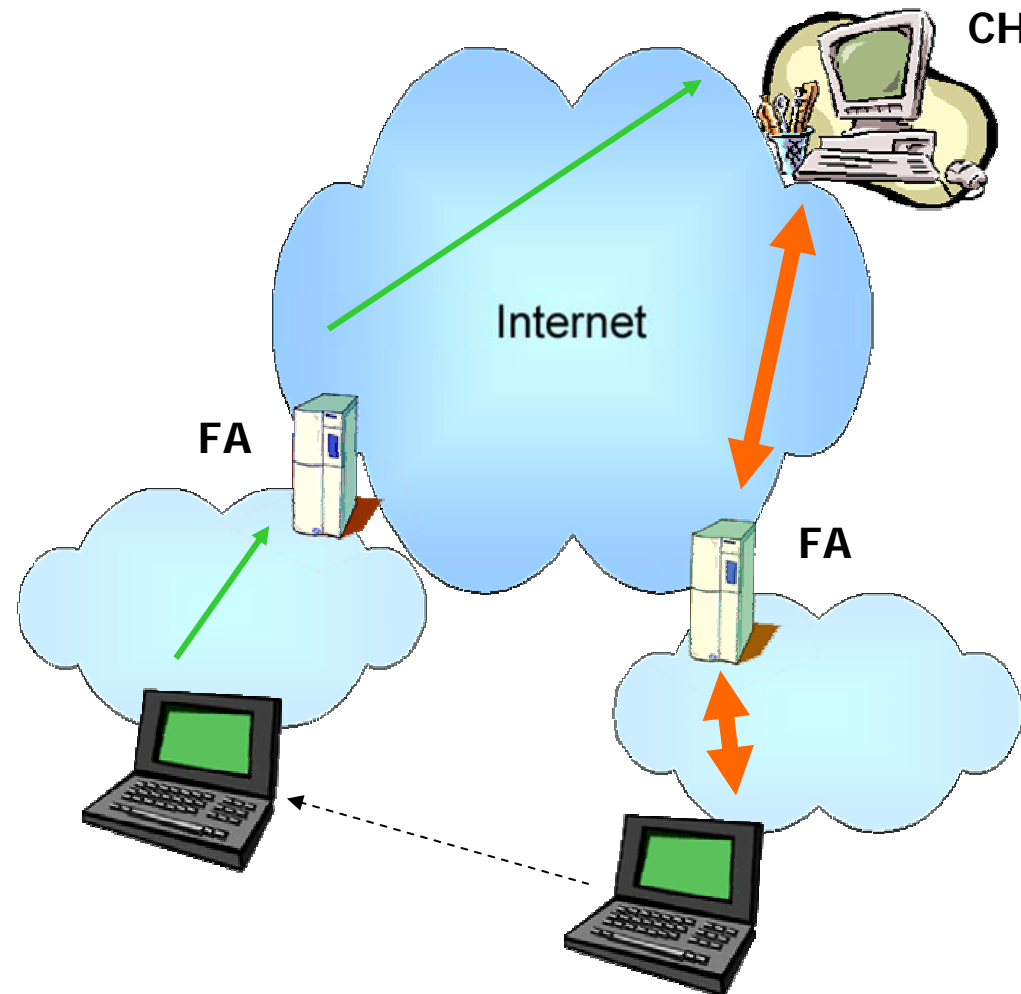# MIP Overview: Reverse Routing

MIP Overview: Reverse Routing
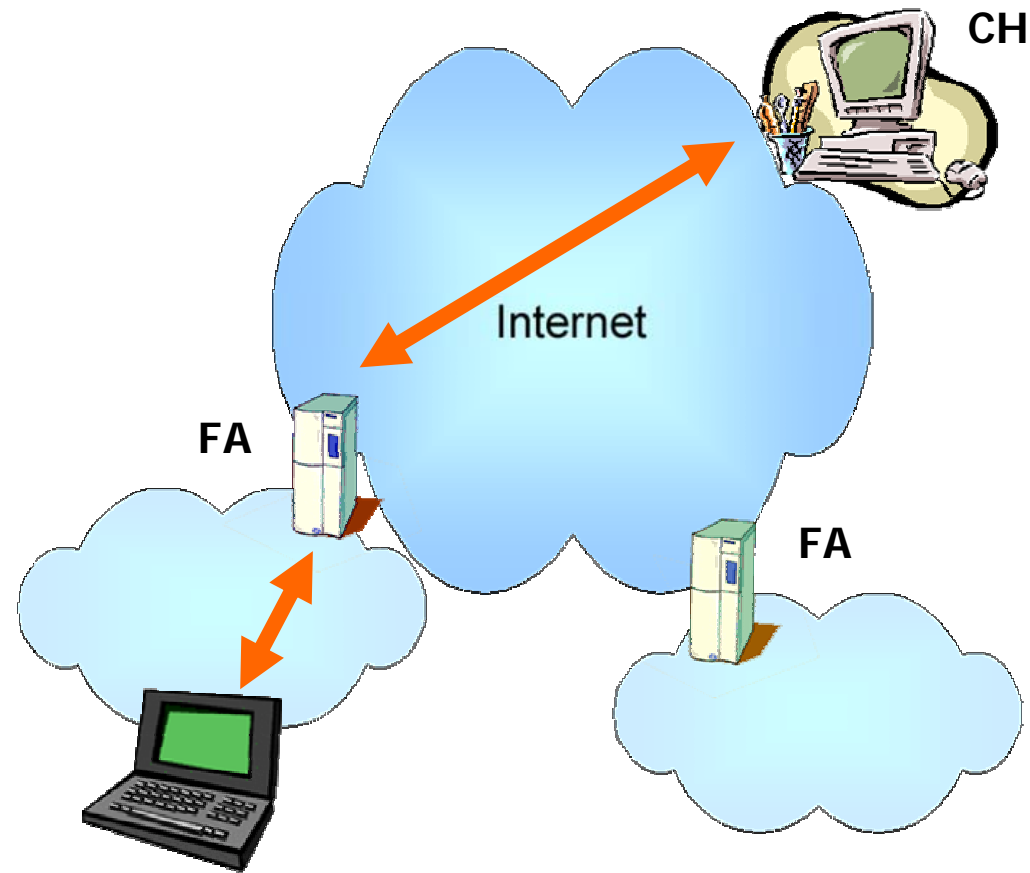
MIP Overview: Reverse Routing

Internet

CH

FA

FA

MIP Overview: Reverse Routing

Implementation

- **Installed NS 2.1b8 on Linux**

- **Got Leo's implementation working**

- **Completed the Route Optimization protocol**

  - Added Binding Request Handling

  - Added Binding Acknowledge Handling

  - Added smooth handoff

- **Added Reverse Routing**

- **Upgraded to NS 2.26**

Implementation

C++

Agent
- MIPBSAgent
- MIPMHAgent

Classifier
- MIPEncapsulator
- MIPDecapsulator

OTCL

Node
- MobileNode
  - MIPBS
  - MIPMH

Legend:
- 🟧 Route Optimization
- 🟨 Reverse Routing
- 🟩 Both
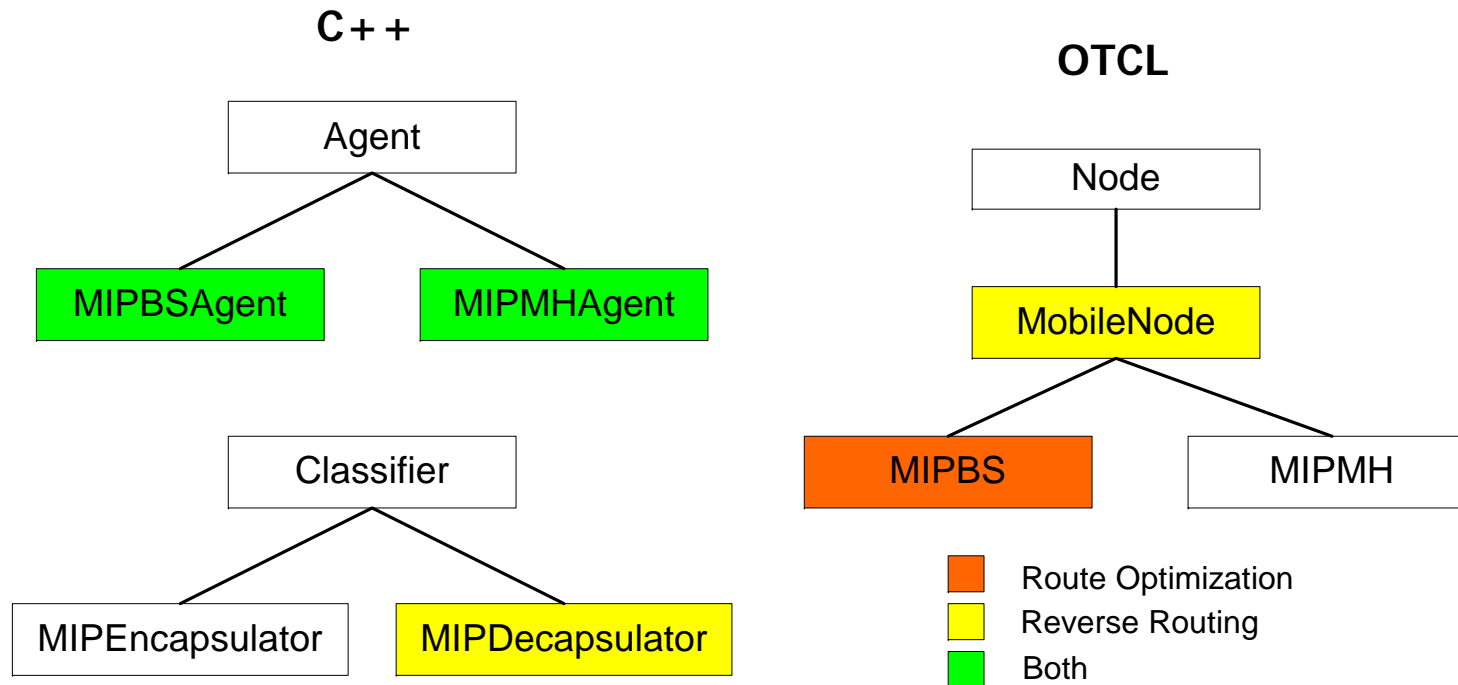
Results & Analysis

Protocol performance of ROMIP vs. MIP

Average Delay (s)
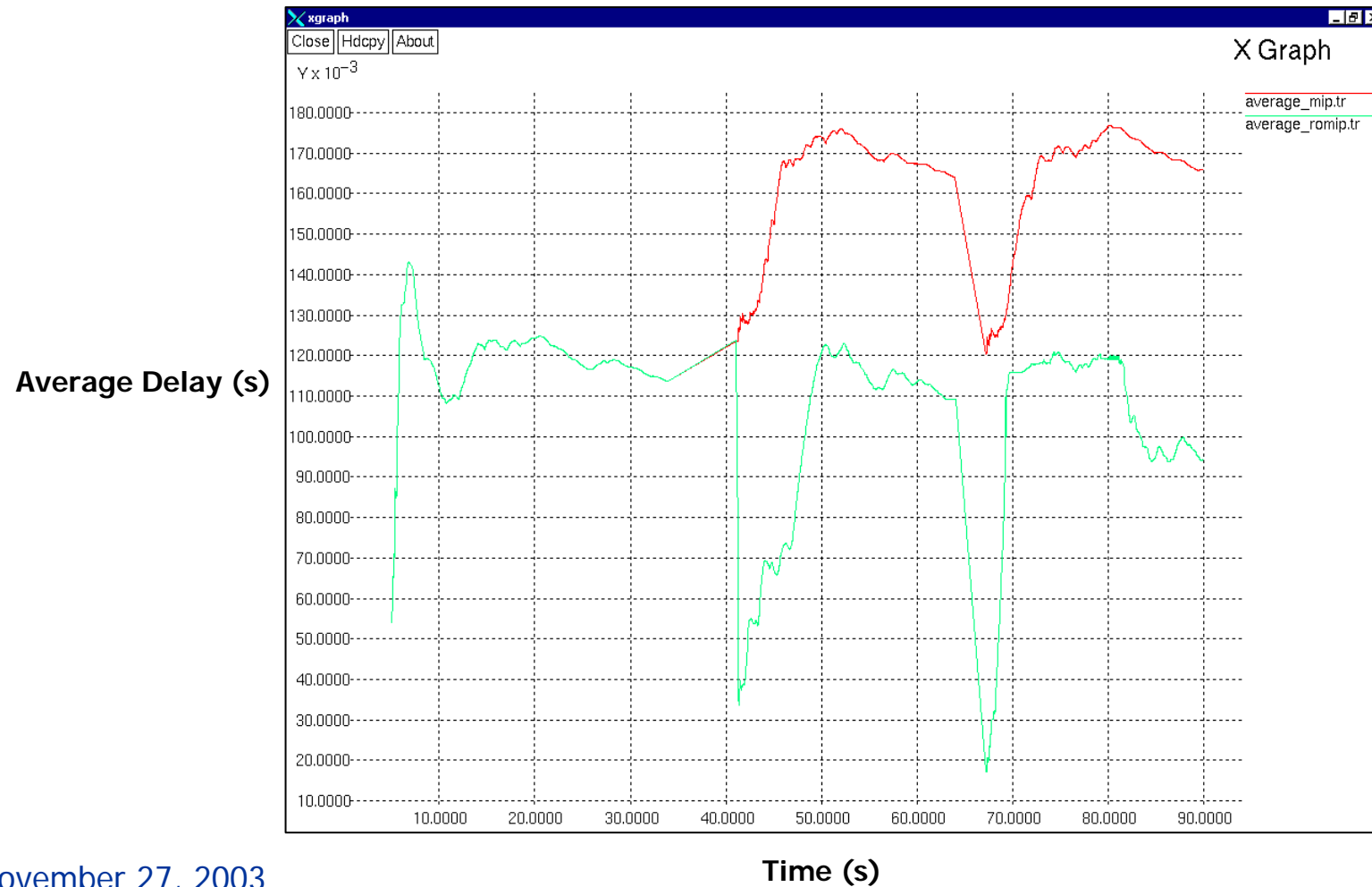
Time (s)

Results & Analysis

Smooth handoff performance (compared to Leo's)

Average Delay (s)
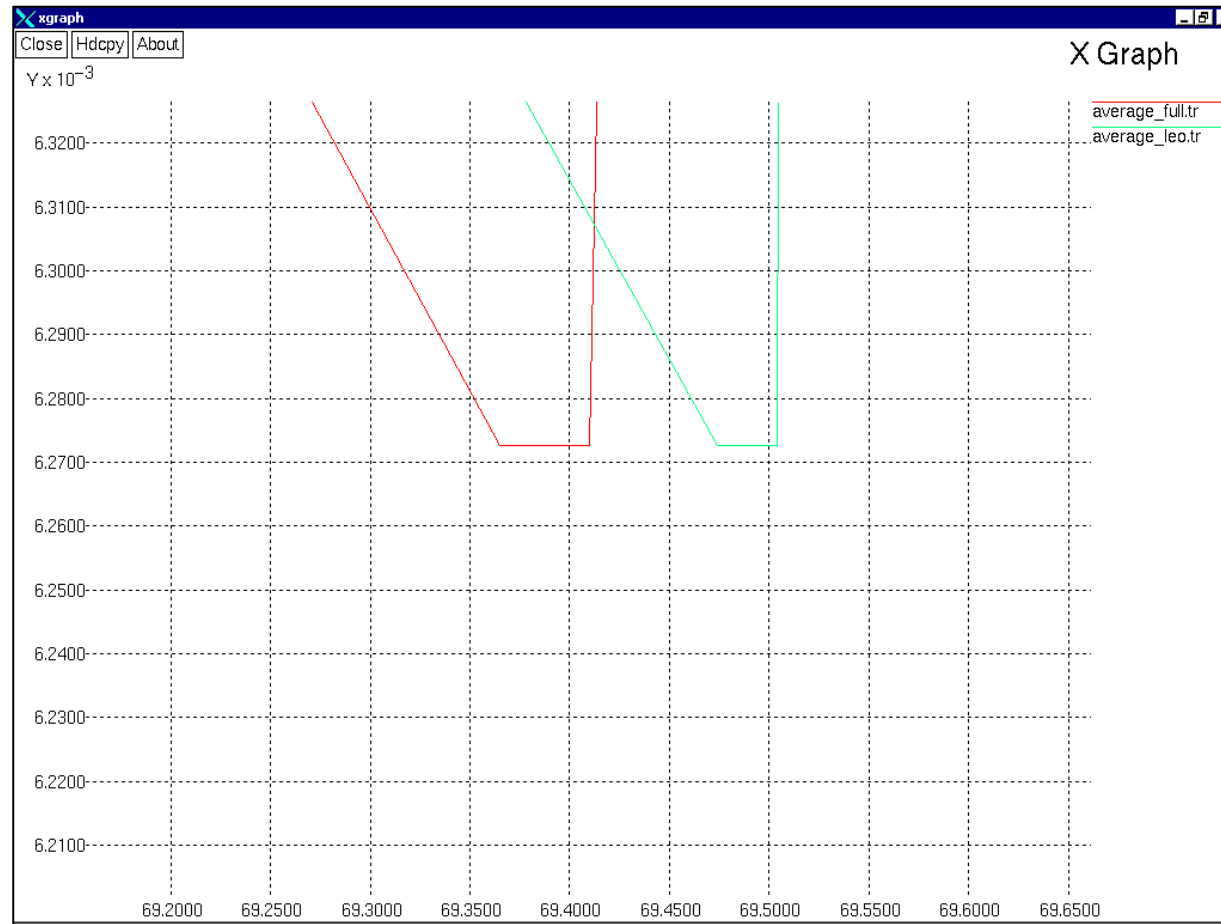
Time (s)

Results & Analysis

Reverse Routing performance graph

Average Delay (s)

Time (s)
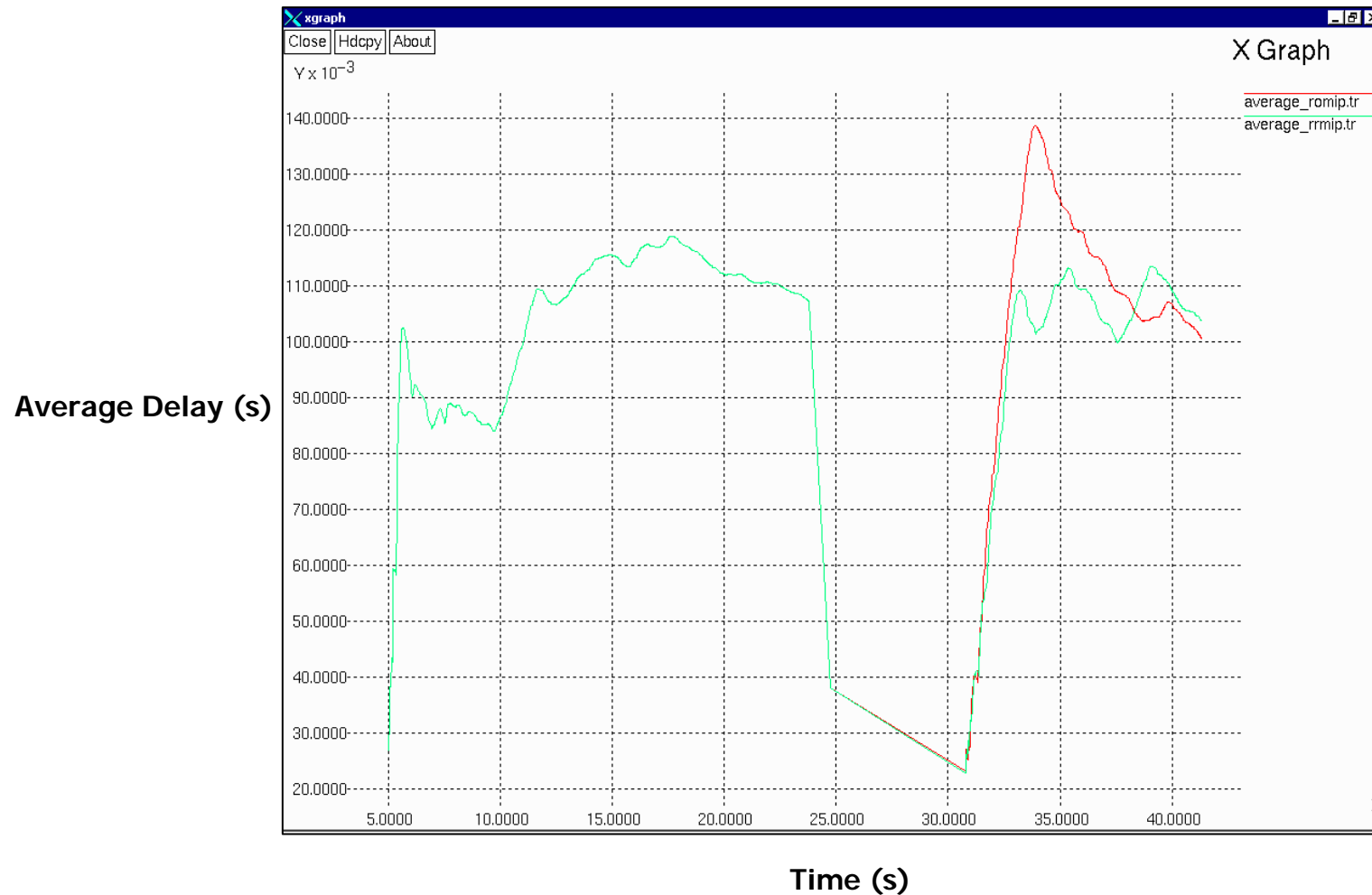
Future Work

- **Comparison of ROMIP/RRMIP with other approaches [7]**

- **Comparison of mobility support between IPv4 and IPv6**

Conclusion

- **ROMIP does offer better performance than MIP**

- **Smooth handoff offers smaller packet lost during 'transition' periods**

- **Reverse Routing does eliminate inefficiency of MIP and complexity of ROMIP**

References

[1] H. Chen and L. Trajkovic, "Simulation of Route Optimzation in Mobile IP," SFU, Sept 11, 2002.

[2] C. Perkins, "IP Mobility Support," RFC 2002, October 1996: http://www.ietf.org/rfc/rfc2002.txt (accessed in October 2003).

[3] C. Perkins, "IP Mobility Support For IPv4," RFC 3220, January 2002: http://www.ietf.org/rfc/rfc3220.txt (accessed in October 2003).

[4] C. Perkins and D. Johnson, "Route Optimization in Mobile IP," Internet Draft, February 2000: http://people.nokia.net/~charliep/txt/optim/optim.txt (accessed in October 2003).

[5] P. Calhoun and C. Perkins, "Mobile IP Challenge/Response Extensions," RFC 3012, November 2000: http://www.ietf.org/rfc/rfc3012.txt (accessed in October 2003).

[6] P. Zhou and O. Yang, "Reverse Routing: An Alternative to MIP and ROMIP Protocols," Proceedings of 1999 IEEE Canadian Conference on Electrical and Computer Engineering, Volume 1, pp. 150-155.

[7] R. Jain, T. Raleigh, et al. "Enhancing Survivability of Mobile Internet Access Using Mobile IP with Location Registers", INFOCOM'99. Proceedings of Eighteenth Annual Joint Conference of the IEEE Computer and Communications Societies. Volume: 1 pp. 3 – 11.