Characterizing Errors in Wireless LAN

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Goals

- Characterizing Transmission Errors in 802.11
  - Network Capacity
  - Protocol Design
  - Determining the position of stations
- To improve on the existing models of wireless transmission errors
Project deliverables

- Collecting a comprehensive set of data recording the behavior of operational wireless network.
- Packet-level analysis
- Bit-level analysis
- Signal-strength analysis
- Map the observed errors to specific mathematical model of the communications channel i.e. n-state Hidden Markov Model (HMM)
Introduction

- Wireless Technologies
  - Personal Area Network
    - Bluetooth, IR
  - Local Area Network
    - IEEE 802.11
  - Wide Area Network
    - GSM, GPRS, 3G
## Introduction (cont)

<table>
<thead>
<tr>
<th>Wireless Technologies</th>
<th>Standard</th>
<th>Data Rate</th>
<th>Frequency Band</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal Area Networks</strong></td>
<td>Bluetooth</td>
<td>1 – 22.4 Mbps</td>
<td>5 GHz</td>
<td>10 m</td>
</tr>
<tr>
<td></td>
<td>IR</td>
<td>1 – 15 Mbps</td>
<td>0.76 – 1.33 MHz</td>
<td>5 m</td>
</tr>
<tr>
<td><strong>Local Area Networks</strong></td>
<td>WLAN</td>
<td>11/54 Mbps</td>
<td>2.4/5 GHz</td>
<td>50 - 150m</td>
</tr>
<tr>
<td></td>
<td>Hiperlan</td>
<td>20 Mbps</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wide Area Networks</strong></td>
<td>GSM</td>
<td>9.6 Kbps</td>
<td></td>
<td>30 Km</td>
</tr>
<tr>
<td></td>
<td>GPRS</td>
<td>170 Kbps</td>
<td></td>
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</tr>
</tbody>
</table>
WLAN provides a very effective and proficient infrastructure for wireless communication systems.

Effective communication is of paramount importance.

802.11a and 802.11b
## 802.11 Comparisons

<table>
<thead>
<tr>
<th>Standard</th>
<th>Data Rate (Up to)</th>
<th>Frequency Band</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>802.11b</td>
<td>11 Mbps</td>
<td>2.4 GHz</td>
<td>100 m</td>
</tr>
<tr>
<td>802.11a</td>
<td>54 Mbps</td>
<td>5 GHz</td>
<td>50 m</td>
</tr>
</tbody>
</table>
Impairments

- An important characteristic of WLAN is that transmission errors can occur from impairments.

- These transmission characteristics may affect:
  - The range of wireless devices
  - The level of coding needed to protect frames from error
  - The ability of wireless networks to meet the delay requirements
  - The design of transport layer protocols
Source of WLAN Impairments

- WLAN error characteristics can vary widely, to confidently characterize WLAN behavior, we would first need to identify possible wireless impairments:
  - Attenuation
  - Front End Overload
  - Narrowband Interference
  - Natural Background Noise
  - Multi Path Interference
  - Path Loss (dispersion)
  - Motion
Source of WLAN Impairments

- Other independent variables that could affect loss and error rates.
Related Work

- Research papers
  - Measurement and Analysis of the Error Characteristics of an In-Building Wireless Network
    David Eckhardt and Peter Steenkiste

- Thesis Report
  - Wireless LAN Measurements Project
    Aziz Dhanani and Neeraj Tuli
Measurement and Analysis of the Error Characteristics of an In-Building Wireless Network

- Abstract
- Methodology
- Conclusion

- Abstract
- Methodology
- Conclusion
Development

- **Equipment used**
  - Two laptop PCs
  - Wireless NICs – 802.11a, 802.11b (two of each)
  - Access Point
Methodology

- **Approach**
  - Modify 802.11a NIC drivers to retain error frames
  - Extending the program developed by previous group
  - Collect data through experiments (for 802.11a/b)
    - Environmental measurements
- **Analysis**
  - Bit level analysis of errors
  - Gilbert-Elliot Model
Schedule

- **14 Jul – 17 Aug (5 wks)**
  - Reproduce previous group’s experiments on 802.11b
  - Investigate ways to capture MAC level packets for the 802.11a

- **18 Aug – 14 Sep (4 wks)**
  - Development and extension of programs

- **15 Sep – 5 Oct (3 wks)**
  - Experiments carried out

- **6 Oct – 2 Nov (4 wks)**
  - Analysis of data collected

- **3 Nov – 16 Nov (2 wks)**
  - Finalization of Thesis report.
Conclusion

- Characterising and modeling errors in WLAN
- Errors in WLAN affect:
  - Network capacity
  - Protocol Design
  - Determining positions of stations
Thank you for your participation.