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

Hybrid Automatic Repeat Request (HARQ)

Non-adaptive synchronous HARQ with four redundancy versions is now supported [1]. Upon transmission failures, up to four re-transmissions of user packets are performed, enhancing BLER, S(I)NR, and throughput performance.

256-QAM and 1024-QAM

BLER mapping curves have been added for the simulation of transmission with up to 256-QAM and 1024-QAM according to 3GPP TS 36.213 [3].

Weighted Round Robin Scheduler

User groups can now be assigned a scheduling weight that defines how many resource blocks a user is assigned when scheduled by the round robin scheduler. This feature allows to simulate premium users that get priority service.

Uplink Lite Signal to Interference and Noise Ratio (SINR)

In addition to the downlink results (throughput, SINR, BLER, ...), an uplink *lite* SINR is calculated. The *lite* SINR is an instantaneous SISO SINR that considers large scale fading effects as well as instantaneous small scale fading channel realizations, but ignores precoding and scheduling.

Flexible LOS/NLOS Decision

The decision whether a link is a LOS-link can now be chosen to be geometry-based, random, static, or standard-defined [2, 4].

Small Cell Association Bias

A bias factor can be set to favor association with small cells. This avoids empty small cells with low transmit power.

New Traffic Models

Additional traffic models [5] have been added to the existing constant rate and full buffer models:

- FTP
- HTTP
- Video streaming
- Gaming
- VoIP

Flexible Precoding

Precoders are now set per base station allowing the use of different precoding codebooks for different technologies, e.g, 5G codebook for 5G network slice and LTE codebook for LTE network slice.

NOMA Feedback and MIMO Extension

NOMA MIMO transmission is now supported and feedback has been extended to consider power share factor and interference from NOMA transmission.

QuaDRiGa MIMO Support

The QuaDRiGa [6] interface is extended to support MIMO channels. An additional license from QuaDRiGa is required to access the QuaDRiGa channel models.

Bug Fixes and Improvements

- inter-numerology interference (INI) power normalization bug is resolved
- maximum user speed is used for channel trace generation (before a predefined speed was set for channel trace generation)
- more optional additional results are available (macroscopic fading, shadow fading, wall loss, antenna gain)
- uniform distribution of street users and interference region base stations now possible by fixing number of Poisson distributed users or base stations
- signaling overhead of reference and synchronization signals can now be turned off
- path loss calculation is refactored for easier use

References

[1] 3rd Generation Partnership Project (3GPP). *Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification*. TS 36.321. 3rd Generation Partnership Project (3GPP), June 2021.

[2] 3rd Generation Partnership Project (3GPP). *Study on channel model for frequencies from 0.5 to 100 GHz (Release 16)*. Tech. rep. 3rd Generation Partnership Project (3GPP), 2020.

[3] 3rd Generation Partnership Project (3GPP). *Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures*. TS 36.213. 3rd Generation Partnership Project (3GPP), Jan. 2015.

[4] 3rd Generation Partnership Project (3GPP). *Study on 3D channel model for LTE*. TR 36.873. 3rd Generation Partnership Project (3GPP), May 2018.

[5] 3rd Generation Partnership Project (3GPP). *LTE physical layer framework for performance verification*. TSG RAN1-070674. 3rd Generation Partnership Project (3GPP), Feb. 2007.

[6] S. Jaeckel, L. Raschkowski, K. Boerner, and L. Thiele. "QuaDRiGa: A 3D Multi-Cell Channel Model With Time Evolution For Enabling Virtual Field Trials". In: *IEEE Transactions On Antennas and Propagation* 62 (2014), pp. 3242–3256.