Project	**IEEE 802.20 Working Group on Mobile Broadband Wireless Access <http://grouper.ieee.org/groups/802/20/>**
Title	**Requirements to Support Network Layer Mobility**
Date Submitted	**2003-05-05**
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Re:	MBWA Call for Contributions
Abstract	This document reviewed IP-based network layer mobility protocols discussed in IETF. In particular, Fast-handoff for Mobile IP (FMIP), a protocol to support IP-based cellular communications, is described in details. These protocols require lower layers' support, such as layer two triggers, to work perfectly. This document indicated requirements for lower layers in order to support network layer mobility management.
Purpose	This document is provided as network requirements for 802.20 standards.
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Requirements to Support Network Layer Mobility

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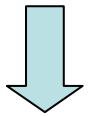
Overview

- Handover events necessitate both network-layer and lower layers actions
- Network-layer needs information from link-layer to better respond to handovers
  - Need to establish IP connectivity as fast as possible
- IP needs standards-based interface with the lower layers, e.g., IEEE 802 links

Mobile IP Handovers

- Slow, because:
  - IP stack has to detect the movement by listening to router advertisements
  - Configure a new IP address (DHCP or IPv6 address auto-configuration)
  - Send binding update to home agent
- Doing these after the handover creates considerable delays for IP-layer connectivity



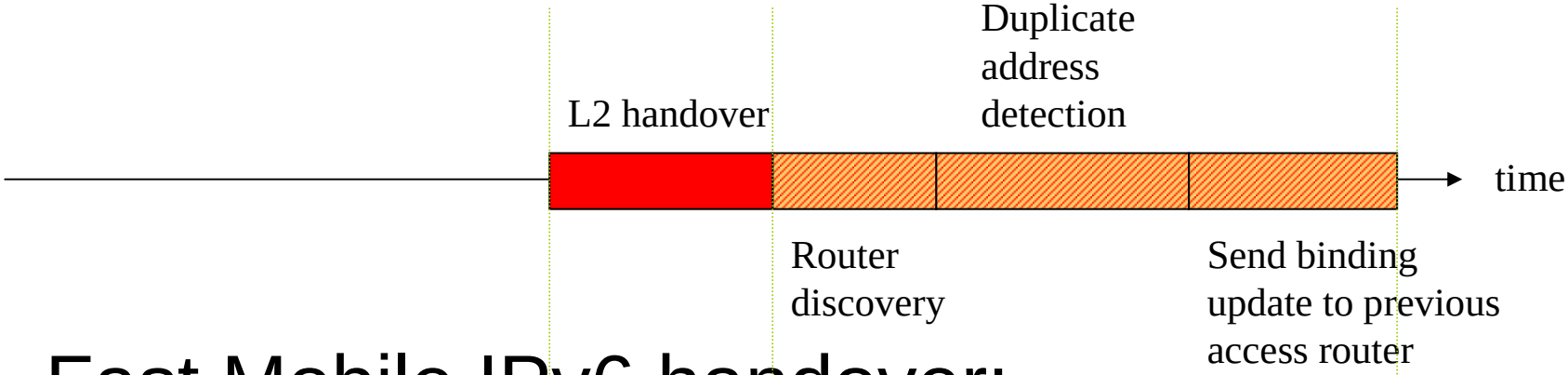
Too many packet loss during handover for realtime applications

Fast Handovers for Mobile IPv6

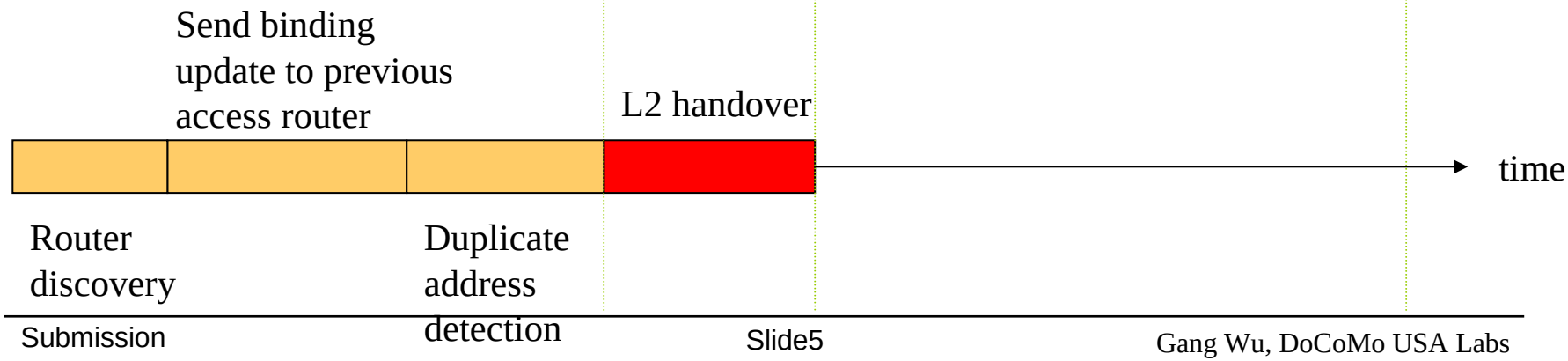
- Basic idea:
  - –Anticipate movement with the help of link layer (triggers)
  - –Prepare network and host in advance
    - Anticipated handover: pre-configured CoA
      - – Initiated by Mobile Node, Source/Target Network
    - Bi-directional Tunnel-based Handover (BETH): defer to acquire CoA
      - – Initiated by Source network or target network
  - –After L2 movement, L3 is ready to serve
    - Done!
- IETF Mobile IP WG work item:
  - –draft-ietf-mobileip-fast-mipv6-06

Slow vs. Fast!

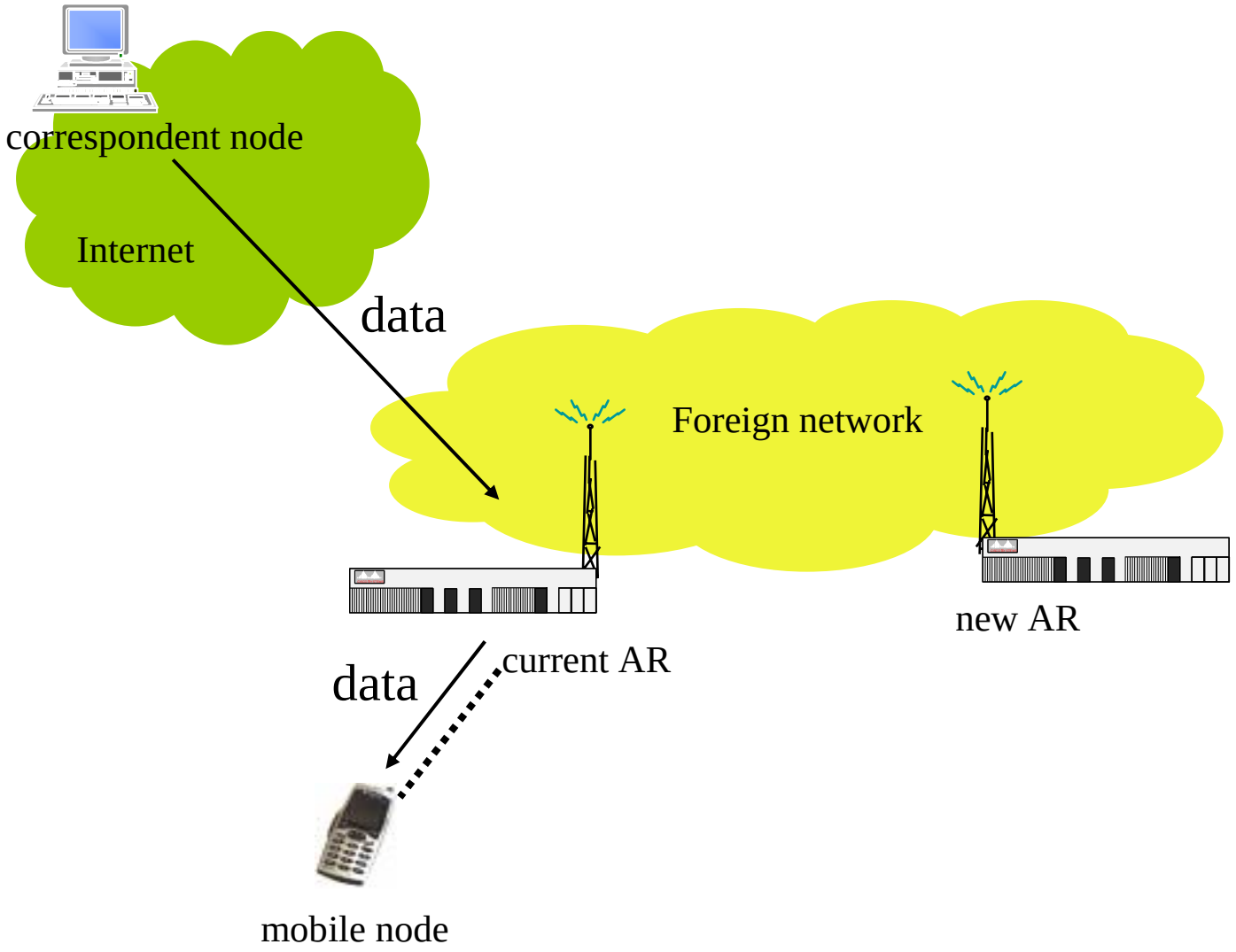
- Standard Mobile IPv6 handover:



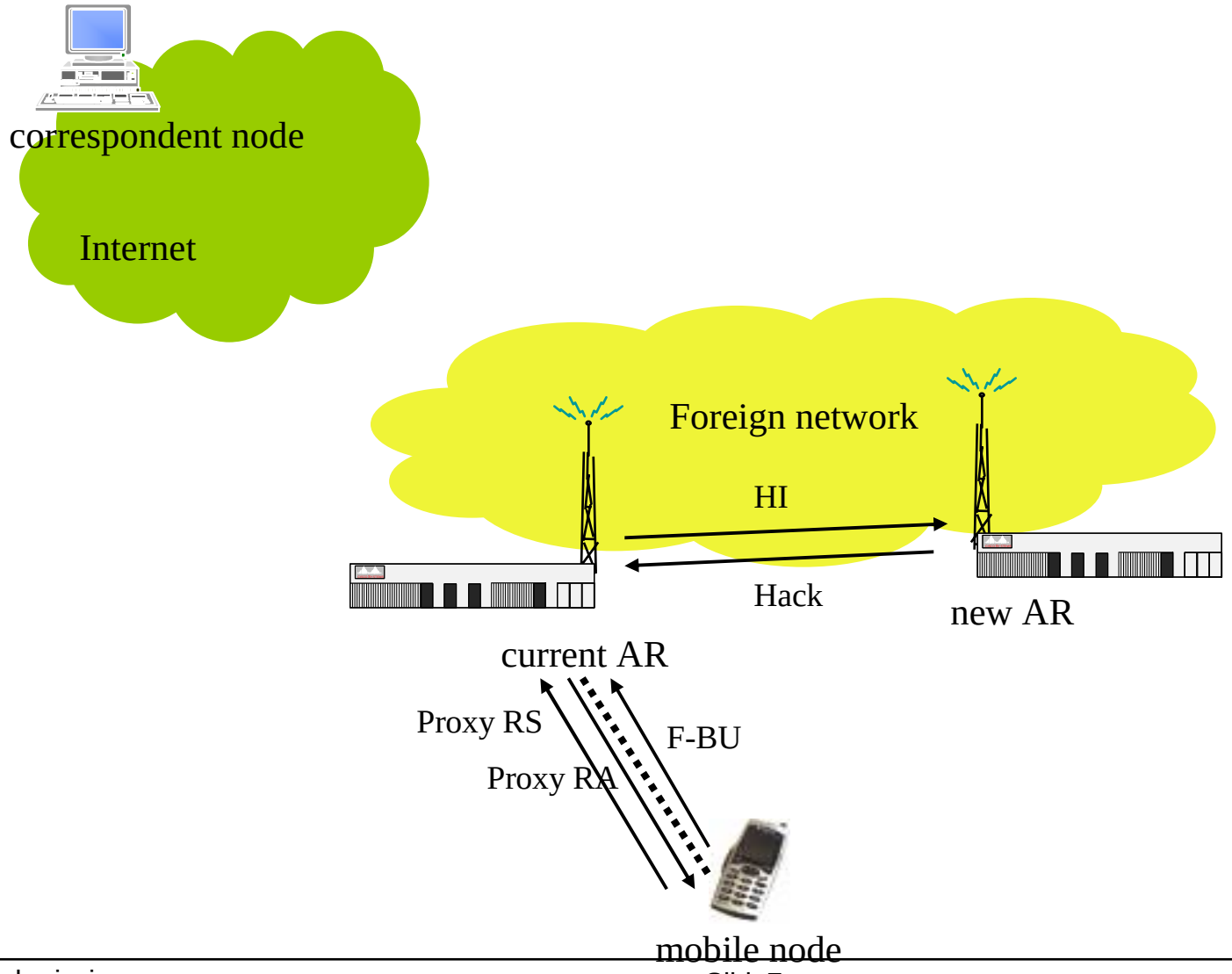
- Fast Mobile IPv6 handover:



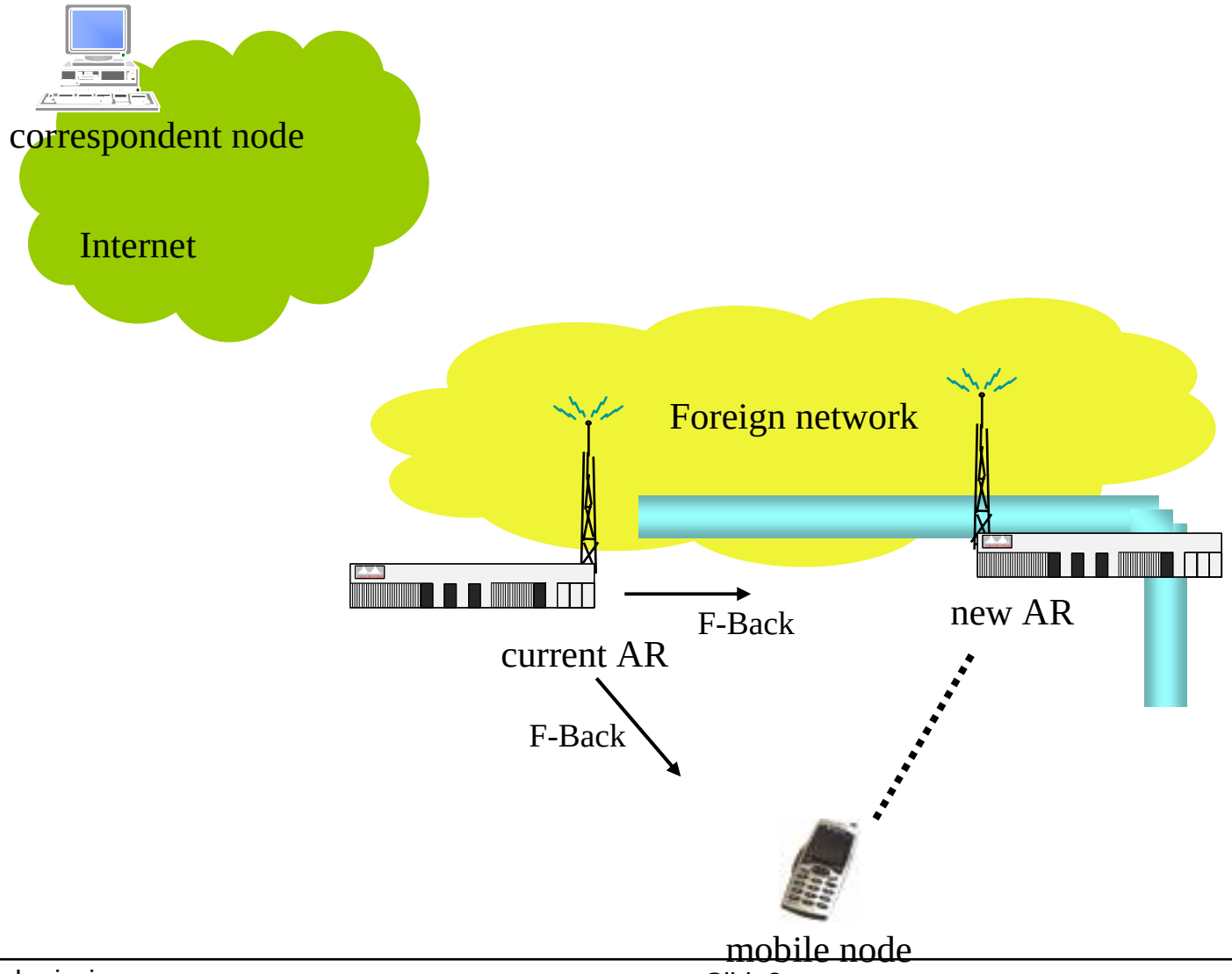
IP Signaling



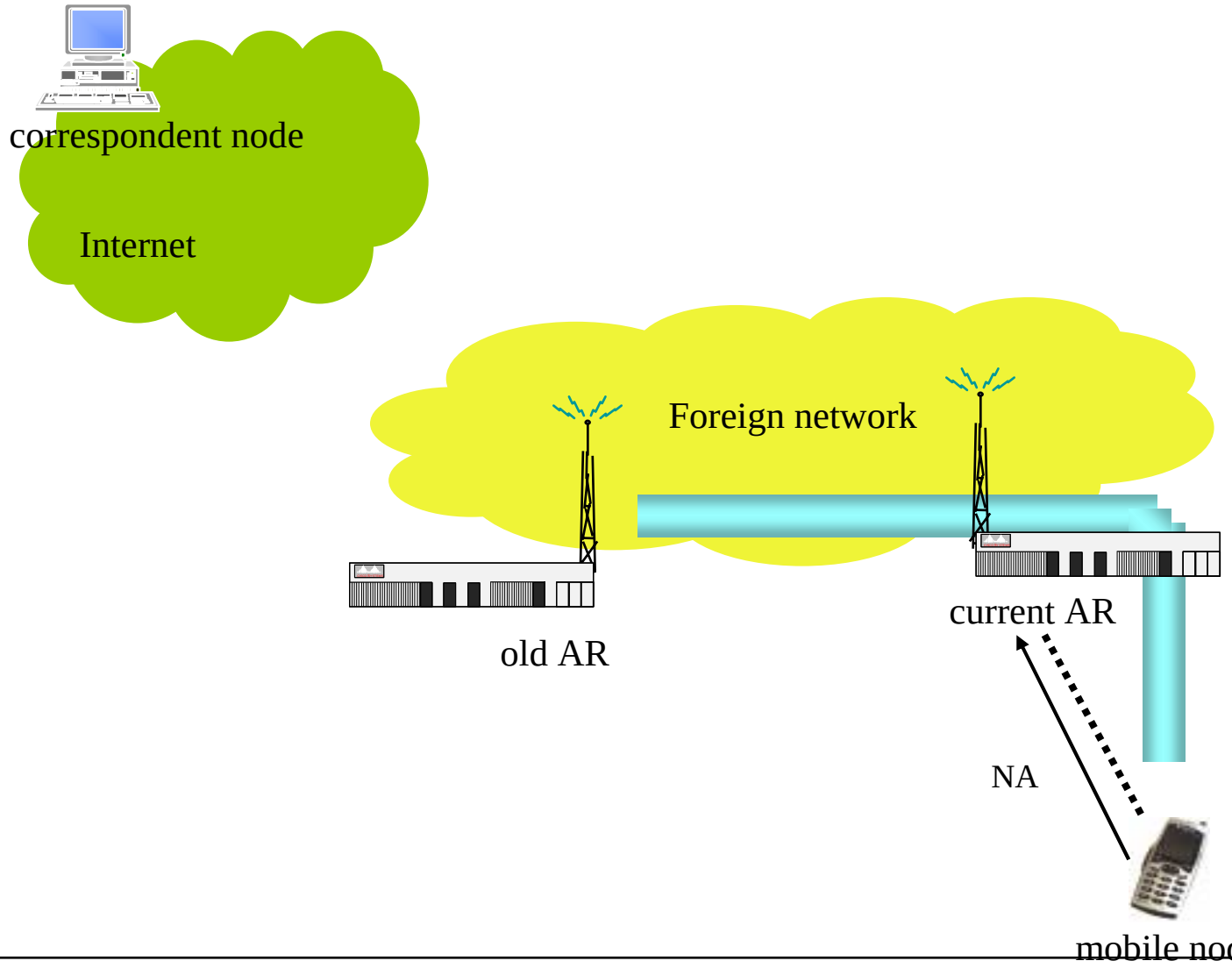
IP Signaling



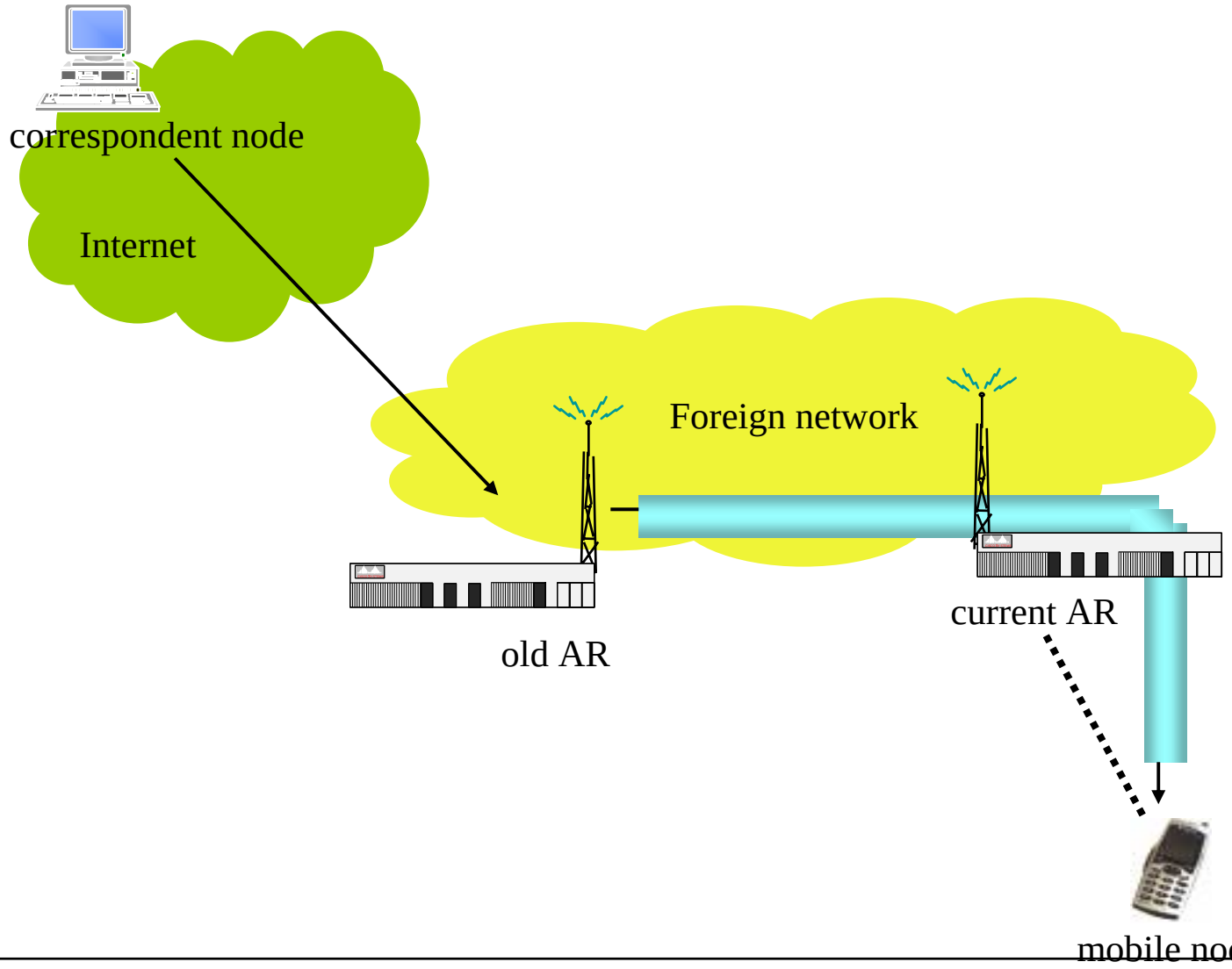
IP Signaling



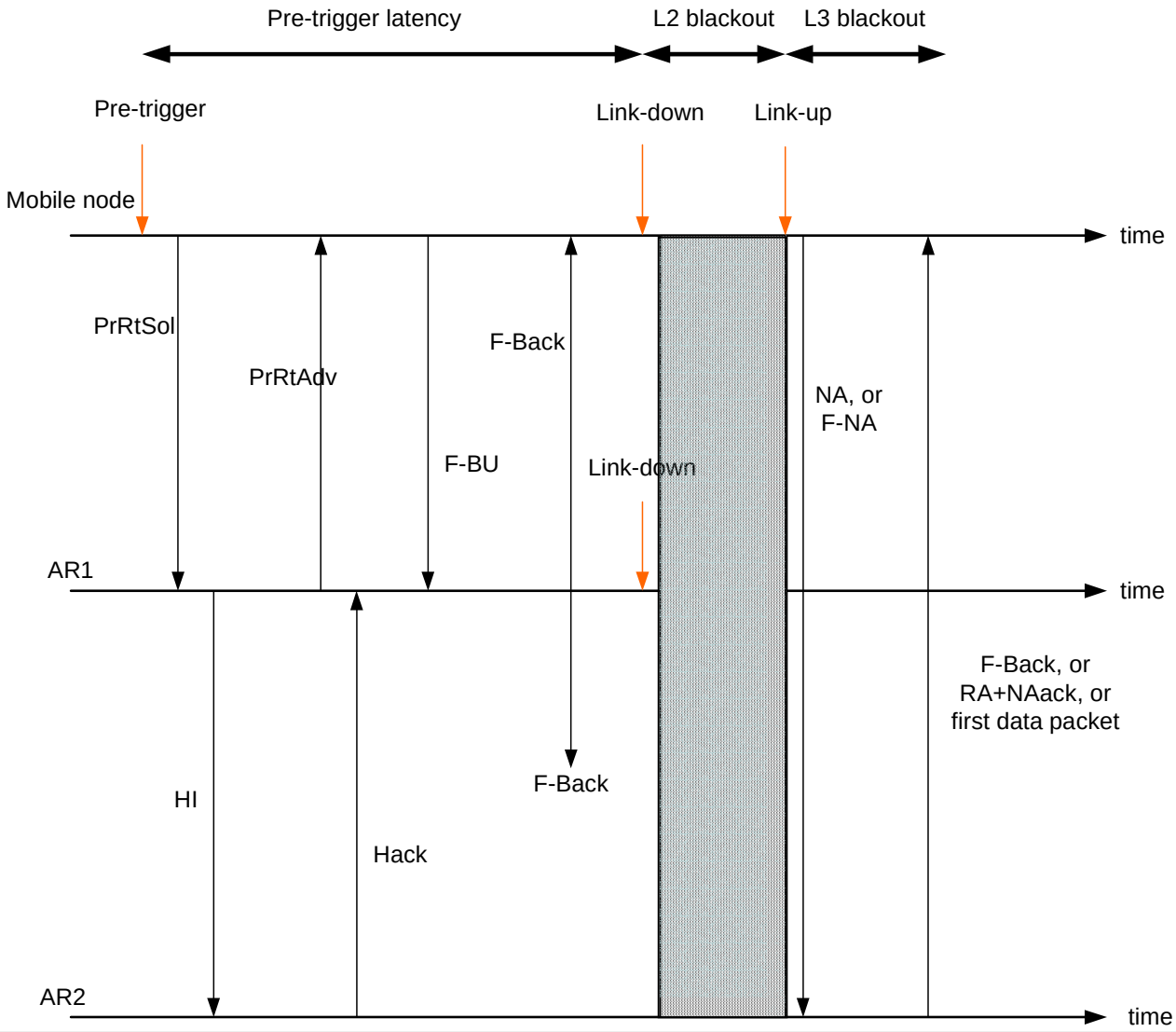
IP Signaling



IP Signaling



Protocol Events

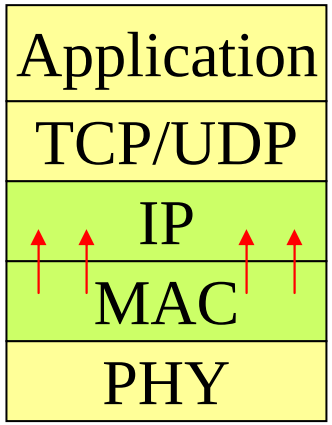


FMIP Needs...

- FMIP needs link-layer to provide some indications that handover is imminent or (at least) it has just happened

Link-layer Triggers

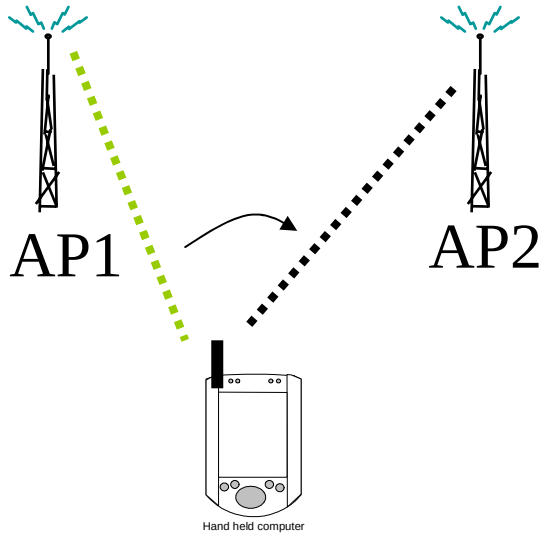
- An abstraction of a notification from link-layer (potentially including parameter information) that a certain event has happened or is about to happen



  - IETF draft:
    - draft-manyfolks-l2-mobilereq-01

Link-layer Triggers

- Link Up
- Link Down
- Source Trigger
- Target Trigger
- Mobile Trigger



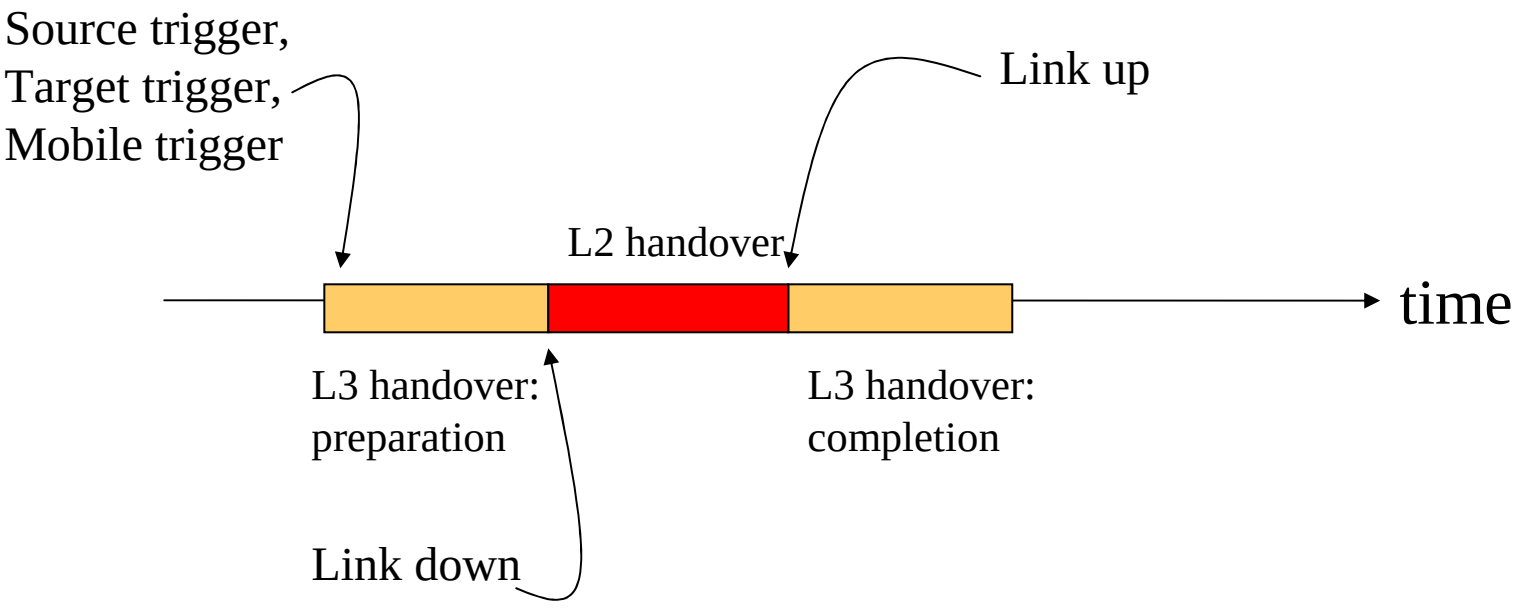
- First, AP1 receives source trigger, AP2 receives target trigger, mobile receives mobile trigger
- Then, AP1 and client receive link down
- Finally, AP2 and client receive link up

- Not all link-layer technologies can produce all of these triggers
- Not all IP-layer mechanisms need all of these triggers

Use of Link-layer Triggers

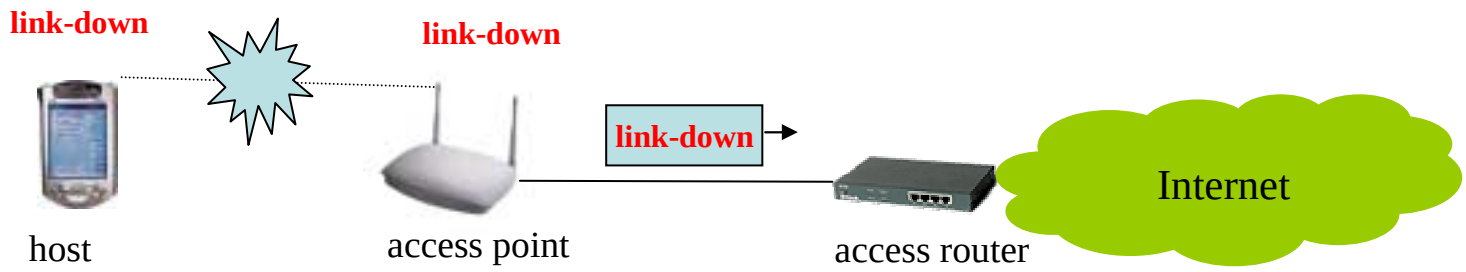
- IP handovers
  - Mobile IP, FMIPv4/v6 rely on the existence of a subset of triggers
    - High performance, efficient mobility management
  - Clean-up state
    - Access router can flush ARP and ND cache entries when the host detaches from the link
  - Faster router discovery
    - Access router can send unsolicited router advertisements as soon as it detects the new host
- Context transfers
  - Access router can take context transfer actions upon detecting handovers

Link-layer Triggers and Handover



Link-layer Triggers Protocol

- When the link-layer access device is not co-located with the access router, a protocol is needed to carry event notifications



- IETF draft:
  - draft-yegin-l2-triggers-00.txt

Link Layer Triggers

Name	Recipient	Information
Link Up	nAR or MN	MN_{MAC} or nAR_{MAC}
Link Down	oAR or MN	MN_{MAC} or oAR_{MAC}
Mobile Trigger	MN	nAR_{MAC}
Source-network Trigger	oAR	nAR_{MAC} and MN_{MAC}
Target-network Trigger	nAR	oAR_{MAC} and MN_{MAC}

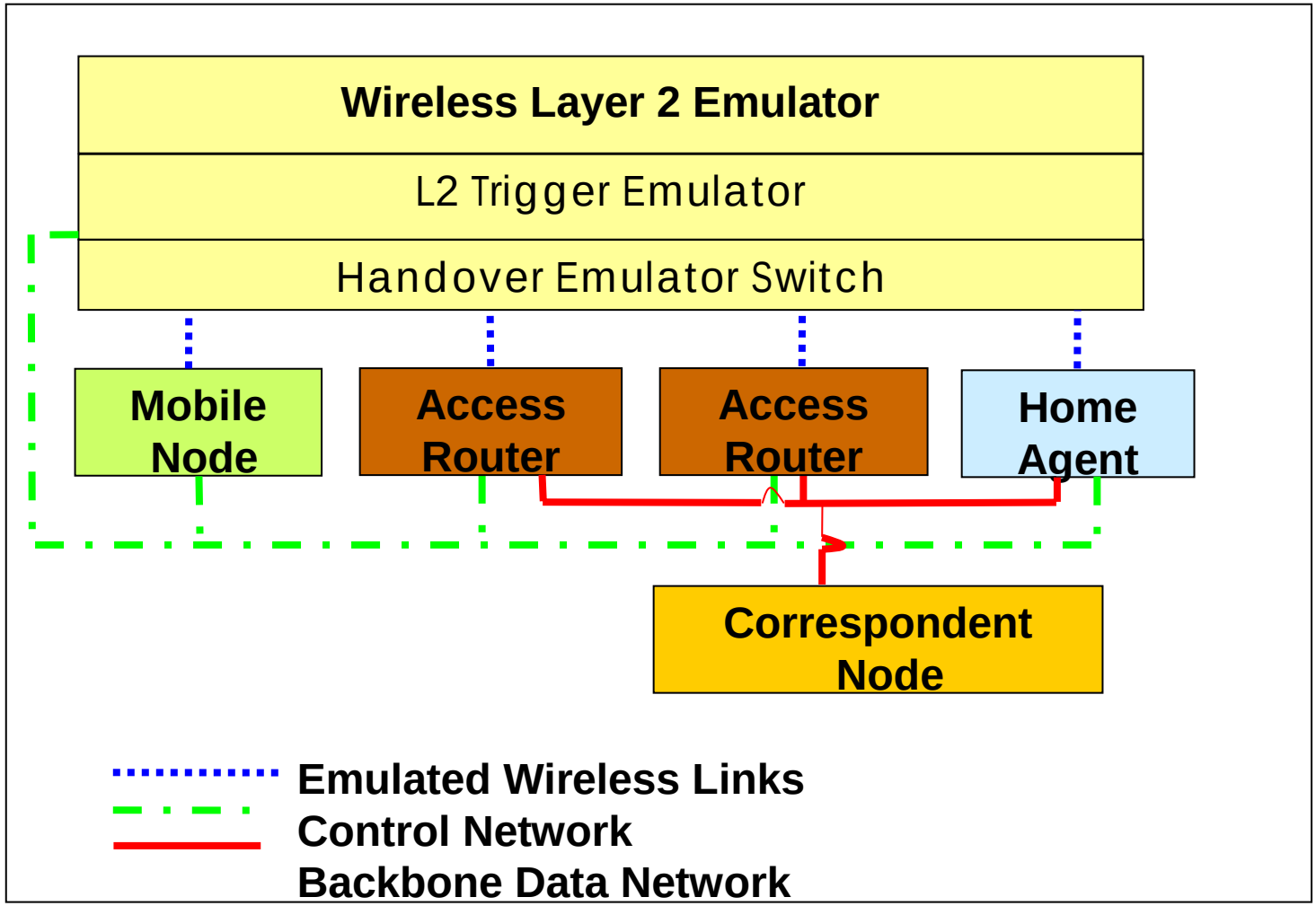
FMIP + Link Layer Trigger

	oSMIP	mFMIP	sFMIP	tFMIP	sBETH	tBETH
LinkUp	Y	Y	Y	Y	Y	Y
Link Down		Y	Y	Y	Y	Y
Mobile Trigger		Y				
Source Trigger			Y		Y	
Target Trigger				Y		Y

An Experimental Platform

- Software
  - RedHat Linux 7.2 (kernel 2.4.16 and 2.4.18)
  - Mobile IPv6: MIPL developed by HUT
  - Fast Mobile IPv6: in-house
  - Real Time Traffic Generator: in-house
  - Wireless Handover Emulator: in-house
- Hardware
  - AR: Pentium III 800MHz PC
  - MN and CN: IBM T23 laptop
  - Wired Network Connection: 100Mbps
  - Wireless Network Connection: Configurable

Handover Emulation Test Bed

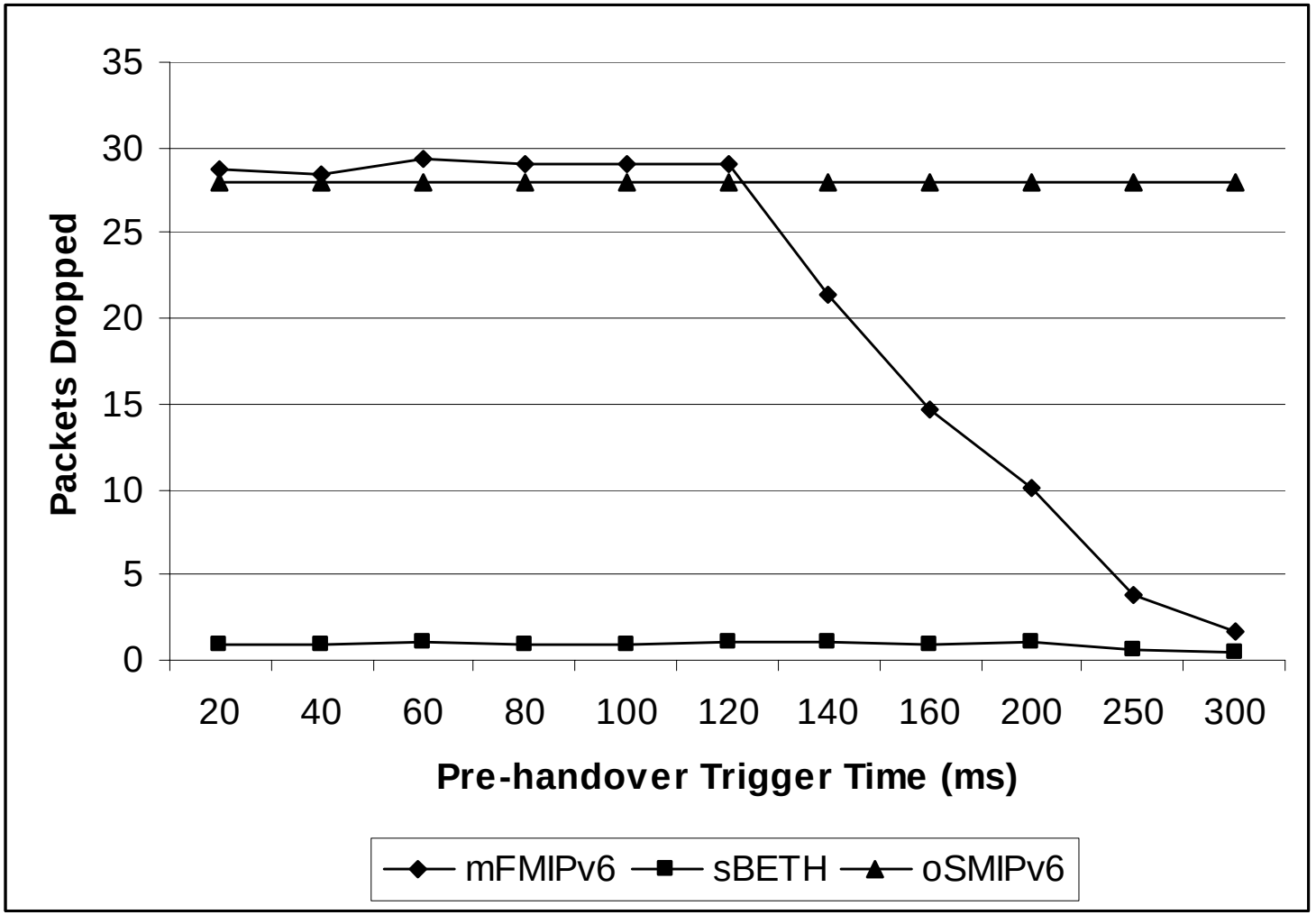


Traffic Model

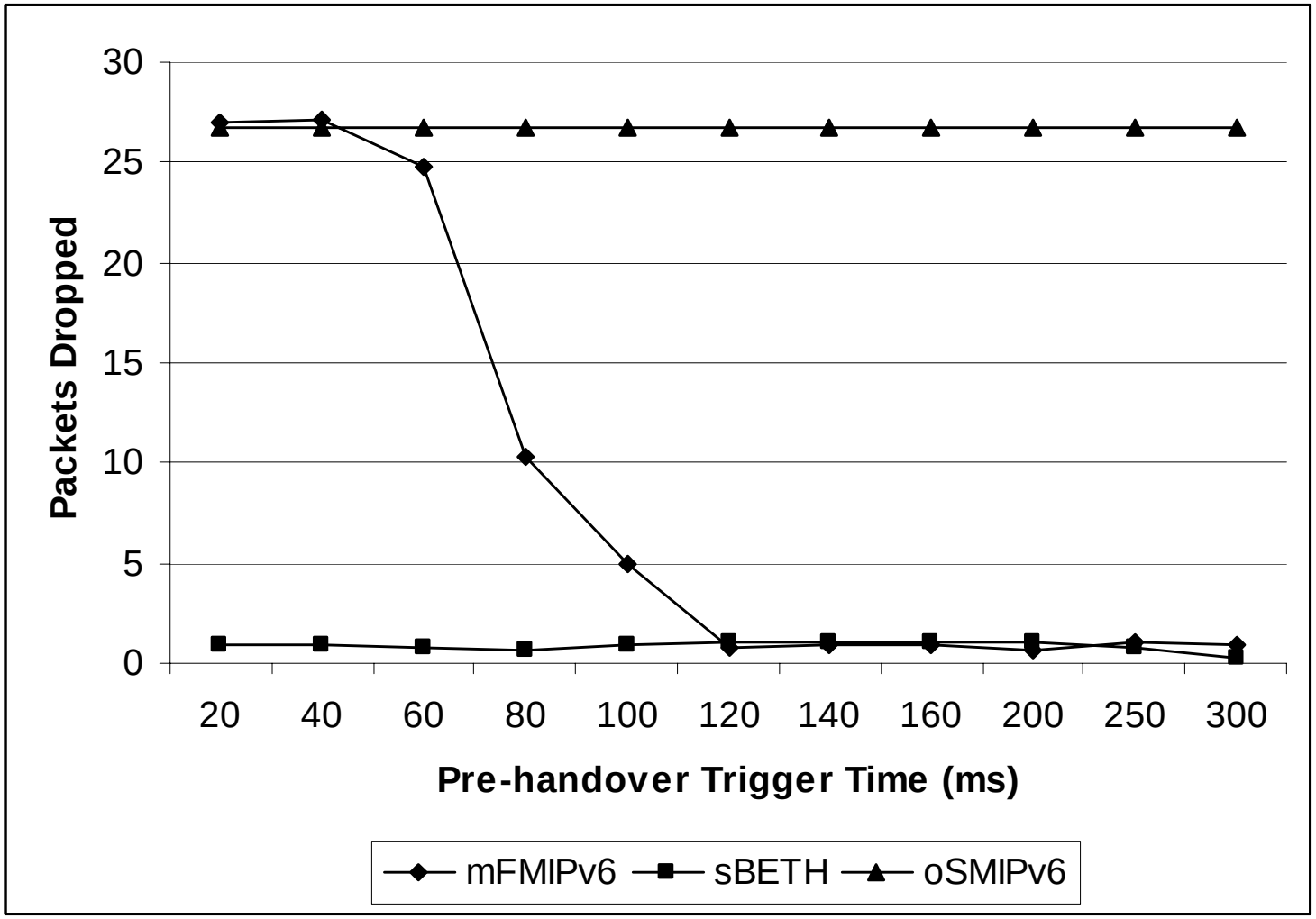
Simulated Radio BW	Actual Radio BW	UDP Payload Size	Packet Frequency
9.6kbps	44kbps	20Bytes	20ms
64kbps	98.4kbps	128Bytes	20ms
384kbps	418.4kbps	768Bytes	20ms

Link Delay: 10ms
Link Layer Blackout Time: 40ms

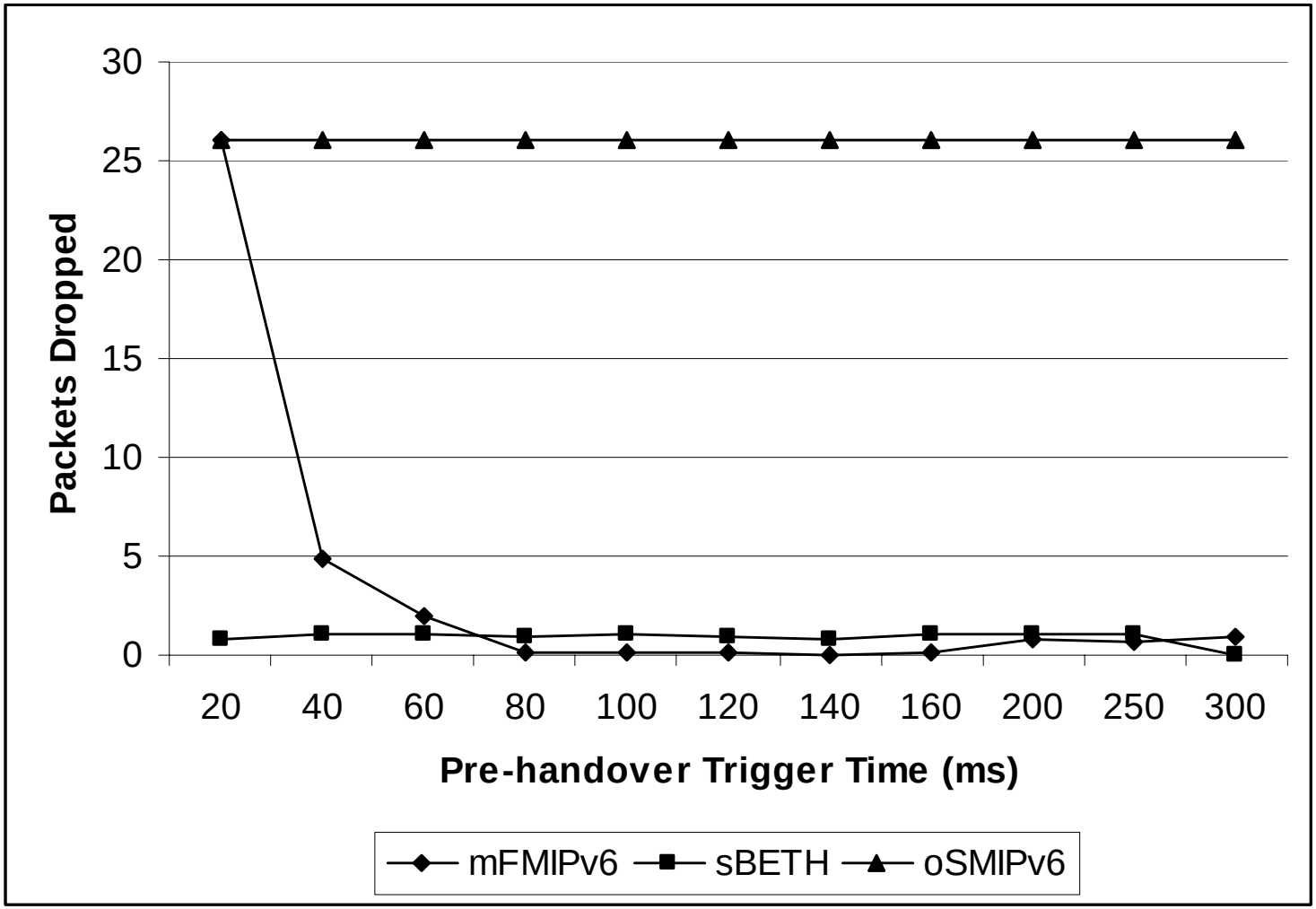
Average Packet Drops for Simulated 9.6 kbps Wireless Link



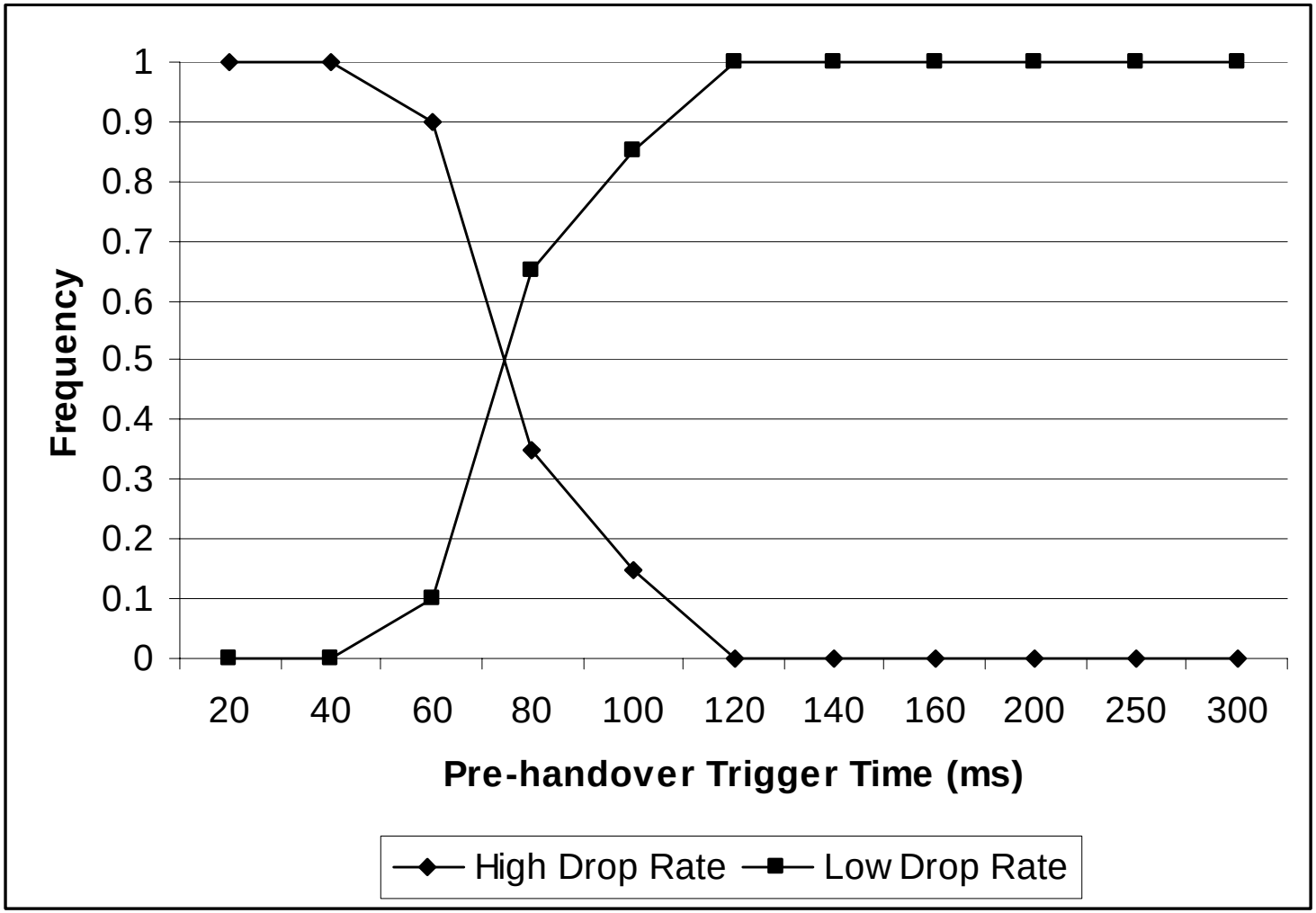
Average Packet Drops for Simulated 64 kbps Wireless Link



Average Packet Drops for Simulated 384 kbps Wireless Link



Frequency of High/Low Drop Rate for 64 kbps Wireless Link



Observations

- sMIPv6 packet loss number is controlled by the frequency of router advertisement
- mFMIPv6 is sensitive to pre-trigger timing.
- As link bandwidth increases, pre-trigger time required for mFMIPv6 decrease.
- sBETHv6 reduces packet loss reliably, in regardless of pre-triggering time.
- In worst case, mFMIPv6 performance is on par with oSMIP; in best one, mFMIPv6 performance is on par with sBETHv6.

Recommendation to IEEE

- Formal definition of IEEE 802 link-layer events for IP-layer's consumption
- Definition of an API for IP to obtain relevant triggers
- Support standardization of Link-layer Triggers Protocol at IETF (or, alternatively, make it an IEEE-only standard)
- .... so that IP operates better on IEEE 802 links