Vienna 5G Link Level Simulator v1.3 - List of Features

General Functionality

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

- simulate a wide range of wireless technologies for 5G and beyond
- choose parameters individually for each node in your simulation scenario

Channels and Links

FDD and TDD frame structure are supported.

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

Intermediate Nodes

Intermediate nodes assisted simulations are supported.

- reconfigurable intelligent surfaces (RISs)

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
- codebook: LTE-A compliant (up to 4 antennas), 5G compliant (up to 32 antennas), and user defined (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
Geometric layout	• distance-based path loss (free space, urban, etc.) • geometry-based LOS angle of arrival

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

Power Amplifier Models

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

Modulation

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

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) • uplink CRC-based IC
Non-orthogonal multiple access	• 3GPP MUST (Downlink) • uplink NOMA

Equalization and Detection

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

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