CS 525M – Mobile and Ubiquitous Computing Seminar

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Introduction

• Real-world measurement of 802.11b wireless performance
  – Signal/noise ratio
  – Average bandwidth
• Divided into 4 phases
  – Phase 0 – distance
  – Phase 1 – building materials
  – Phase 2 – environmental effects
  – Phase 3 – interference
How we tested (equipment)

- Proxim ORiNOCO 802.11b pcmcia card
- Linksys “Instant Wireless” Wireless Access Point Router
- Two laptops from the ATC
And the power?

- A car starter battery along with a power inverter does wonders!
Software

- 2 measurements taken...
  - Signal/noise with NetStumbler
  - Average bandwidth with QCheck
Why?

• NY Stock Exchange
• Short of “ray-tracing” how can you tell what factors are involved in 802.11b performance?
  – Are there any simple rules for planning the design of your home wireless network?
Phase 0 - distance

- First test on the football field
- As expected, SNR drops as distance increases
- At about 15 yards, throughput started to become erratic. By 30 yards, we could not get an accurate measurement.
Phase 0 – distance

Our setup on the football field
Phase 0 – distance

- Second test in a long hallway in the Campus Center
- Throughput is erratic, but confined to two distinct plateaus
Phase 0 – distance

• Just like in the football-field experiment, the SNR decreases as one would expect with distance…
• At the maximum distance tested which was longer than the distance on the football field, we had 2x the SNR
Phase 0 – distance

- Third test in a large open room (Harrington Auditorium)
- At about 15 yards, bandwidth dropped significantly just like in the previous experiments.
- At 53 yards, it returned to full bandwidth!
  - Shape of the room
Phase 0 – distance
Phase 1 – building materials

• Unfortunately, by the time that we were about to conduct the building materials test, we realized it was ill conceived.
• Learned from the distance tests that radio waves are much less line-of-sight than we thought.
• We didn’t have the resources to do a better test, so we decided to continue with the test as-is.
Phase 1 – building materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Obstruction</td>
<td>4.7</td>
</tr>
<tr>
<td>3/4'' Particle Board</td>
<td>4.6</td>
</tr>
<tr>
<td>Cement Board</td>
<td>4.5</td>
</tr>
<tr>
<td>Sheetrock</td>
<td>4.4</td>
</tr>
<tr>
<td>Polyisocyanurate Insulation</td>
<td>4.3</td>
</tr>
<tr>
<td>Ceiling tile (hard)</td>
<td>4.2</td>
</tr>
<tr>
<td>Ceiling tile (foam)</td>
<td>4.1</td>
</tr>
<tr>
<td>1/2'' 3ply birch plywood</td>
<td>4.0</td>
</tr>
<tr>
<td>3/8'' 3ply Pine</td>
<td>3.9</td>
</tr>
<tr>
<td>3/4'' 4ply Plywood</td>
<td>3.8</td>
</tr>
<tr>
<td>3/8'' 4ply Plywood</td>
<td>3.7</td>
</tr>
<tr>
<td>Insulation (pink panther)</td>
<td>3.6</td>
</tr>
</tbody>
</table>
Phase 1 – building materials

Laptop Stolen
Phase 2 – environmental

- What are the effects of humidity on wireless, if any?

- Very slight downward trend
Phase 3 – interference

- Tested with two sources of noise in the 2.4ghz band
  - Microwaves
  - Roommate’s phone that *ruins* my wireless headphones
Phase 3 – interference

Effect of Microwave Oven on Throughput

Microwave Off
Microwave On
Phase 3 – interference

Effect of 2.4Ghz Phone on Throughput

- No Phone
- Idle Phone
- In Use

Channel

Mbps

1 2 3 4 5 6 7 8 9 10 11

0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
Conclusions

• Wireless signals may be too complex to conduct research with based solely on empirical evidence

• Although we did not reach many of our goals, we learned a lot about wireless
  – Line of sight is less important than structures that tend to “focus” radio waves such as the ends of Harrington
  – Without surfaces to bounce off of, 802.11b behaves very poorly as shown by our outdoor test
Conclusions

- Interference with other devices using the same band is a **big** problem
- If you get poor performance, try moving just a little bit – small changes in position or orientation can have huge effects on performance
- Always keep a close watch on your laptop
Questions?