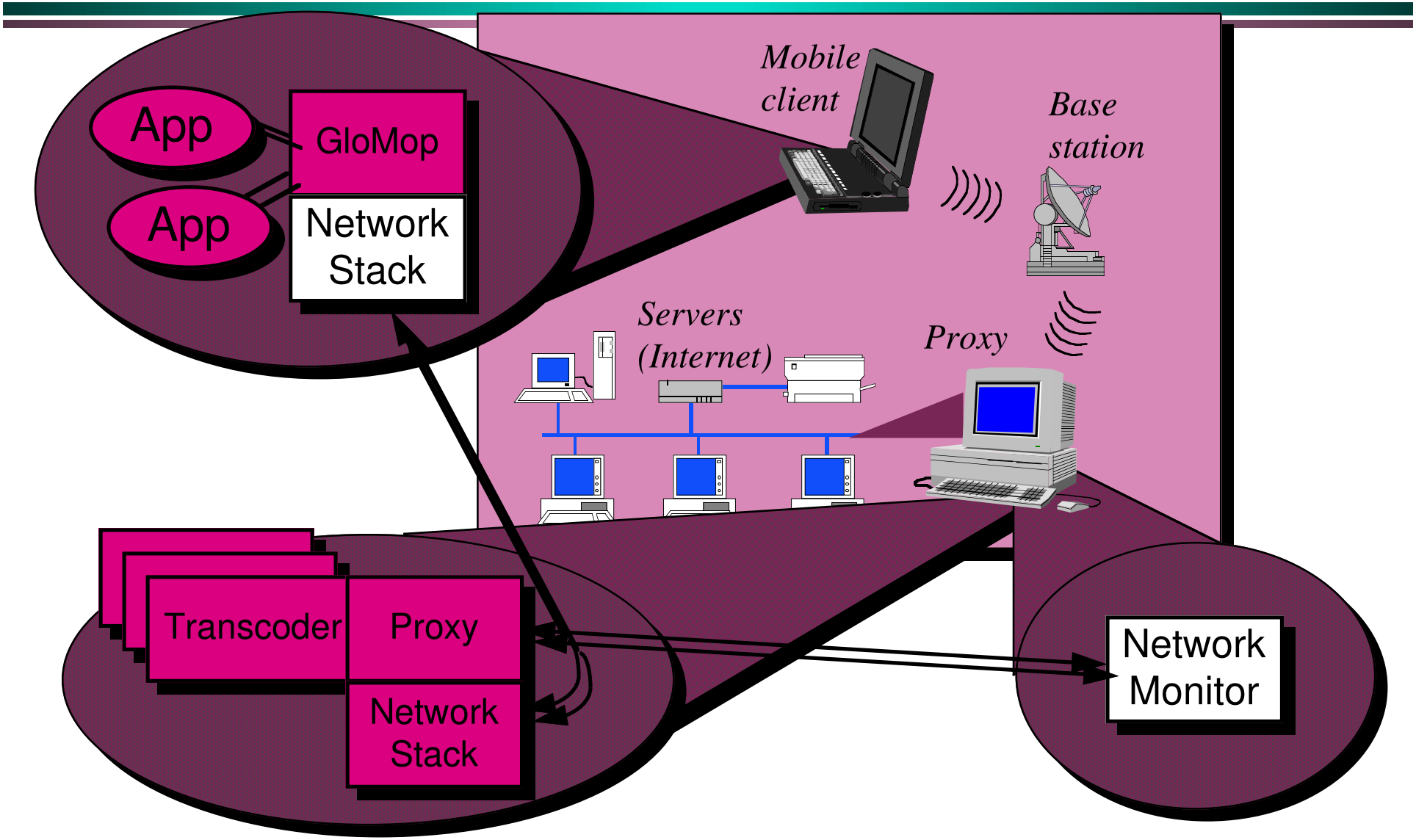
Network Monitoring and Handoff in Daedalus

Mark Stemm
Daedalus Group
University of California at Berkeley

You Are Here

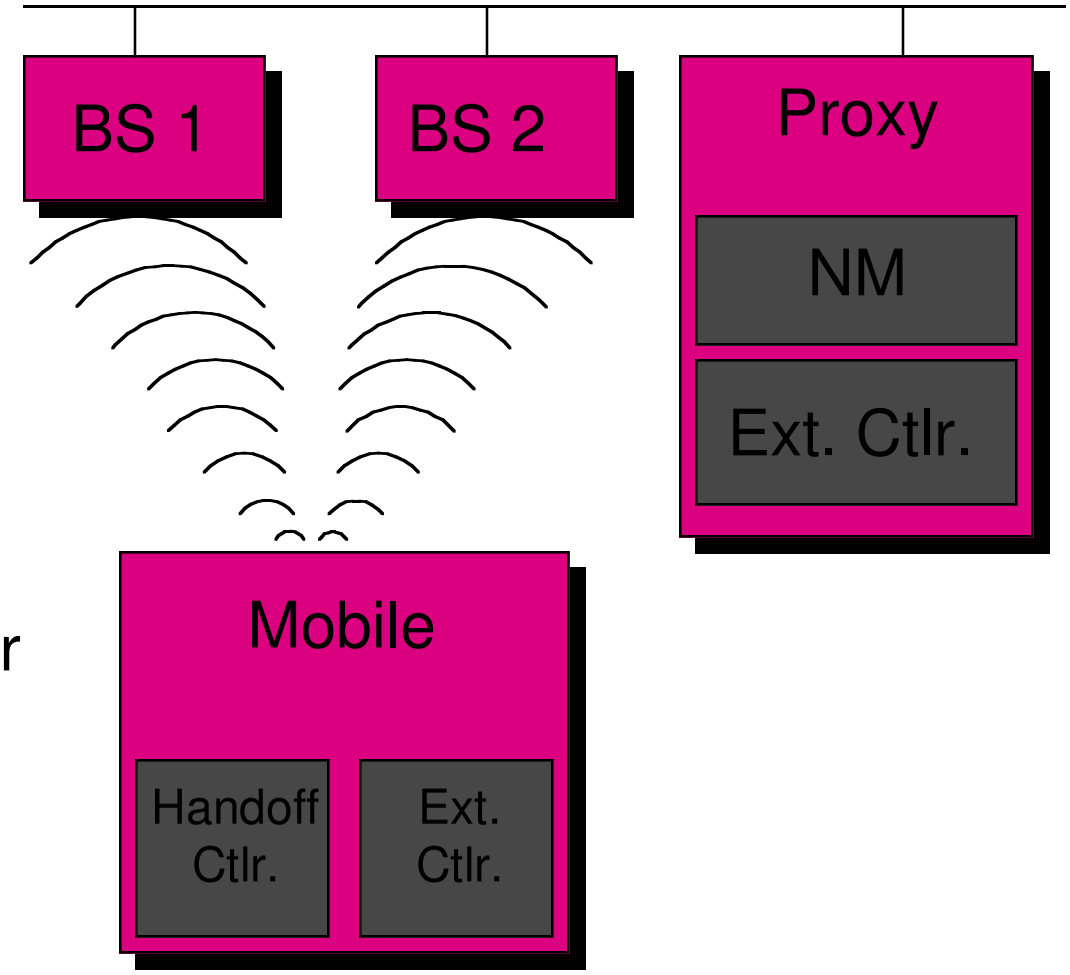

App
App
GloMop
Network Stack
Mobile client
Base station
Servers (Internet)
Proxy
Transcoder
Proxy
Network Stack
Network Monitor

Motivation

- All about management of network state:
  - Proxy needs to know network state to perform the right amount of distillation.
  - User needs a way to have ultimate control over and find out about network state.
- Need to choose the active network/base station due to:
  - Mobility.
  - Network QOS parameters, (dollar and power) cost constraints.

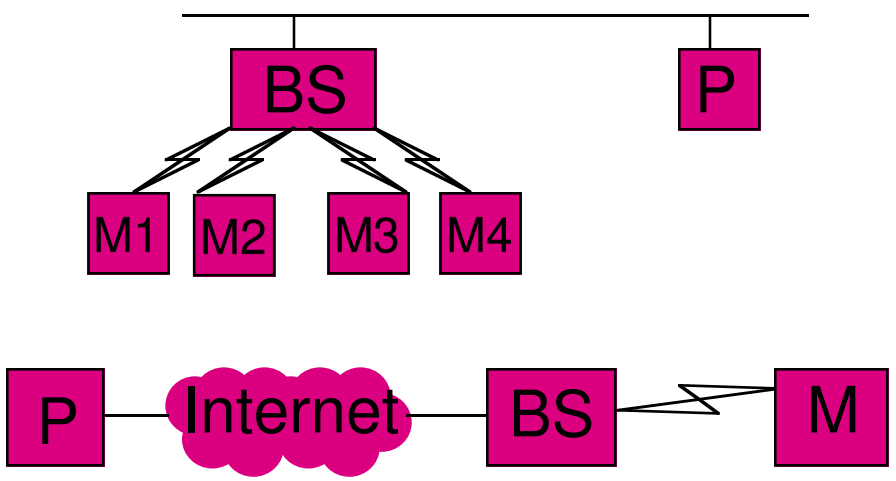
The Components

- Handoff Controller: decides when to hand off.
- External Controller: mechanism for user control.
- Network Monitor: collects data and acts as repository for network statistics.



Where do they live?

- Handoff Controller at mobile.
- External controller at proxy or mobile.
- Network Monitor at proxy(not at mobile, not at basestation). Why?
  - Not at mobile because all information has to get back to proxy anyway(waste of bandwidth).
  - Not at BS because not end-to-end(Proxy may be far away).



Details

- Network Monitor
  - Makes measurements for each interface.
  - Acts as data repository, serves data to others.
  - Can register callbacks for when things change.
- Handoff Controller
  - Makes decision of when to make horizontal and vertical handoffs.
  - Can take *advice* from an external controller, uses this when making handoff decisions.

Details(cont.)

- External Controller
  - Acts as a tool for user-assisted handoff.
  - Allows the user or proxy to provide advice in making handoff decisions.
    - “Don’t use CDPD for web browsing--costs too much”
    - “Only Use Metricom--I’m low on power and Wavelan uses too much. I’m only reading mail, anyway.”
  - Can be more than one at a time.
  - Can be of different types (text-based vs. Tcl/Tk).

Constraints

- Portability
  - All communication via sockets. Allows components to move.
- Unreliability of components
  - If one component crashes, other components should still act sanely.
- Unreliability of messages
  - Any message can be lost.
- Avoid sending info over the low-bandwidth link.

Reasons To Handoff

- Two reasons for handoff
  - Handoff Controller only hands off due to mobility.
  - External Controller on proxy issues advice based on network conditions.
- Where is the network state?
  - Beacon packets include state necessary for mobility decisions.
  - Network monitor collects network state necessary for load balancing.

Beacon Packets

- Only include BS identifier.
- Device drivers on mobile measure signal strength, quality, SNR
- Handoff Controller uses this for handoff.
- Beacons may include in future:
  - Other networks that are “nearby”.
    - e.g. Wavelan BS near building entrance will have Metricom as a “near” network.
    - Allows us to hide network registration latency.
  - Snapshot of NM’s collected statistics.

Network Monitor State

- Data Repository for:
  - Latency, Bandwidth, Jitter.
  - Packet error rate.
  - Cost(in watts or cents) to send/recv a “chunk”.
  - Maximum and optimal packet size, used for chunking decisions.
- Measurements kept for each mobile’s network interface.
- All measurements have confidence intervals.

Sample Ext. Controller Msgs.

- To handoff controller:
  - Use this network/basestation
    - Switch to this network if it is available.
  - Don’t use this network/basestation
    - Unless it is the only one available.
  - Use any network/basestation
    - Removes all constraints.

Handoff Controller Msgs.

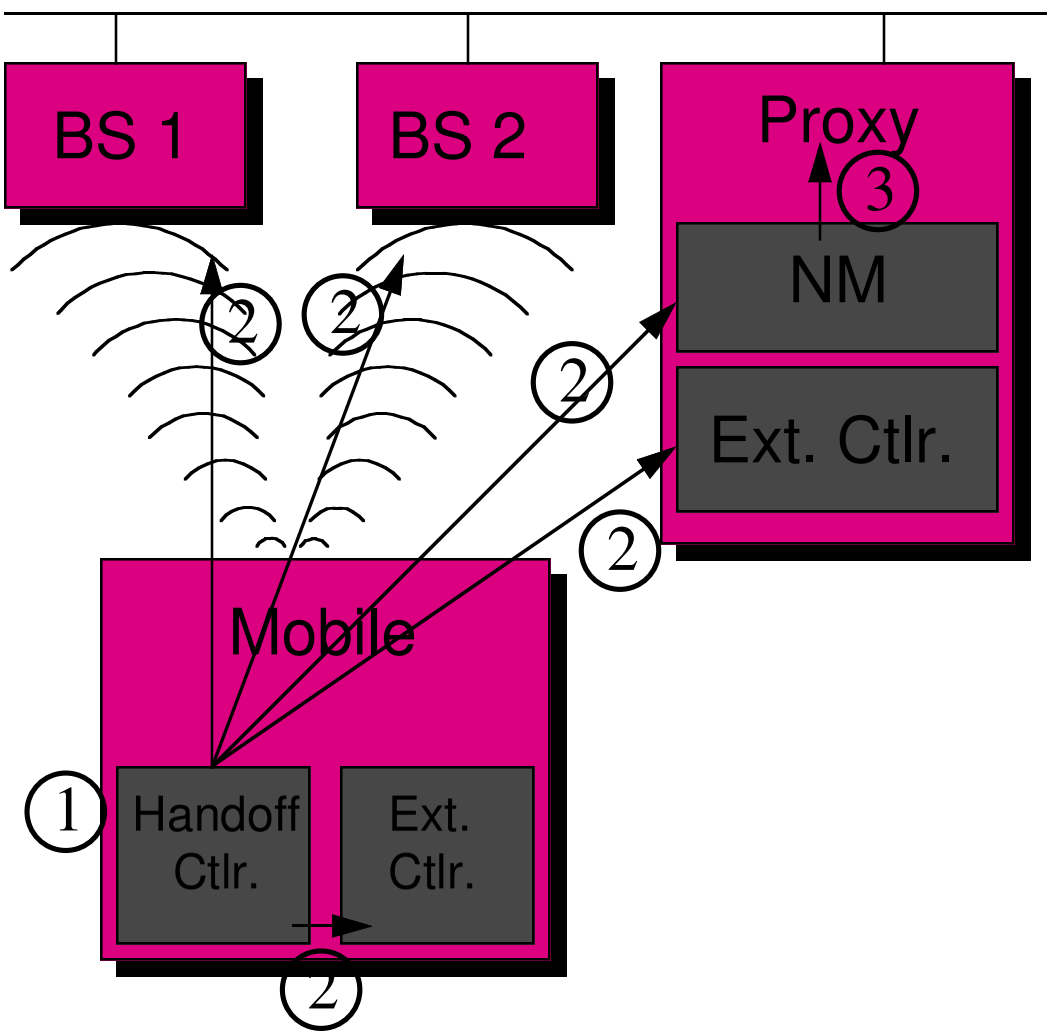
- To external controller/NM(for state)
  - List (all, active) networks/basestations
  - List used network/basestation
    - If a certain net/bs is “locked in”.
  - List unused network/basestation
    - If a certain net/bs is “locked out”.
- To basestations(for routing)
  - list-active-network/bs-reply
- To client-side GloMop library:
  - disconnected-network

Network Monitor Messages

- Serves collected data:
  - whatis-current-bandwidth-reply
  - whatis-current-latency-reply
- Registers callbacks for when measurements change:
  - register-bandwidth-lessthan
  - register-bandwidth-greaterthan
  - etc.

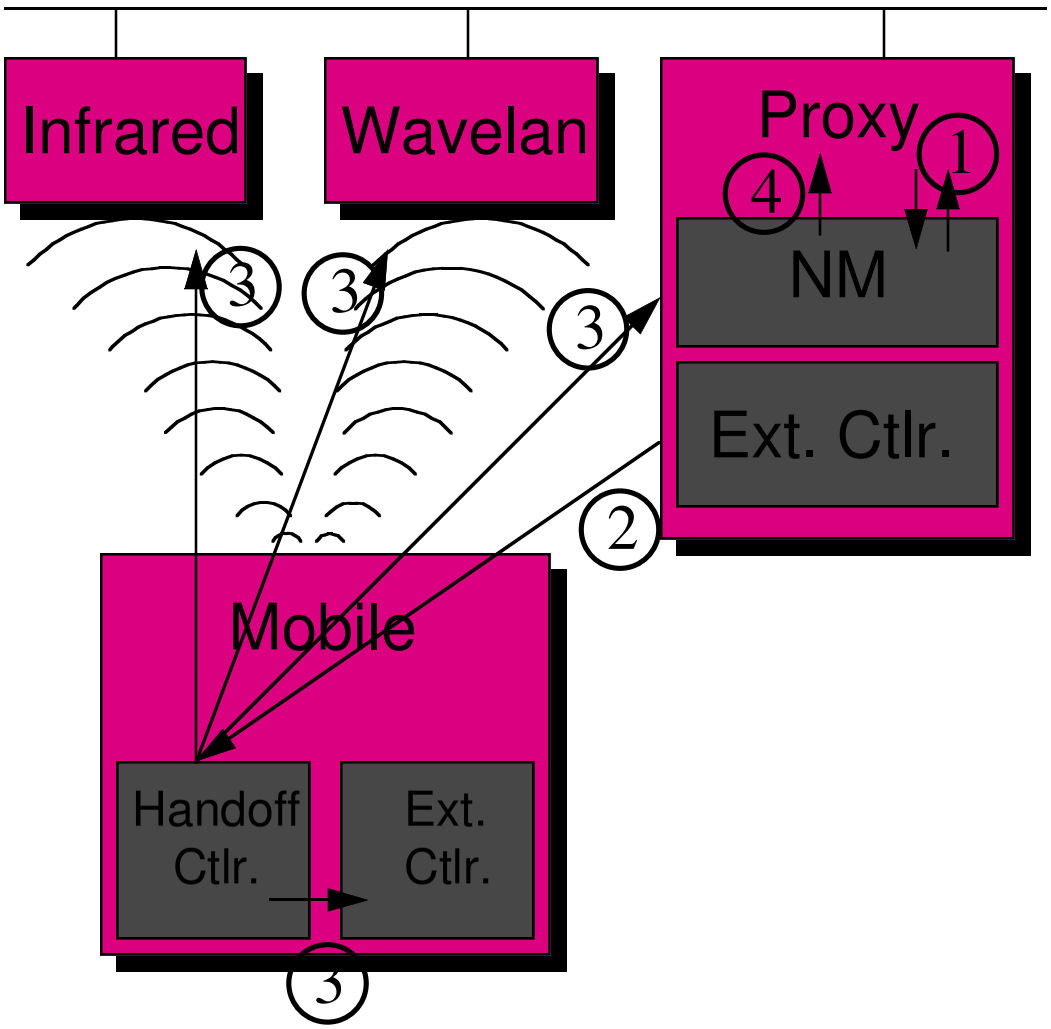
Scenario 1 (Mobility)

- Handoff controller receives beacon packets and notices that new BS has higher SNR.
- Sends routing msgs to BS, new BS state to ext. controller & NM.
- New BS's lower bandwidth triggers a previously registered register-bw-lessthan event, so NM tells Proxy, which changes amount of distillation.



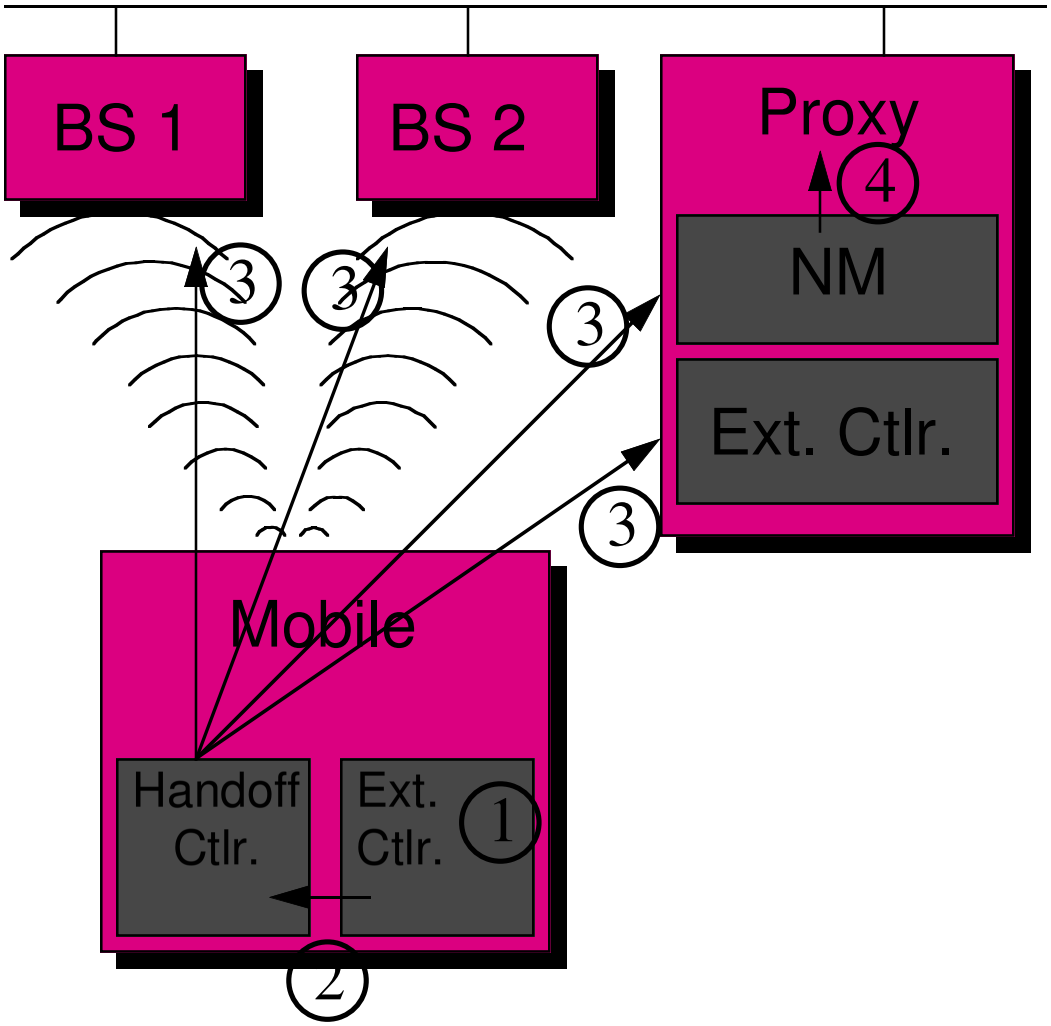
Scenario 2 (Load Balancing)

- Proxy queries NM and notices that Infrared is overused while Wavelan is underused.
- External Controller on proxy sends advice to handoff controller on mobile.
- Handoff Controller sends routing msgs to BS, new network state to other Ext. Controller and NM.
- New latency, bandwidth callbacks are triggered and msgs sent to proxy.



Scenario 3 (User Control)

- User (via External Controller) decides to switch to Metricom from Wavelan.
- Ext. Controller sends advice msg to Handoff Controller.
- Handoff Controller sends routing msgs to BS, new network state to other Ext. Controller and NM.
- New latency, b/w callbacks are triggered and msgs sent to proxy.



Current Status/Goals

- Have preliminary handoff controller.
- Have 2 preliminary external controllers.
  - Text-based shell
  - Tcl/Tk GUI
- In next 6 months:
  - NM completed & integrated w/ Proxy.
  - Improve handoff controller to add automatic vertical handoff.

What's Wrong With This Picture?

- Violating KISS?
- Is "advice" really necessary?
  - Maybe the choice for any given situation is actually obvious.
- What happens when there are multiple Proxies?
  - Maybe need a "bandwidth manager" that does the load balancing instead.
- Uploads? Need a "NM-lite"?