Fixing 802.11 Access Point Selection

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Current 802.11 access point selection is broken

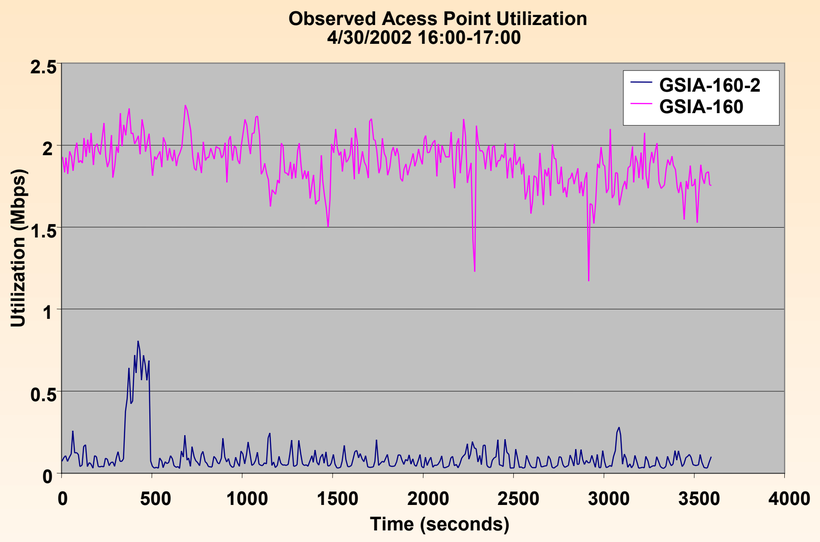
Current model

Currently mobile hosts select the AP with the best signal-noise ratio. The standard does not require this, but the lack of standard support for other mechanisms makes selection via SNR the only viable policy.

Real-life example of why this is bad

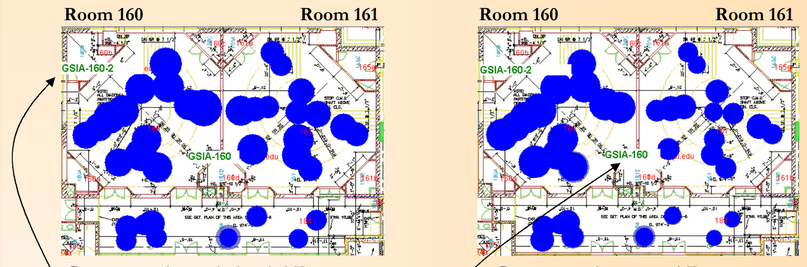
A cell in CMU's business school covering two large lecture halls was routinely overloaded. To alleviate this problem, network administrators installed an additional access point, on a free channel, to cover this area.

Result: Adding an additional access point didn't help!



The source of the problem: Poor access point selection

SNR measurements plotted on two copies of the building floorplan. Larger circle = better SNR.



Despite excellent coverage by both access points, GSIA-160-2 is largely unused! Why? In room 161, GSIA-160 generally has a *slightly* better SNR hence nearly all hosts associate with GSIA-160. (Similar problem in room 160.)

Evaluating alternative models

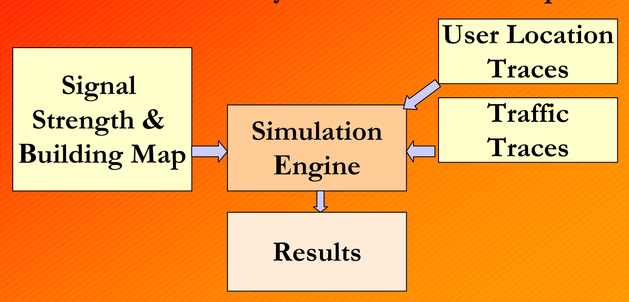
Evaluation Obstacles:

Implementation – AP selection implemented in firmware

Deployment – Difficult to evaluate alternative algorithms on a large scale in a real network

Idea:

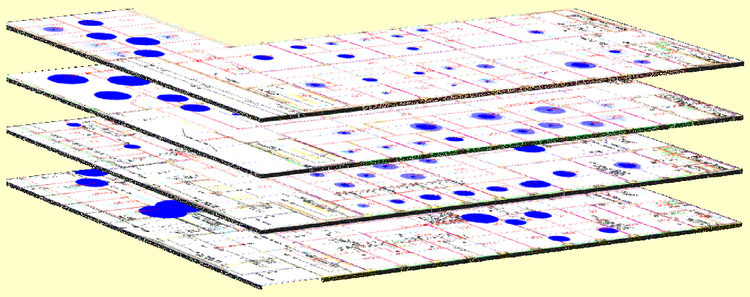
Evaluate load sensitive access point selection using a simulation of 802.11 infrastructure mode; take into account as many real-world factors as possible.



Simulator architecture

Building Map – Used CAD drawings & physical measurements to create a model of the GSIA building

Signal Map – Gathered extensive signal samples throughout GSIA.



Excerpt of GSIA map showing signal samples

Using the above tools, for any given sample location we have good estimates of the SNR from all available access points. For determining interference between stations we use a signal propagation model based on the data obtained.

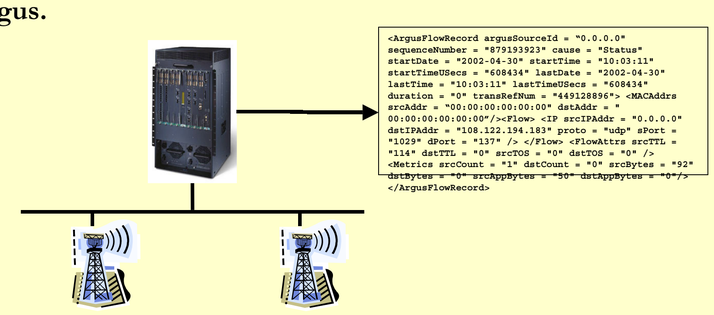
Simulator

Current 802.11 simulators fail to support all the features we desire. In particular, they fail to support infrastructure mode with the ability to read in signal samples

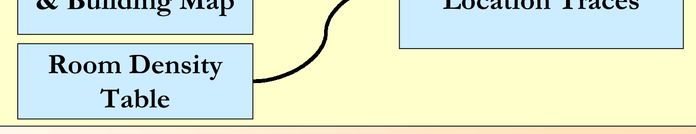
To overcome this we have developed a packet level 802.11 simulator focused on allowing us to evaluate different AP selection models.

Currently, we do not simulate details of higher network layers (e.g. TCP)

Traffic Traces – All flows exiting the wireless network are logged using Argus.



User Location Traces – "Synthetic traces" of user movement generated from cell population traces.



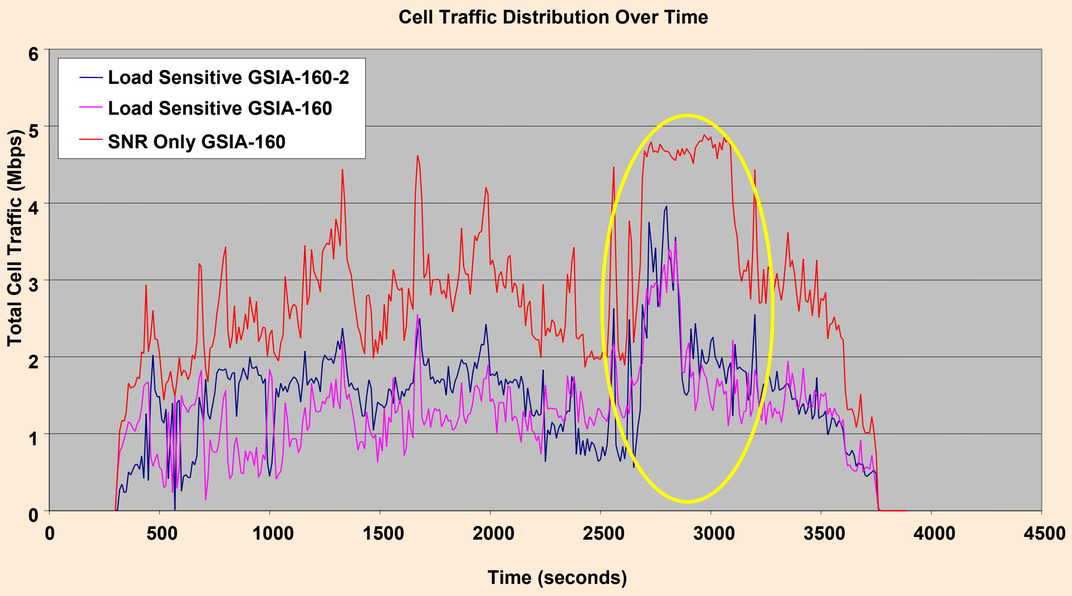
Preliminary Results

Models evaluated

SNR only – Select AP with the best SNR regardless of load or number of users.

Load Sensitive – Consider both SNR and AP load. Select AP that appears to offer the best available bandwidth. Use hysteresis and randomization to avoid oscillation.

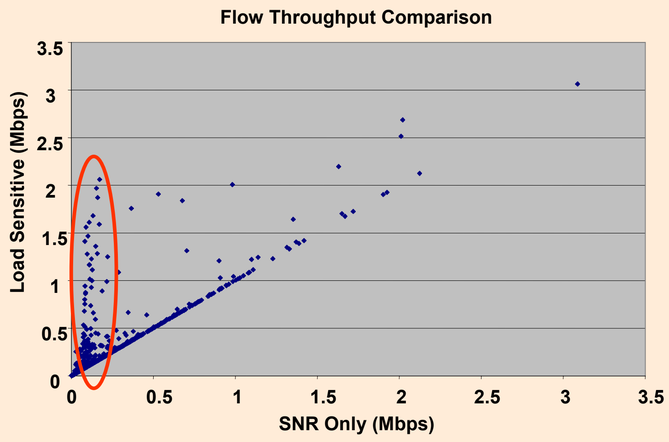
AP Load Sharing Performance



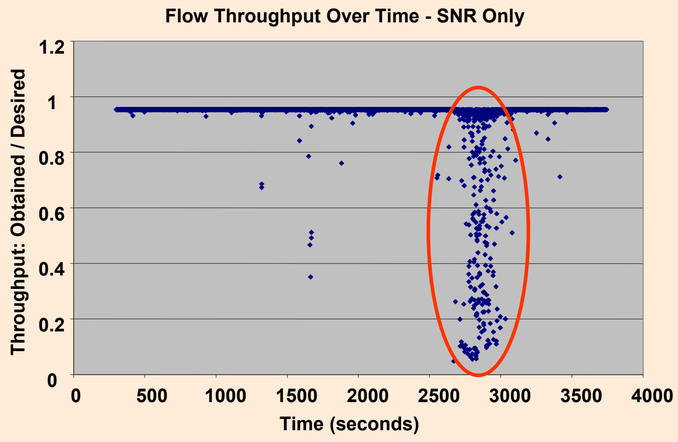
SNR only access point selection puts the entire load onto GSIA-160 while load sensitive AP selection divides the load between the two access points

Note the longer duration of the "busy period" for SNR Only compared to GSIA-160.

Individual Flow Performance



For many flows, Load Sensitive AP selection provides significantly better performance.



The single access point is unable to cope with the large bandwidth requirements of the "busy period" shown.