Measurement-based Characterization of 802.11 in a Hotspot Setting

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Interested in Protocol Itself

- Many components of 802.11 MAC / PHY
- How well do they work in practice?
How well does 802.11 work?

• Many things we don't know:
  • How much air time spent on real data?
  • How well do clients choose bit rates?
  • How does 802.11 react to contention?
  • etc.
Prior Studies Can't Answer

- Shows user / application behavior, not MAC

Wired / SNMP logs...
Use Wireless Traces

- *Record packets in air*
- Learn tracing challenges
- Learn how well 802.11 really works
- Share data for studies
Challenges for Tracing

- Inherently incomplete view
- Capture as much as possible
- Must understand what's missing
Analysis Techniques

• Leverage Hints in Traces
  • Data / ack pairs
  • Retry bit in header
  • Gaps in sequence numbers
• Related work: Merge traces (Yeo, et al)
SIGCOM 2004 Traces

- 5 days, 5 wireless monitors, 3 channels
- Focus on subset:
  - Tues, 8/31/2005
  - 8 am - 7:30 pm
  - Monitor 1, Channel 1
<table>
<thead>
<tr>
<th>Frame Type</th>
<th>Frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>5540</td>
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<tr>
<td>Originals</td>
<td>3988</td>
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<tr>
<td>Retries</td>
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<td>Control</td>
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<td>Mgmt</td>
<td>1098</td>
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<tr>
<td>Totals</td>
<td>12080</td>
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</tbody>
</table>

Overhead for Data

Only 31% original data
Retransmissions

- Correlated with *low signal strength*, as expected
- But, also correlated with *contention*
  - Carrier sense not working
  - Leads to slower rates, thus further contention
Rate Change Effectiveness

- Designed for clients with low signal strength
- Does changing rate lower loss probability?
  - At night, usually so
  - Much worse, given contention
Future Directions

• **Better Analysis Techniques**
  • Merge traces
  • Better protocol inference (time, RSSI, etc)

• **More Protocol Questions**
  • Spatial diversity?
  • Effect of error packets / collisions?
Anonymized Traces Available (22 GB):
http://www.cs.washington.edu/research/networking/wireless/

• Tons of wireless data left to explore:
  • Learn low level protocol behavior
  • Test new analysis techniques
  • Compare against other settings