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Abstract

- The system-level performance of a 3x3 Eigen-Beam-Forming (EBF) 802.11n WLAN solution is compared with a reduced cost 2x2 EBF approach with ideal antenna selection in a home environment. A comparison of directional and omni-directional antennas is considered.
- The in-home propagation channels are modelled using 3D ray tracing and combined with appropriately oriented complex polarimetric antenna radiation patterns.
- PHY layer throughput is calculated for all MCSs and (for the 2x2 case) all possible antenna combinations using a novel RBIR abstraction technique [1][2].
- Results show that with ideal antenna selection the performance of 2x2 EBF is competitive, especially when directional antennas are used at low SNR values (3x3 EBF only 15% better).

Introduction

- WLANs are commonly deployed in the home and office and are used as a wireless extension for the internet. Modern consumer applications like HD video streaming require a cost-effective and reliable high throughput wireless link.
- The recent 802.11n standard for WLANs offers enhanced throughput modes and supports higher quality video computing.
- 3x3 EBF: 8 MCS modes for 1, 2 and 3 spatial streams.
- 2x2 EBF: 9 antenna selection combinations, 8 MCS modes for 1 and 2 spatial streams.
- Channel bonded 40MHz transmission using 128 subcarriers (SGH carrier).
- The ideal MCS is chosen using the RBIR abstraction technique (the mode that maximizes throughput for PER<10%).

Test Environment & Antenna Configuration

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Ideal omni-directional elements with 80% efficiency</th>
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Link-level Abstraction and Validation

- Link-level analysis for large numbers of locations, MCS modes, antenna configurations and orientations is computationally prohibitive with bit-accurate PHY simulation.
- A novel Received Bit mutual Information Rate (RBIR) abstraction technique is used to compute PHY layer throughput.
- Fig. 3 verifies the accuracy of the RBIR abstraction technique when compared to measured results.
- 5 hours of computing time with a bit-accurate simulator correspond to 20 seconds with the RBIR abstraction technique.

Simulation Parameters

- 1000 channel matrix snapshots for each client location and orientation.
- 3x3 EBF: 8 MCS modes for 1, 2 and 3 spatial streams.
- 2x2 EBF: 9 antenna selection combinations, 8 MCS modes for 1 and 2 spatial streams.
- Channel bonded 40MHz transmission using 128 subcarriers (SGH carrier).
- The ideal MCS is chosen using the RBIR abstraction technique (the mode that maximizes throughput for PER<10%).

Results

- The performance of 2x2 EBF with optimum antenna selection is competitive to 3x3 EBF, especially when directional antennas are used at low SNR values. For distant rooms, 3x3 EBF is only 15% better (in terms of throughput) than 2x2 EBF when directional antennas and dynamic antenna selection are applied. 2x2 EBF with semi-directional antennas results in a 45% reduction in throughput (compared to 3x3 EBF).
- Multiple directional antennas can enhance 802.11n performance in a home environment. The combined effect of the antennas should provide near isotropic radiation and reduce the impact of client polarization and orientation.
- We conclude that EBF with ideal 2x2 antenna selection (taken from a larger set of 3x3 directional antennas) is an attractive and cost effective solution for wireless applications in the home.

Conclusions

- The performance of 2x2 EBF with optimum antenna selection is competitive to 3x3 EBF, especially when directional antennas are used at low SNR values. For distant rooms, 3x3 EBF is only 15% better (in terms of throughput) than 2x2 EBF when directional antennas and dynamic antenna selection are applied. 2x2 EBF with semi-directional antennas results in a 45% reduction in throughput (compared to 3x3 EBF).
- Multiple directional antennas can enhance 802.11n performance in a home environment. The combined effect of the antennas should provide near isotropic radiation and reduce the impact of client polarization and orientation.
- We conclude that EBF with ideal 2x2 antenna selection (taken from a larger set of 3x3 directional antennas) is an attractive and cost effective solution for wireless applications in the home.
- Future work will incorporate real antenna pattern data into the model.

References