Efficient Physical-Layer Models for MIMO WLAN Simulation

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Background

- Wireless network simulation is used for protocol design and testing, network performance prediction.
- Network simulation tools use simple physical-layer models, do not include multiple antennas at the transmitter or the receiver.
- Network protocols can be designed to combat the challenges presented by the wireless channel.
- The effects of the channel can be mitigated, or even exploited, if the impact is understood.
- Realistic channel models will help to quantify the impact of physical-layer dynamics on higher-layer protocols.

Efficient Network Simulation

- Incorporating bit-level PHY models into discrete-event network simulators is impractical.
  - Most network simulations involve millions of packets, each containing thousands of bits.
  - Waveform-level simulations are processed on a sample-by-sample basis.
  - Each individual block is simulated in detail, adding to the simulation complexity.
- Discrete channel models are computationally efficient and reduce simulation time.
  - Discrete channel models can model the temporal correlations that create burst errors.
  - Simulation is at the symbol rate – 1/8 to 1/16 the sample rate.
  - High level of abstraction further reduces the computational burden.
  - Typically implemented using Hidden Markov Models.

802.11n

- Standard is currently in development, may provide data rates up to 600 Mbps.
- Inclusion of two spatial streams at access points is mandatory; up to four spatial streams at all clients is optional.
- Additional changes in the physical layer and the MAC layer.
- Proposed uses and environments are diverse
  - Real-time residential multimedia delivery
  - Interactive gaming presents stringent delay constraints
  - Outdoor applications will have higher delay spreads

Research Goal

- Develop waveform-level simulation of 802.11a PHY with multiple antennas
- Use the error data to develop Markov models
- Implement the Markov models in network simulation tool (e.g., ns-2)
- Use simulation for performance analysis of network protocols

References