Study of Best-Effort VoIP Handovers between WLAN and EVDO Networks

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Wireless Emergence

- Variety of Networks
  - WiFi, CDMA, HSPA, WiMax
  - Coverage vs. bandwidth trade-offs
- User Devices
  - PDAs, Smartphones, iPhone
  - User devices can choose networks
- Applications
  - Web, VoIP, Video, ..
  - Need for everywhere-anywhere availability

Wireless means Mobility

- Application mobility (handovers)
  - Video and VoIP
  - Independence from wireless network type

- Why is it hard?
  - A gamut of choices!
  - Asymmetry in coverage between WLAN and WWAN
  - When do you choose between either networks?
  - Can all these networks support VoIP?
  - What can we do to better support VoIP mobility?

Outline

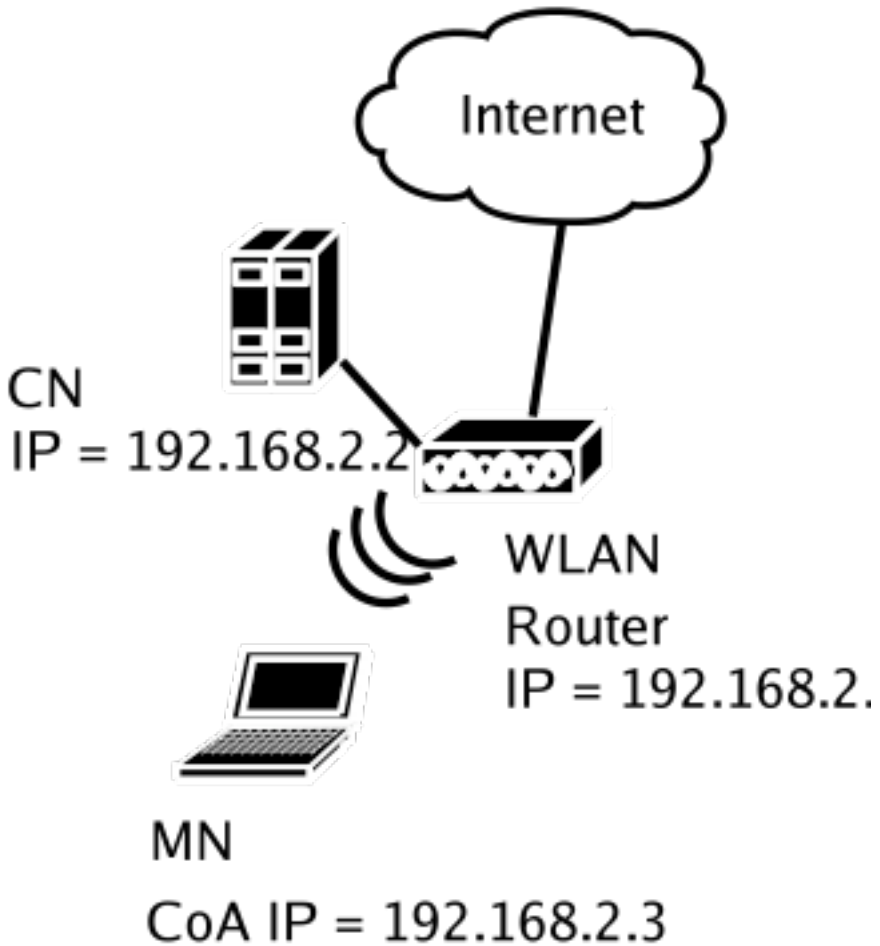
- Experimental setup
  - Skype VoIP call handovers between WiFi and CDMA EVDO
- Feasibility of VoIP over EVDO
  - Characteristics of EVDO links
- Feasibility of mobility
  - Including link acquisition and performance of Mobile IP
- Conclusions

Experiments

- Objectives
  - Feasibility of VoIP call handovers
  - Evaluate performance of VoIP over EVDO network (Rev 0)
- Setup
  - Mobile Node (MN): Wireless laptop with WiFi and EVDO interfaces
  - Correspondent Node (CN): A fixed node on the DSL network
  - Home Agent (HA): Mobile IP router providing support for a persistent address
  - WiFi access point connected to a DSL connection
  - Skype VoIP application, handovers between WiFi and EVDO

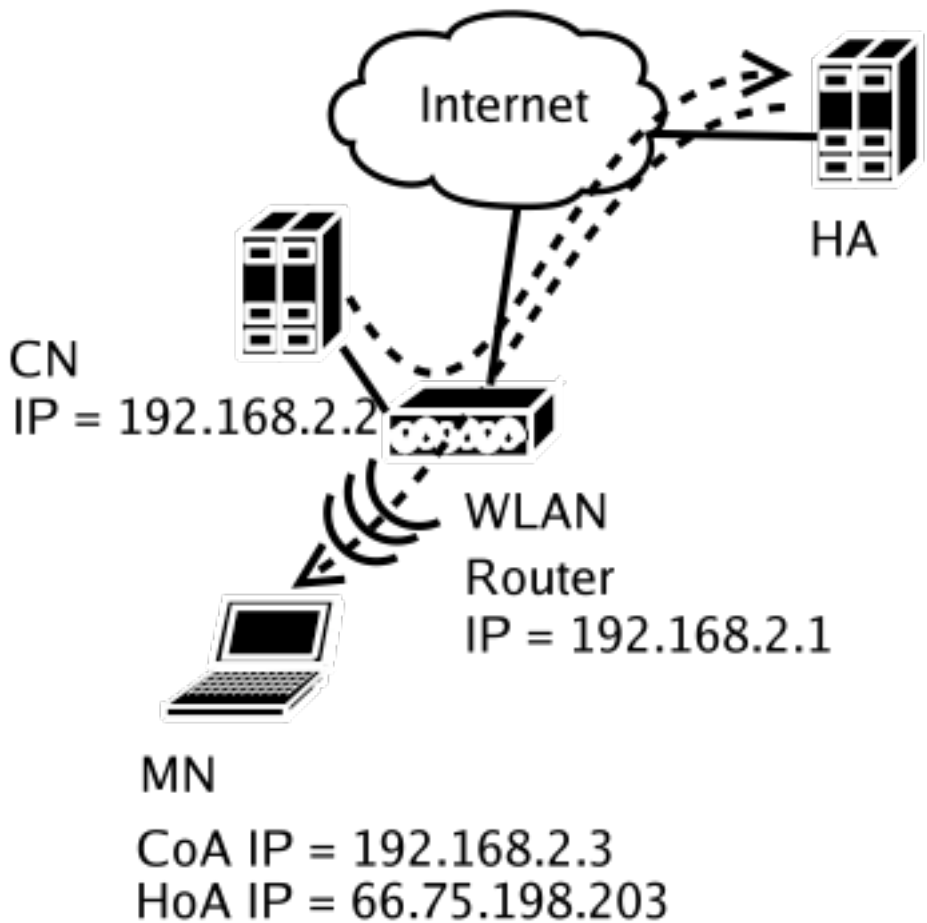
Experiment flow

- Step 1
  - Client associates with WiFi access point
  - Client obtains an IP address (CoA) from the access point



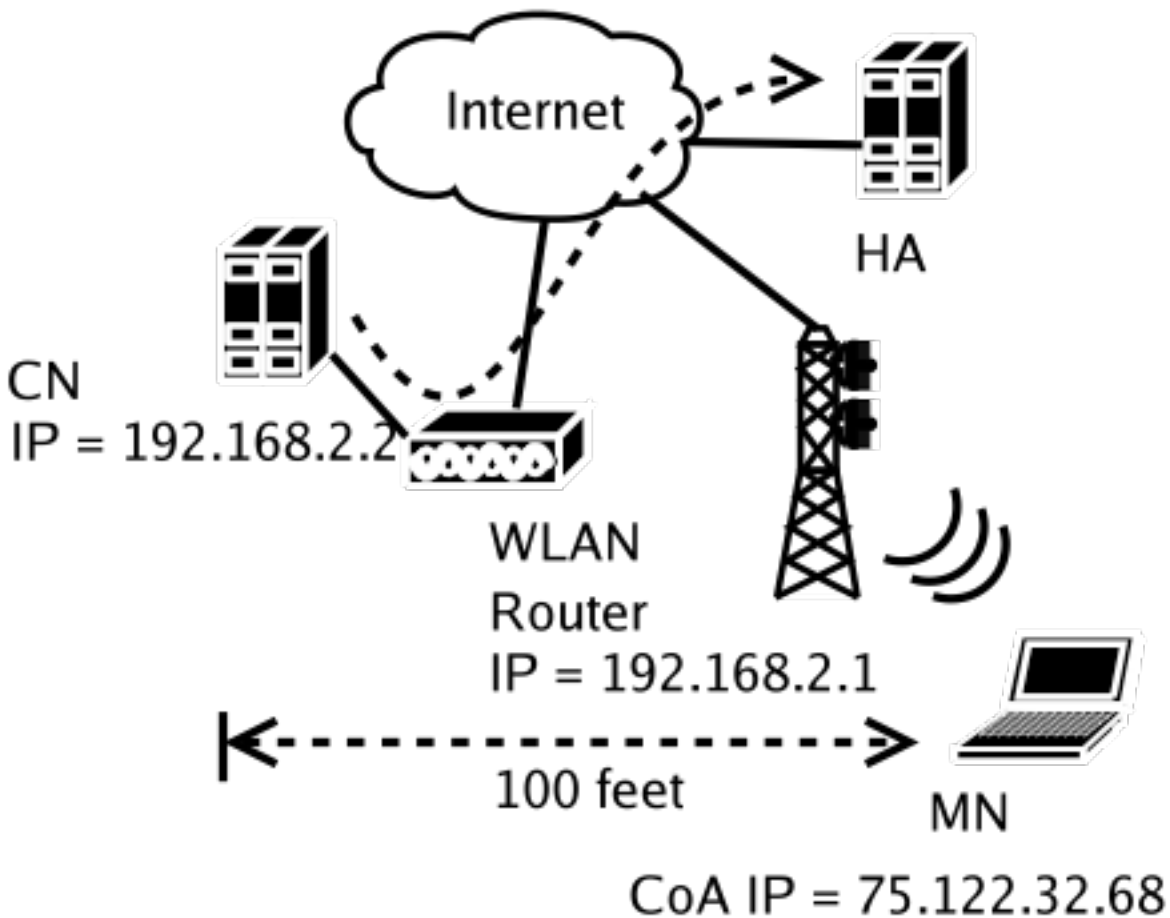
Experiment flow

- Step 2
  - Client receives an HoA from the Birdstep HA
  - Client initiates a Skype VoIP call to the CN using HoA



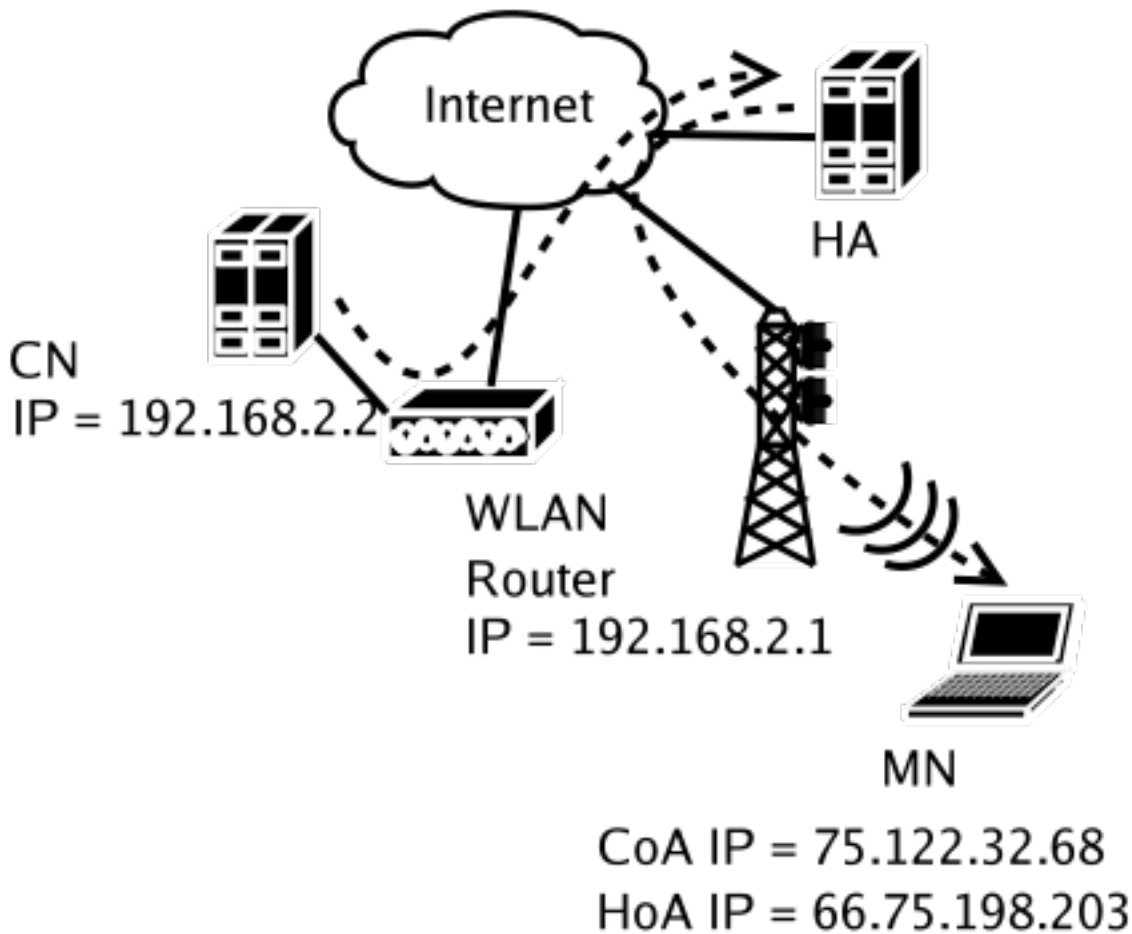
Experiment flow

- Step 3
  - Client walks ~100 feet away from WiFi access point
  - Initiates an EVDO association



Experiment flow

- Step 4
  - Client updates its CoA with the HA
  - Skype VoIP call is redirected to the client via the HA

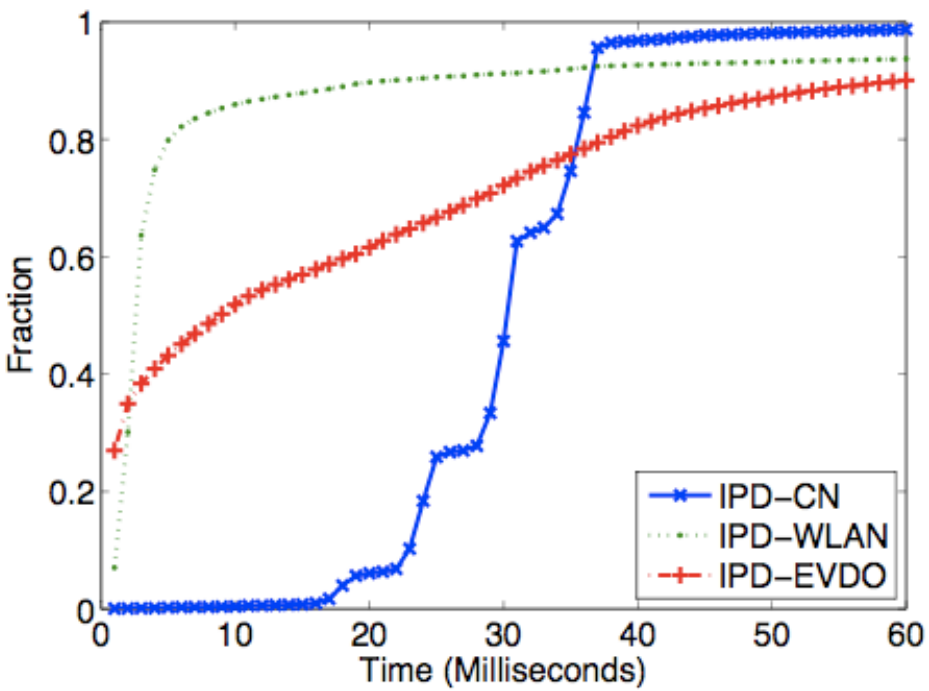


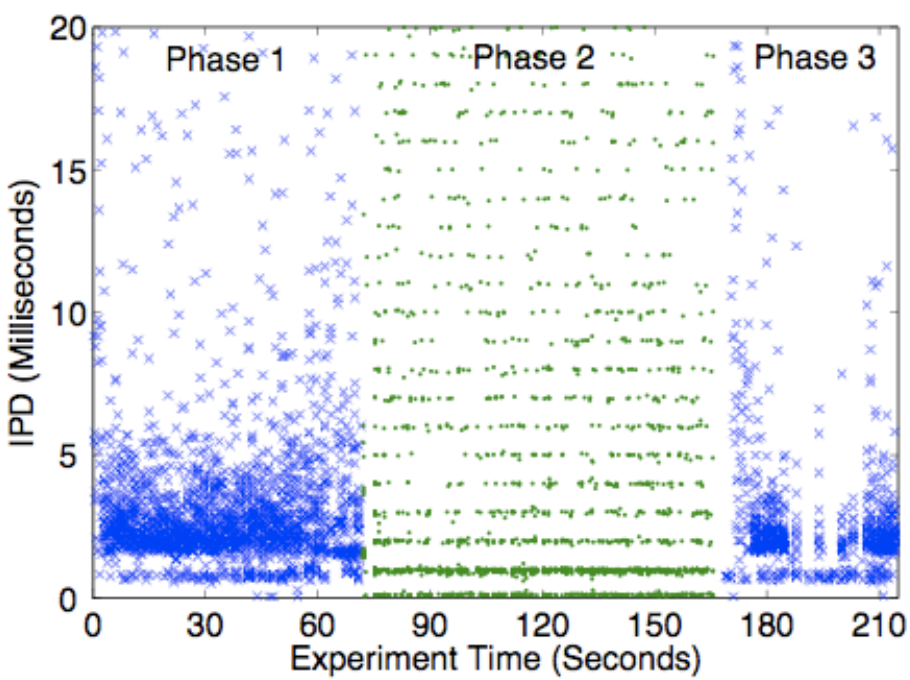
Evaluation

- Questions
  - What is the VoIP call quality on current EVDO networks?
  - Are VoIP call handovers between WiFi and EVDO feasible?
  - What impact do mobility protocols have on handovers?
- Metrics
  - Inter-packet delays
  - EVDO association delays
  - Mobile IP operation delays

Inter-packet Delays (IPD)

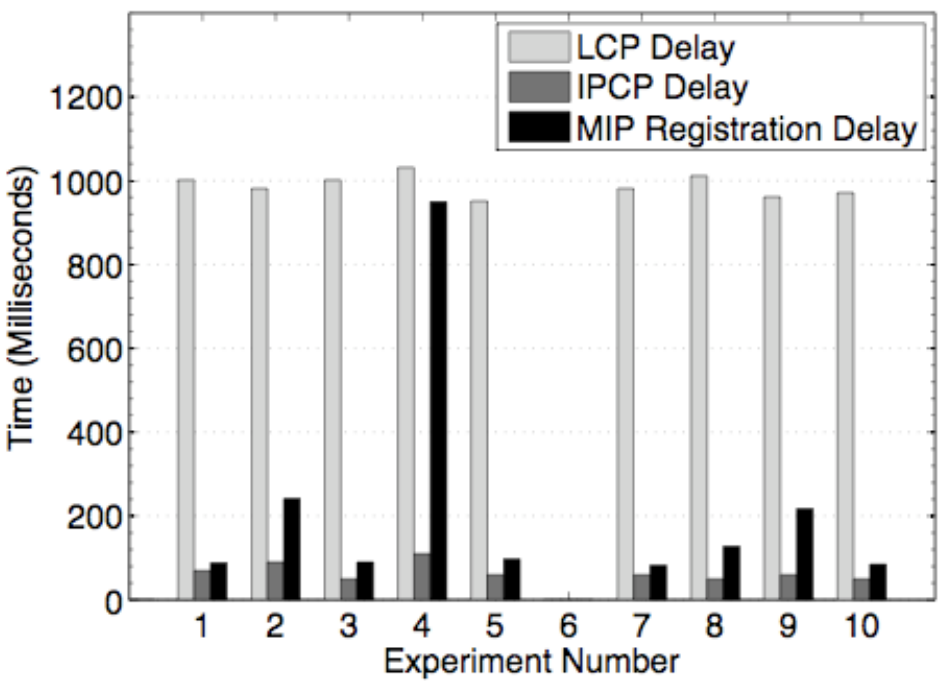
- Skype uses UDP for communication
- IPD reveals the feasibility of a network to support VoIP
- Reception of packets on EVDO link appears to follow “pause and burst”
  - IPDs on EVDO can be significantly long
  - VoIP calls are dropped because of such delays





EVDO and Mobile IP Delays

- Delay in associating with an EVDO network
  - ~1.2 seconds
- Delays in receiving MobileIP HoA from HA
  - Ranging from ~100ms to several hundred milliseconds
- These delays can often cause call failures



Recommendations

- Applications such as Skype require better delay adaptation
  - Applications designed for wireline Internet often perform poorly on wireless Internet
  - Additional knowledge of link characteristics can be used
  - Session progress like RTCP for long silences + packet bursts

- Handover Planning
  - In a wireless environment with multiple, heterogeneous networks, intelligent mobility management algorithms are necessary

Conclusions

- VoIP call handovers between *disparate* wireless networks is an important benchmark
- Bandwidth and coverage trade-offs exist
- Quality and persistence of VoIP calls on EVDO networks can suffer because of its bursty packet forwarding
- VoIP call handovers require better delay adaptation based on the characteristics of wireless links
- Predicting the movement of clients can help reliable handovers

Thanks!

- Questions/comments?

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