CS 525M – Mobile and Ubiquitous Computing Seminar

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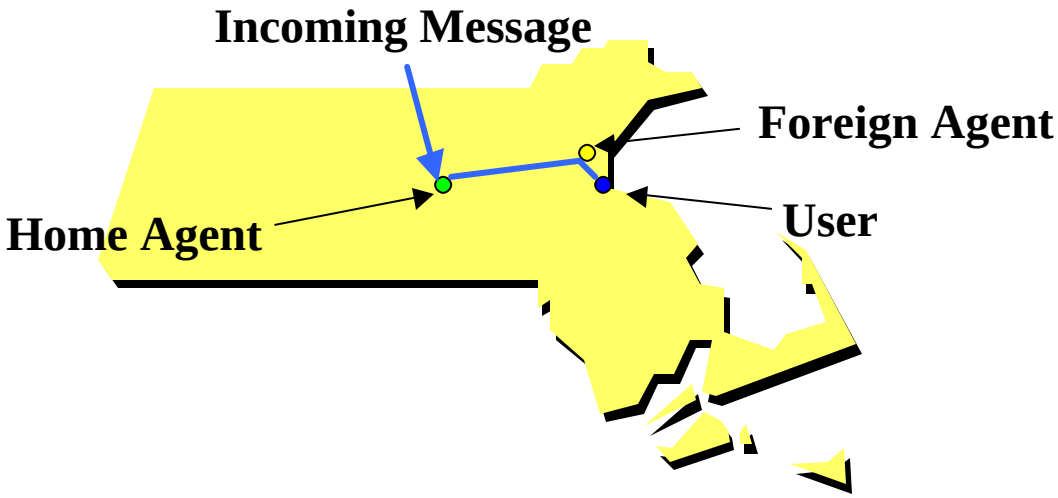
Overview: Micromobility Protocols

- “Comparison of IP Micromobility Protocols” (2002, Campbell et al.)
- Background
  - What is micromobility?
- Paper
  - Paper goals
  - Protocols (CIP, Hawaii, HMIP)
  - Results
- Conclusions

Micromobility

Micromobility

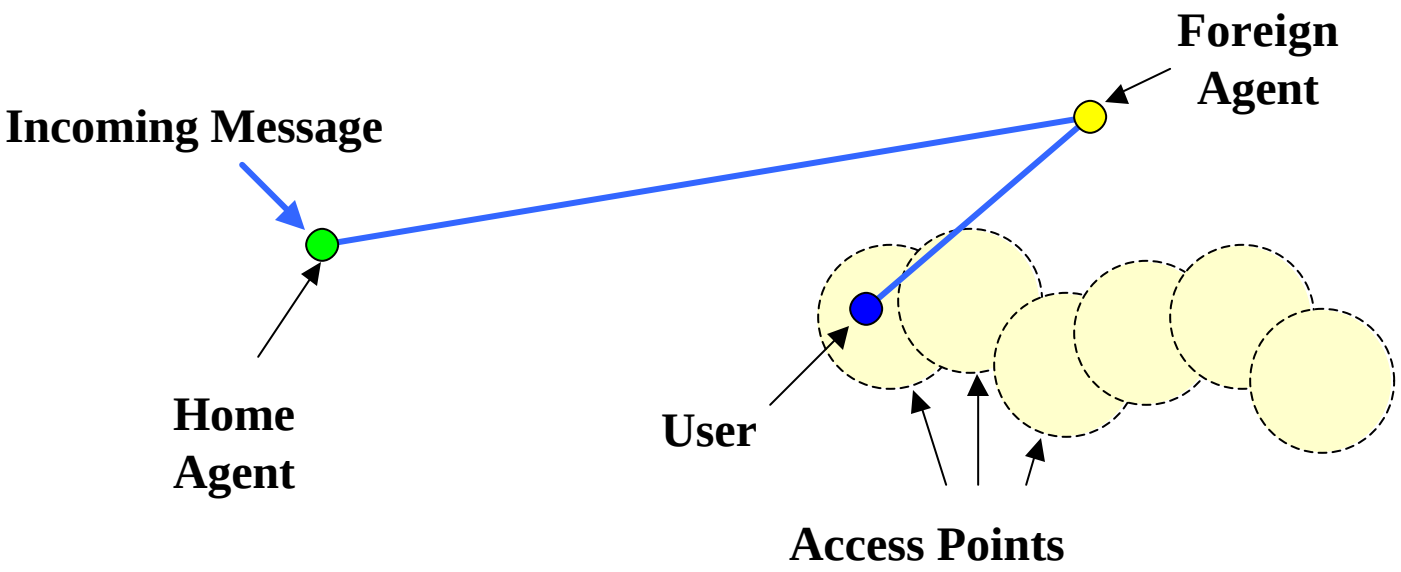
- Mobile IP



- Works fine when user is stationary
- What if user moves frequently?
  - Disrupts data stream, especially real-time data (ex: Voice over IP)

Micromobility (cont.)

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



Micromobility (cont.)

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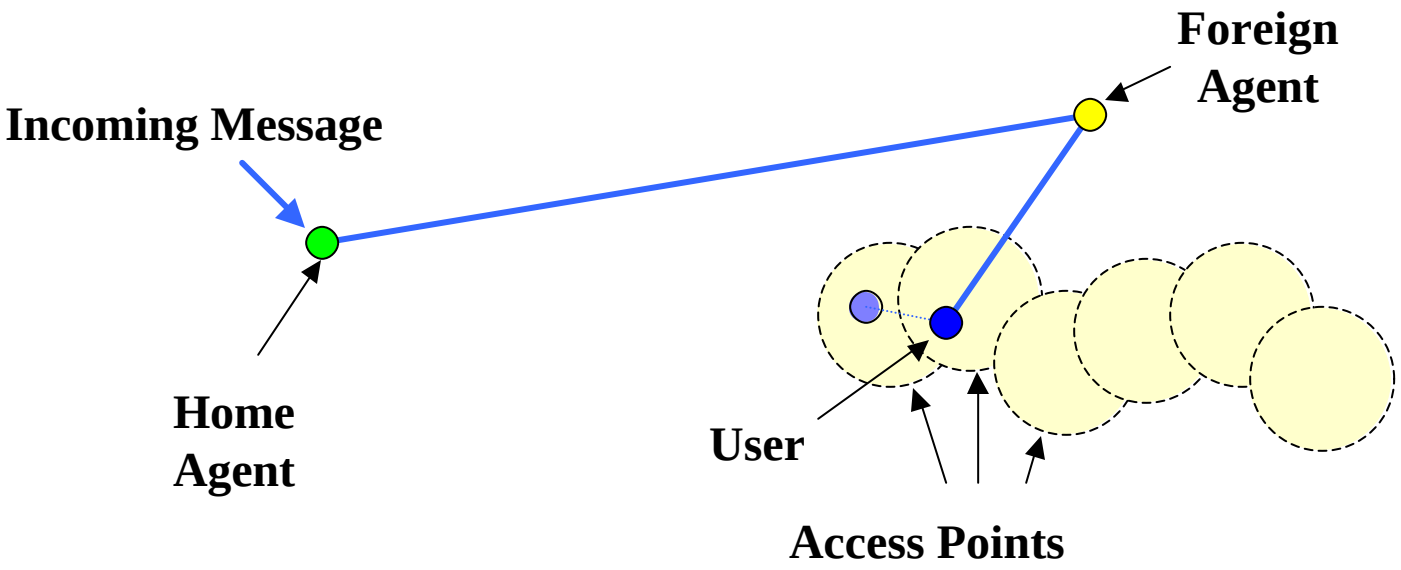


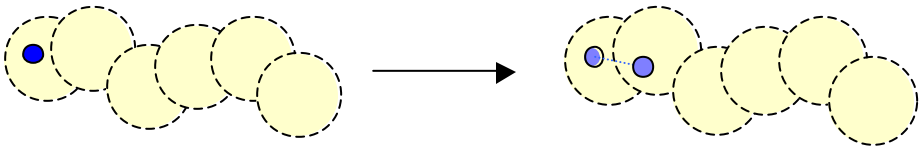
Paper Overview

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

Paper Overview (cont.)

- 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

	Cellular IP	Hawaii	Hierarchical Mobile IP
Layer	3, Network (IP)	3, Network (IP)	3.5, IP Tunnels

- 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.)

	Cellular IP	Hawaii	Hierarchical Mobile IP
Signaling	In-band (data packet)	Out-of-band (signaling message)	Out-of-band (signaling message)

- In-band
  - Use existing data packets to detect nodes, update routes
- Out-of-band
  - Use explicit signaling messages

Protocol Overview (cont.)

	Cellular IP	Hawaii	Hierarchical Mobile IP
Routing	Mobile-specific routing (reverse path routes)	IP routing w/mobile-specific (location) info	Hierarchical tunneling (GFA sets up tunnels)

- 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.)

	Cellular IP	Hawaii	Hierarchical Mobile IP
Other Features	IP paging for idle hosts; hard & semi-soft handoffs	IP paging; 4 handoff types	Gateway FA

- 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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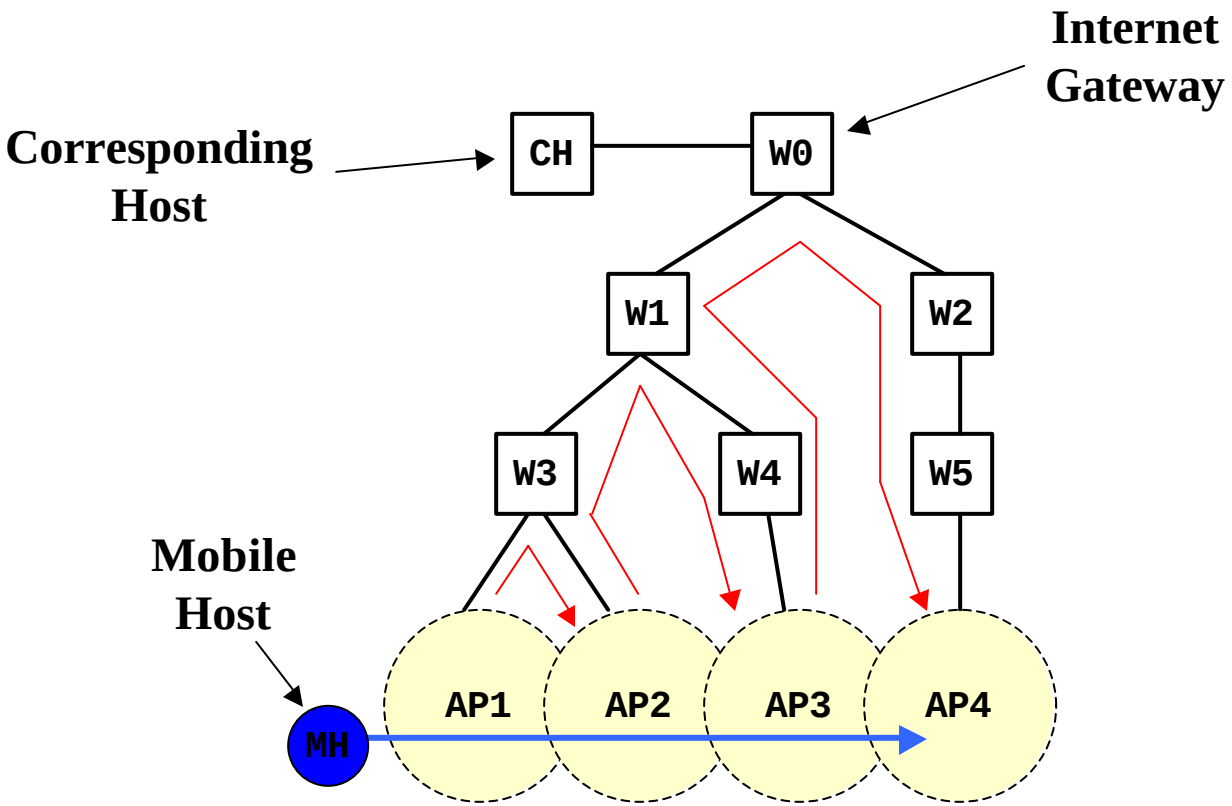
Simulation

Simulation Goals

- Simulation of handoff scenarios
  - Module for ns-2
- Evaluation criteria:
  - Packet loss/duplication
  - Routing updates
- Ways to improve handoff process

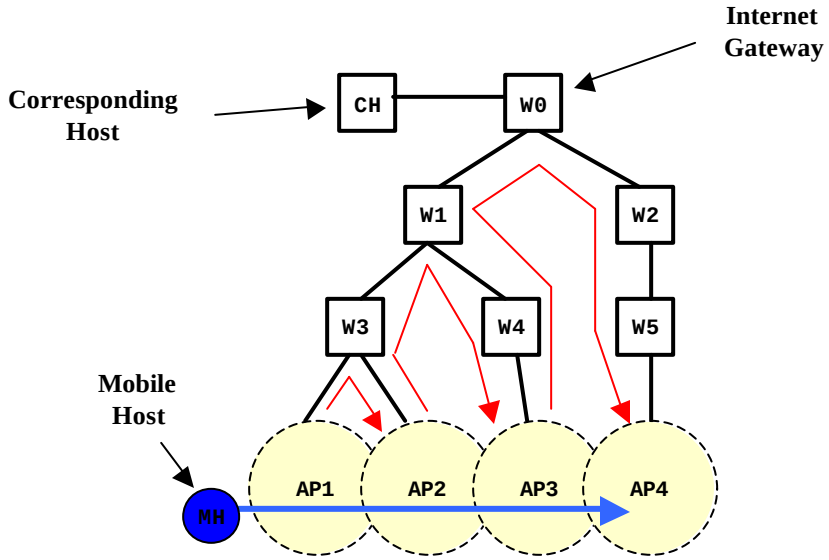
Simulation (cont.)

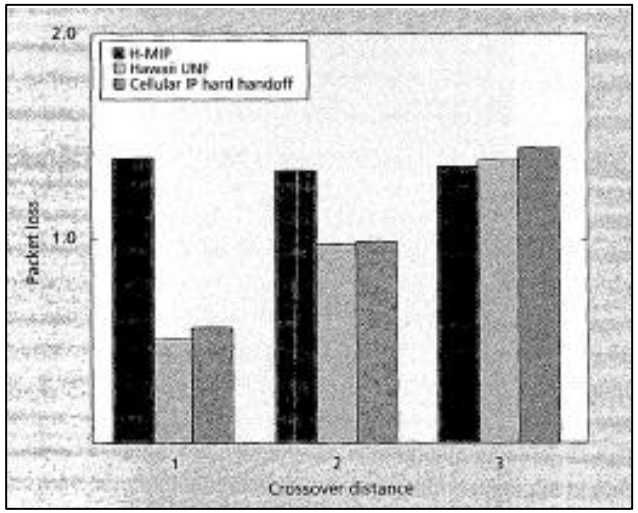
- Simulation scenario #1 (tree, hard handoffs):



- Tests effect of crossover distance

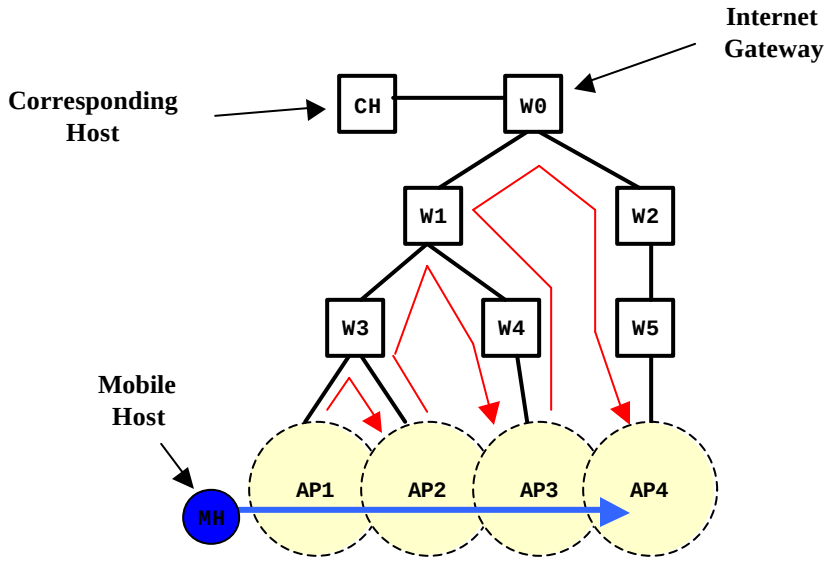
Simulation (cont.)

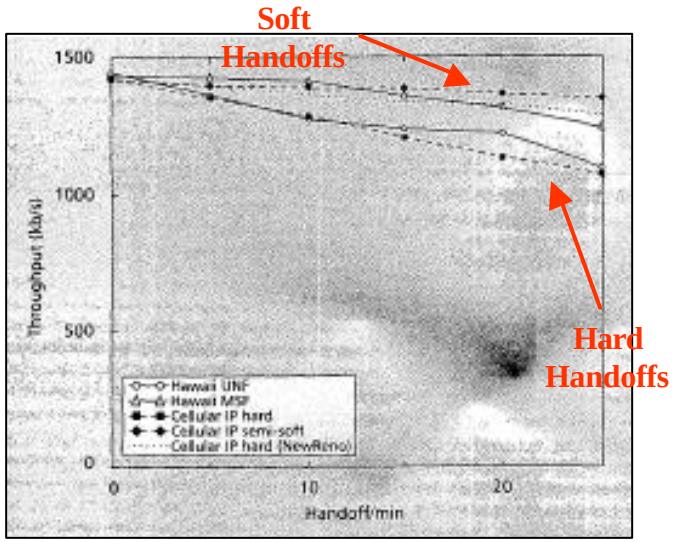




- Measured packet loss during crossover
  - Cellular IP & Hawaii vary linearly with distance
  - Hierarchical Mobile IP is constant
  - HMIP: Routing decisions are made at Gateway FA (highest node)

Simulation (cont.)

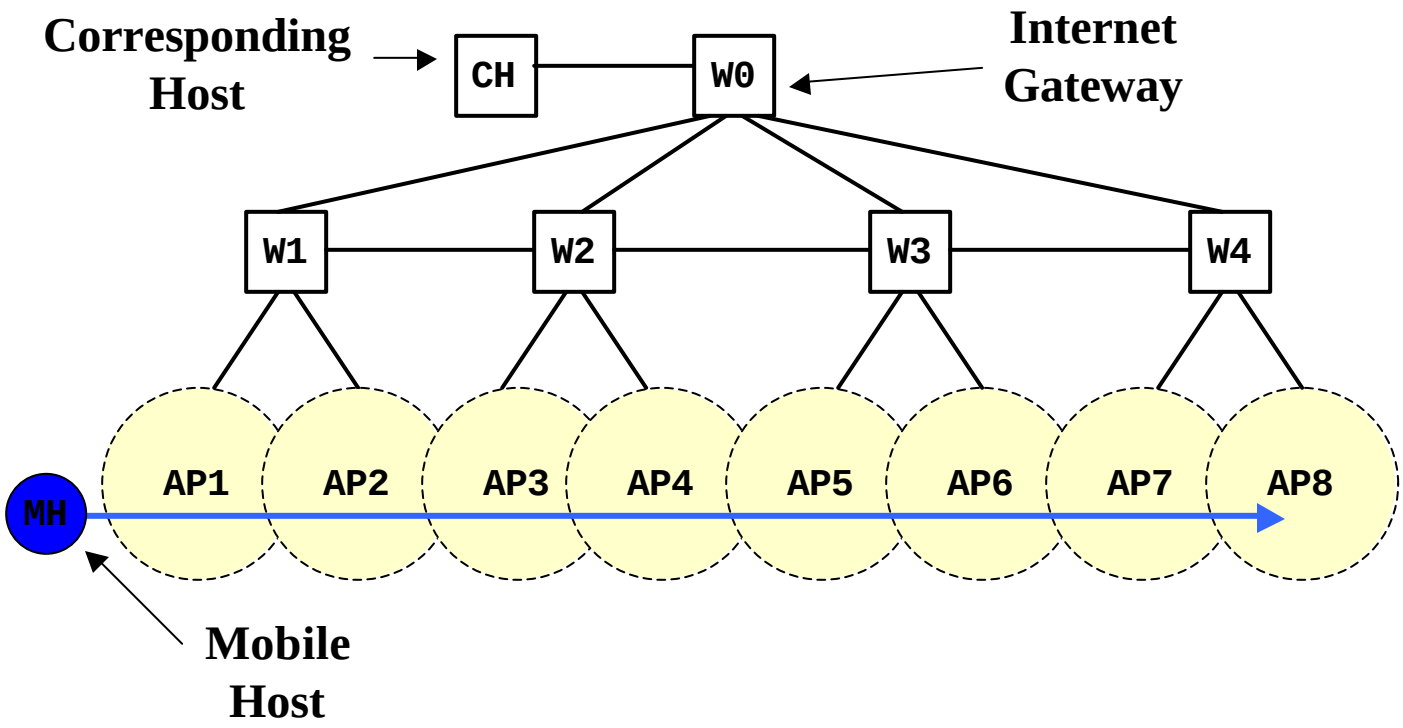




- Measured throughput vs. handoff type
- Hard handoffs
  - Low signaling overhead, but tend to lose packets
  - Cellular IP hard handoff
  - Hawaii UNF
- Semi-soft handoffs
  - Prepare new access point before performing handoff
  - Cellular IP: bi-casting
  - Hawaii MSF: buffer & forward

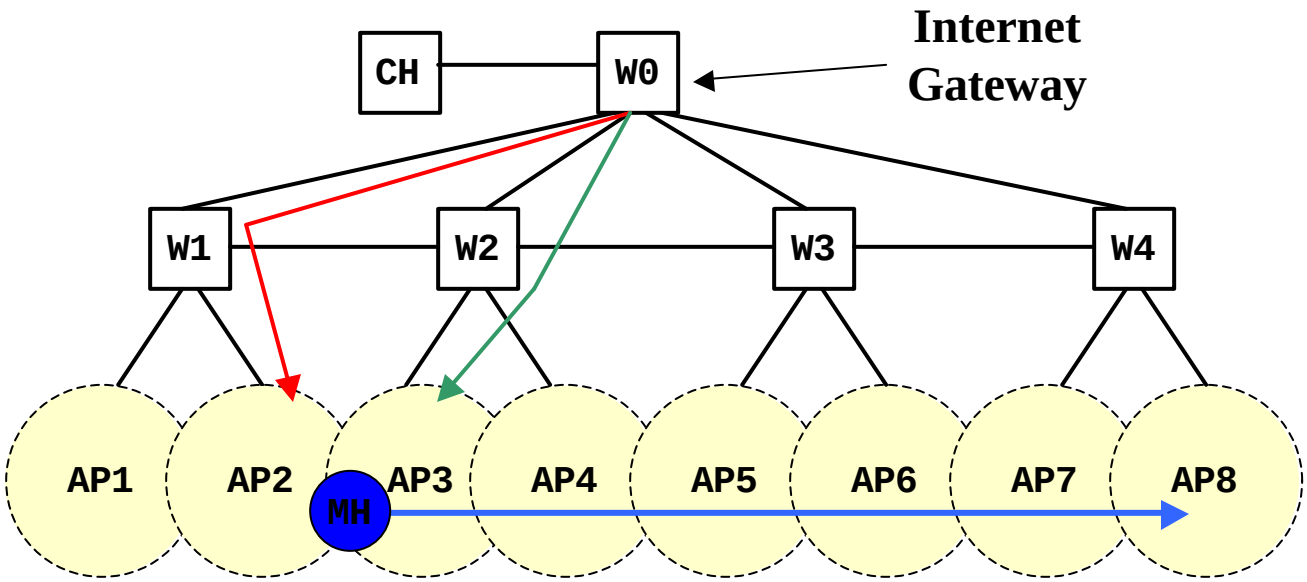
Simulation (cont.)

- Simulation scenario #2 (connected tree):



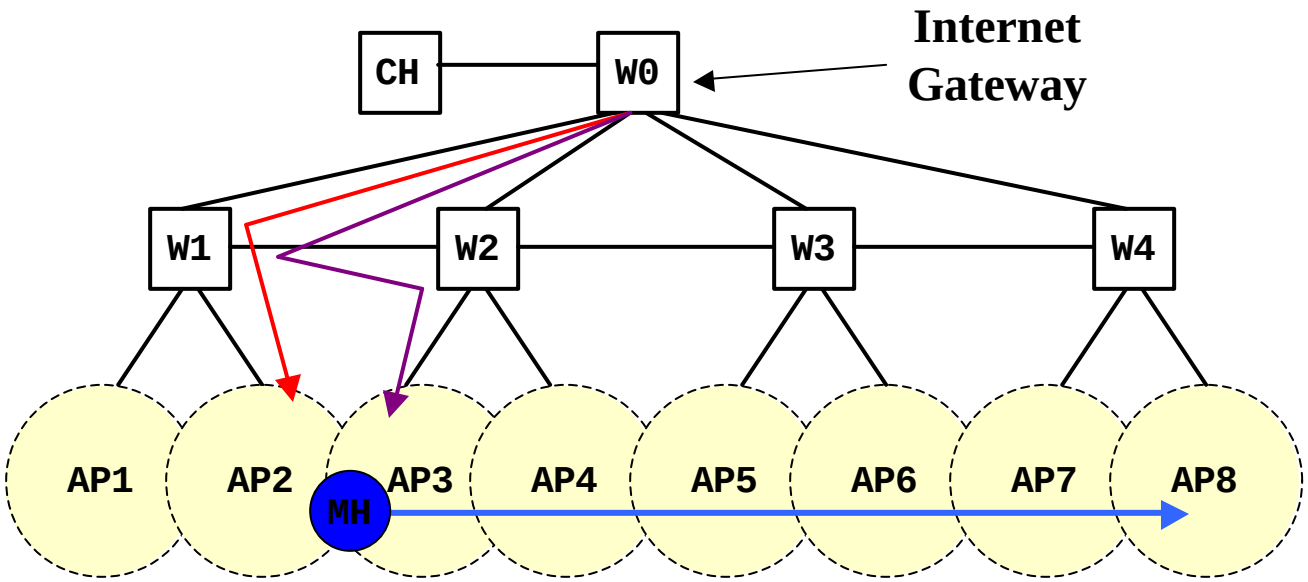
- Tests protocol routing against non-tree topologies

Simulation (cont.)



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

Simulation (cont.)



- 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

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?