Vienna 5G Link Level Simulator v1.2 - List of Features

General Functionality

The Vienna 5G Link Level Simulator evaluates the average PHY layer performance by means of Monte Carlo simulations.

- no explicit geometry supported, defined by links
- simulate a multitude of multicarrier systems
- choose parameters individually for each node

Channels and Links

FDD and TDD frame structure are supported.

- Uplink data channel
- Downlink data channel
- flexible subcarrier spacing (5G Numerology)

Channel Coding

Different channel coding schemes may be chosen for different cells to investigate their co-existence.

- Turbo coding
- TB convolutional coding
- Polar coding
- LDPC coding

Feedback

Quantized feedback to adapt the transmission parameters to the channel conditions.

- CQI, RI and PMI feedback selectable
- LTE-A compliant codebook (up to 4 antennas)
- 5G compliant codebook (up to 32 antennas)
- user defined codebook (arbitrary number of antennas)
- variable feedback delay (in multiples of the frame duration)

Channel Models

Doubly-fading channel model	• parameterizable from $500\,\text{MHz}$ to $100\,\text{GHz}$ • time selectivity via sum of sinusoids (Jakes) • frequency selectivity via tap delay models (pedestrian, vehicular, etc.) • spatial correlation via Kronecker model • TDL models with adjustable RMS delay spread • correlated time selectivity via sum of sinusoids • TWDP and Rican fading (static)
Spatial Channel Model	• based on TR38.901 • artificially defines geometry via angles between users • includes time, frequency and spatial correlation • spatially consistent correlation

Channel Estimation

Pilot based channel estimation	• LTE/5G compliant diamond pattern • rectangular or diamond shaped pilot patterns • LS channel estimation • perfect channel knowledge • symbol domain orthogonal pilot symbols for multi-user MIMO mode

Modulation

Different modulation schemes and waveforms may be chosen for different cells to investigate their coexistence.	• OFDM • f-OFDM • WOLA • FBMC • UFMC

Transmission Modes	
MIMO modes	• transmit or receive diversity • open loop spatial multiplexing • closed loop spatial multiplexing • downlink multi-user MIMO (MRT, ZF, block diagonalization) • uplink mulit-user MIMO (MRC, ZF, MMSE)
Non-orthogonal multiple access	• 3GPP MUST

Equalization and Detection	
One-tap equalization with MIMO detection schemes	• ZF • MMSE • Sphere Decoder • Maximum likelihood

Power Amplifier Models	
Non-linear power amplifier models for downlink transmissions	• Rapp model • adjustable amplifier back-off

Performance Evaluation	
Simulation results for up- and downlink:	• throughput per user • cell sum throughput • coded and uncoded Bit Error Ratio • Frame Error Ratio • channel estimation MSE • transmit signal peak-to-average power ratio • Peak-to-Average power ratio ECDF