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Adaptive MIMO OFDMA for Future Generation Cellular Systems in a Realistic Outdoor Environment

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OVERVIEW

- Link Adaptation and PHY mode selection algorithms allow the system to achieve the best possible throughput by having MIMO, coding, and modulation schemes adapted to the changing channel conditions
- Realistic sub-optimal LA algorithms are proposed based on SNR only and on both SNR and H matrix determinant respectively

CHANNEL MODEL

- Outdoor Ray Tracing Model: Models 400mx400m urban area of Bristol, UK
- BS: 23m above ground level, 2 patch elements (2λ spacing) (MS: 1.7m above ground, covering an area of 400mx400m. 2 monopole elements (0.6λ spacing)
- Reference Uncorrelated Statistical Channel Model: A typical large environment for NLOS conditions, 250ns average rms delay spread
- All channels are assumed to be quasi-static
- Rather than having any detailed knowledge of the realistic channel, the statistical channel model is essentially arbitrary and has not been optimized to the overall environment or route.

PROPOSED SUBOPTIMAL LA ALGORITHMS

- Received SNR Only Approach — PHY mode is chosen based on the statistical channel link throughput result (SNR lookup table)
- Received SNR and H Matrix Determinant Approach — Based on the SNR only LA algorithm, choice of PHY mode can be affected by the level of the H matrix determinant

THROUGHPUT PERFORMANCES OF THE ADAPTIVE MIMO OFDMA BASED ON THE SUBOPTIMAL LA ALGORITHMS

PHY MODEL

- OFDMA system: a candidate PHY layer for 4G systems, and all usable sub-carriers are allocated to different users to support multi-user transmission
- For this work, only one user is considered, and hence the analysis equally applies to an OFDM system
- 2x2 MIMO Architecture: switch between STBC and SM
- Space-Time Block Codes: achieve diversity gain
- Spatial Multiplexing: MMSE linear detection, increase transmission rates

CONCLUSIONS

- An effective sub-optimal LA algorithm is proposed to examine the possibility of having the system adapted to received SNR or SNR and the H matrix determinant
- Use of H matrix determinant threshold results in substantial reduction in throughput error
- Determinant value governs trade-off between greater probability of small errors and greater maximum error
- For real time applications, excessive delays can be minimized by adjusting the H matrix determinant threshold

FUTURE WORK

- The analysis presented here is sensitive to the degrees of freedom provided by the PHY layer and to the specific environment chosen for simulation. Further work is required to consider other possibilities
- Future work is expected to investigate the adaptability of the H matrix determinant threshold further

Data Table

<table>
<thead>
<tr>
<th>Mode</th>
<th>Modulation</th>
<th>Coding Rate</th>
<th>Coded Bits (megabits/sec)</th>
<th>Max. Data Rate (BPSK)</th>
<th>Max. Data Rate (QPSK)</th>
<th>Max. Data Rate (16 QAM)</th>
<th>Max. Data Rate (64 QAM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BPSK</td>
<td>1/2</td>
<td>2</td>
<td>64 / 128</td>
<td>96 / 192</td>
<td>128 / 256</td>
<td>192 / 384</td>
</tr>
<tr>
<td>2</td>
<td>QPSK</td>
<td>3/4</td>
<td>4</td>
<td>96 / 192</td>
<td>128 / 256</td>
<td>192 / 384</td>
<td>256 / 576</td>
</tr>
<tr>
<td>3</td>
<td>QPSK</td>
<td>7/8</td>
<td>8</td>
<td>192 / 384</td>
<td>256 / 576</td>
<td>384 / 768</td>
<td>512 / 1152</td>
</tr>
<tr>
<td>4</td>
<td>16 QAM</td>
<td>2/3</td>
<td>6</td>
<td>128 / 256</td>
<td>192 / 384</td>
<td>256 / 576</td>
<td>384 / 768</td>
</tr>
<tr>
<td>5</td>
<td>64 QAM</td>
<td>1/2</td>
<td>1</td>
<td>256 / 576</td>
<td>384 / 768</td>
<td>512 / 1152</td>
<td>640 / 1310</td>
</tr>
</tbody>
</table>

Transmission Modes and Data Rates

FUTURE WORK

References