CS 525M – Mobile and Ubiquitous Computing Seminar

Brian Demers
March 2, 2004
Overview: Micromobility Protocols

- “Comparison of IP Micromobility Protocols” (2002, Campbell et al.)

- Background
  - What is micromobility?

- Paper
  - Paper goals
  - Protocols (CIP, Hawaii, HMIP)
    - Results

- Conclusions
Micromobility
Micromobility

- Mobile IP

  - Works fine when user is stationary
  - What if user moves frequently?
    - Disrupts data stream, especially real-time data (ex: Voice over IP)
Micromobility protocols
- Complement Mobile IP
- Improved support for “local” handoffs
Micromobility (cont.)

- Micromobility protocols
  - Complement Mobile IP
  - Improved support for “local” handoffs

![Diagram showing Micromobility protocols]

- Incoming Message
- Home Agent
- Foreign Agent
- User
- Access Points
Paper Overview
Paper Overview

- Compare micromobility protocols
  - Cellular IP
  - Hawaii
  - Hierarchical Mobile IP (HMIP)

- Develop general protocol model

- Analyze design and performance tradeoffs

- Simulate protocol behavior
  - Focus on handoff performance
• Protocol performance factors:
  – Layer of operation
  – Movement detection method
    • In band vs. out-of-band signaling
  – Location of routing information
  – Routing information update process
    • What happens during crossover?
Protocol Overview

<table>
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<tr>
<th>Layer</th>
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<th>Hawaii</th>
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- Layer 3, Network/IP
  - Intermediate nodes are MAC/physical layer
  - All devices in micromobility network must be mobility-aware

- Layer 3.5, IP Tunnels
  - Intermediate nodes are IP nodes
### Protocol Overview (cont.)

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- **In-band**
  - Use existing data packets to detect nodes, update routes
- **Out-of-band**
  - Use explicit signaling messages
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- **Mobile-specific routing**
  - Maintain information specific to mobile nodes/routes
  - Are aware that a routing protocol is in use

- **Hierarchical Tunneling**
  - Rely on tree-like hierarchy
Protocol Overview (cont.)

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- **IP Paging**
  - Allows mobile nodes to enter power-saving mode
  - Provides way to rediscover nodes
- **Handoff algorithms**
  - Hard vs. soft (sudden vs. gradual)
## Protocol Summary

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- **Hierarchical tunneling**: GFA sets up tunnels.
- **IP routing with mobile-specific (location) info**
- **In-band signaling (data packet)**
- **Out-of-band signaling (signaling message)**
- **Mobile-specific routing (reverse path routes)**
Simulation
Simulation Goals

• Simulation of handoff scenarios
  – Module for ns-2

• Evaluation criteria:
  – Packet loss/duplication
  – Routing updates

• Ways to improve handoff process
Simulation (cont.)

- Simulation scenario #1 (tree, hard handoffs):

- Tests effect of crossover distance
• Measured packet loss during crossover
  – Cellular IP & Hawaii vary linearly with distance
  – Hierarchical Mobile IP is constant
  – HMIP: Routing decisions are made at Gateway FA (highest node)
• Measured throughput vs. handoff type

• Hard handoffs
  – Low signaling overhead, but tend to lose packets
  – Cellular IP hard handoff
  – Hawaii UNF

• Semi-soft handoffs
  – Prepare new access point before performing handoff
  – Cellular IP: bi-casting
  – Hawaii MSF: buffer & forward
Simulation scenario #2 (connected tree):

- Tests protocol routing against non-tree topologies
Simulation (cont.)

- Cellular IP
  - Old route
  - New route

- Hawaii (MSF)
  - Old route
  - New route
• Cellular IP
  – Old route
  – New route

• Hawaii (MSF)
  – Old route
  – New route

• Hawaii MSF forms non-optimal routes with non-tree topologies
• ...but it avoids congesting higher level nodes with routing information
Conclusions

• Developed a generic model for micromobility protocols
  – Viewed Cellular IP, Hawaii, and HMIP as instances of this model
• Developed extensions for ns-2 allowing simulation of these three protocols
• Found that location of crossover node is most important performance consideration
Conclusions

• I would add...
  – Provided insight about the handoff problem
  – Identified a potential routing issue with Hawaii (MSF handoff scheme)
  – Laid groundwork for future work relating to security and other practical issues with these protocols
  – Could extend this work to ad-hoc networks (?)
Questions/Comments?