

Vienna Cellular Communications Simulators

Vienna 5G simulators



January 11, 2022

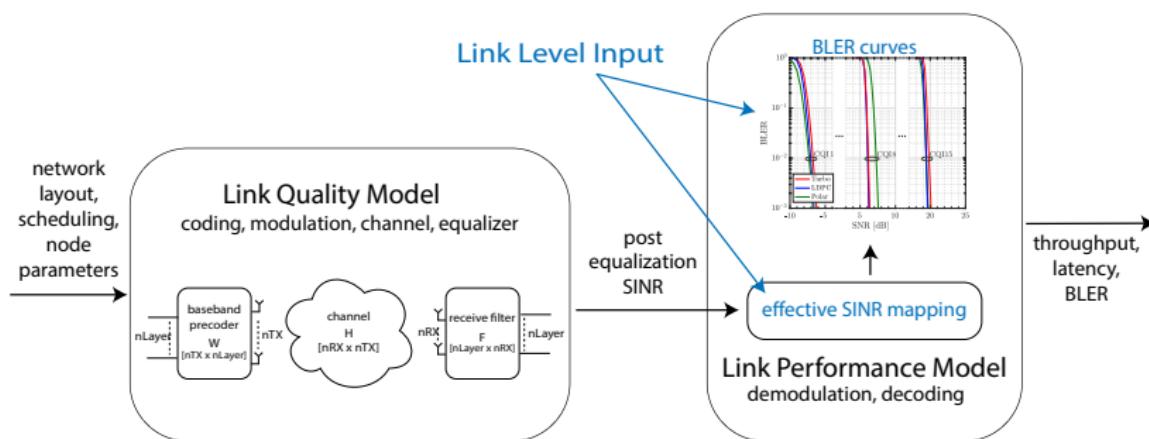
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SLS
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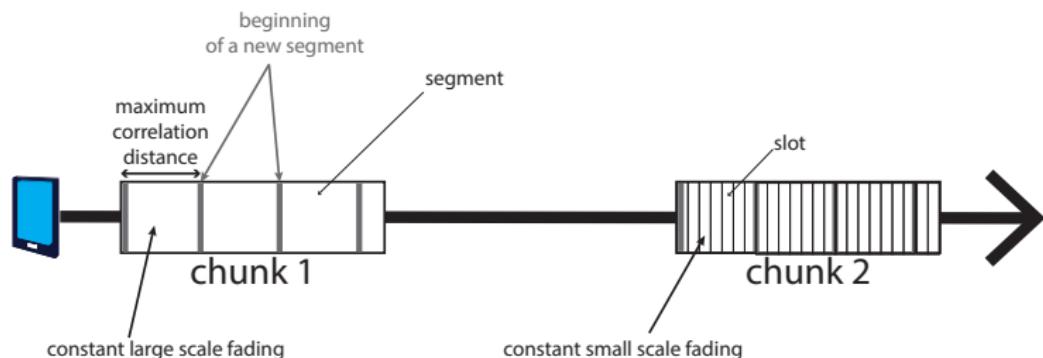
User
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Border
Fading

Scheduler
Feedback
Result
Example

CONNECTING LINK LEVEL AND SYSTEM LEVEL SIMULATIONS

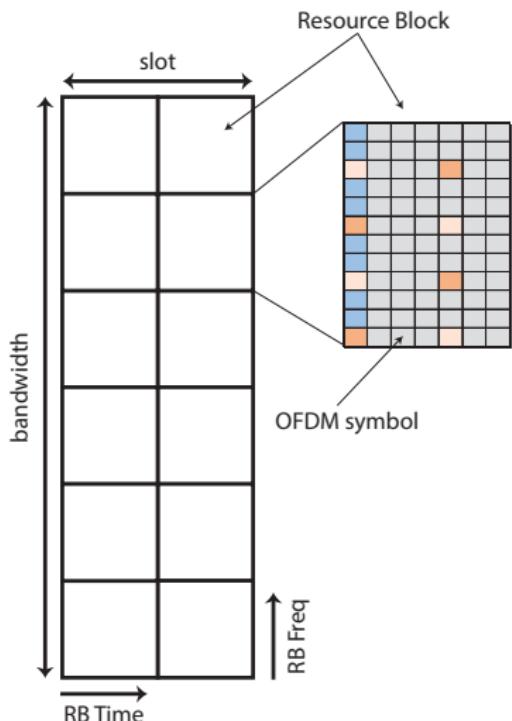


TIME STRUCTURE



- ▶ *slot*: constant small scale fading
- ▶ *segment*: constant large scale fading
- ▶ *chunk*: constant network setup

RESOURCE GRID



RBs are the unit for:

- ▶ scheduling
- ▶ feedback
- ▶ digital precoding
- ▶ post equalization SINR calculation

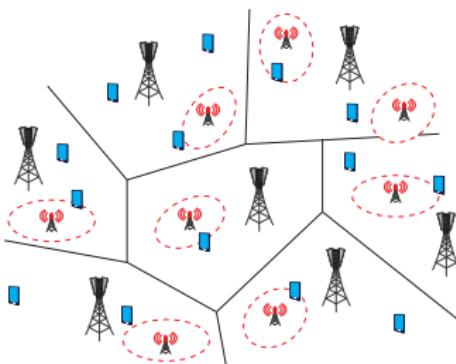
RB: Resource Block

SINR: Signal to Interference and Noise Ratio

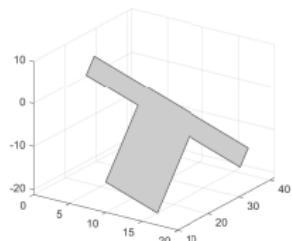
OFDM: Orthogonal Frequency Division Multiplexing

VCCS 5G SYSTEM LEVEL SIMULATOR

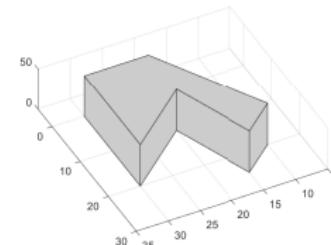
- ▶ large scale network simulations
- ▶ flexible scenarios with different:
 - ▶ user types
 - ▶ base station types
 - ▶ blockages
- ▶ modular implementation
 - ▶ easy extension
 - ▶ stand alone use of components



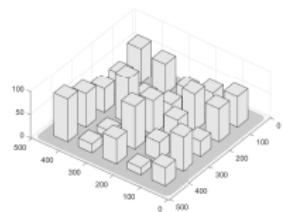
FLEXIBLE SCENARIO CONSTRUCTION



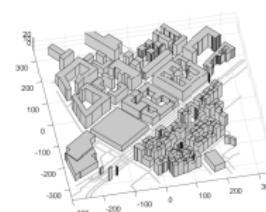
arbitrary wall shapes



arbitrary building shapes



Manhattan city



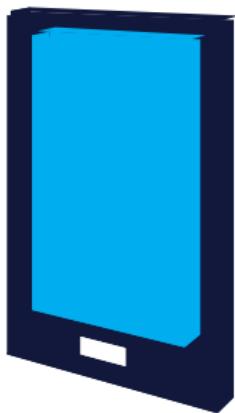
OpenStreetMaps city

DEFINE LINK TYPE THROUGH NETWORK GEOMETRY



USER

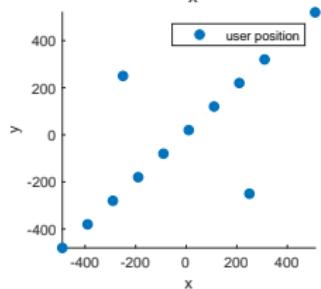
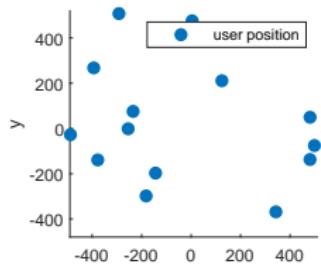
Flexible definition of user groups:



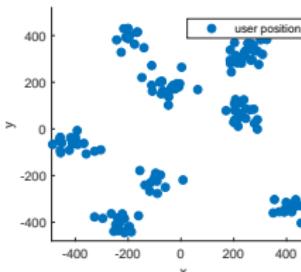
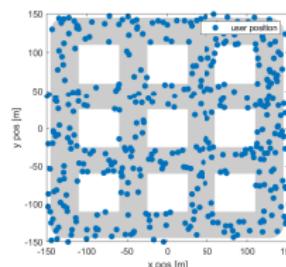
- ▶ nRX
- ▶ position
- ▶ movement type
- ▶ channel type
- ▶ traffic model
- ▶ numerology/technology
- ▶ noise figure

USER POSITIONING

Poisson point process

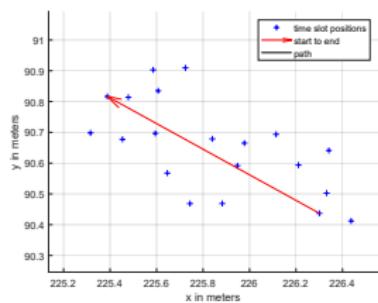


Poisson street

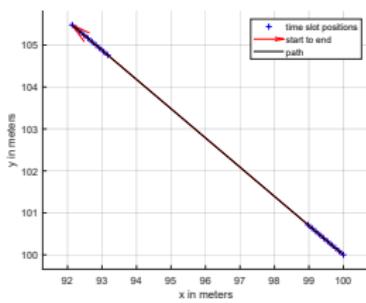


predefined positions

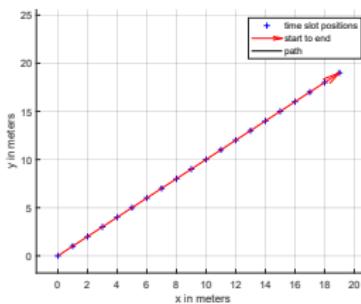
MOVEMENT TYPES



random walk



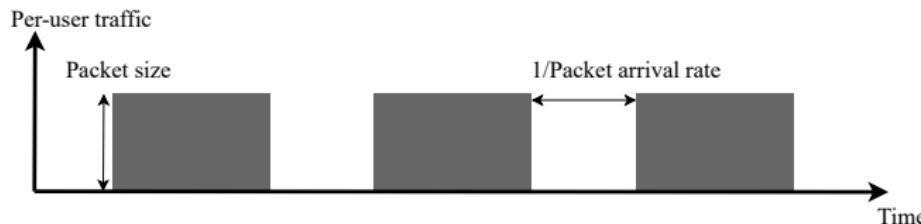
random direction



predefined

TRAFFIC MODELS

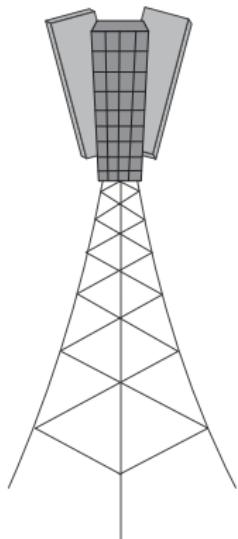
constant rate



full buffer

BASE STATION

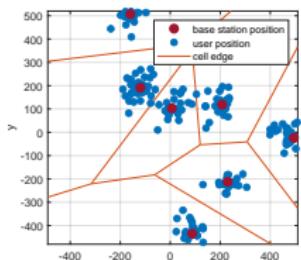
Flexible definition of base station groups:



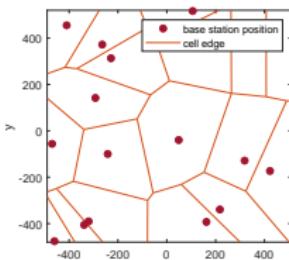
- ▶ nTX
- ▶ transmit power
- ▶ macro, micro, femto
- ▶ position
- ▶ antenna pattern
- ▶ sectors
- ▶ (cell association, precoding)

BASE STATION POSITIONING

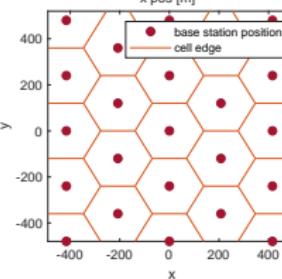
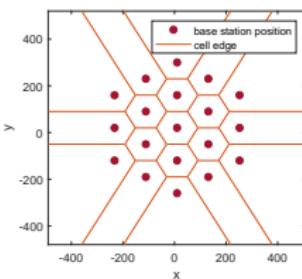
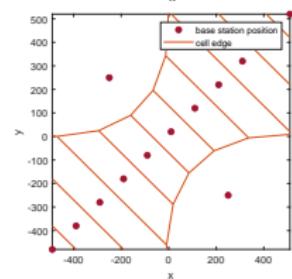
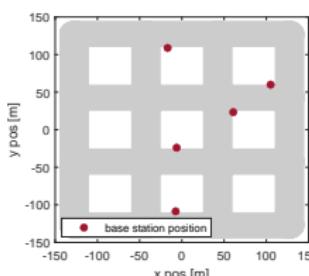
cluster center



PPP



on building



predefined

hex ring

hex grid

ANTENNA PATTERNS

- ▶ omnidirectional
- ▶ three sector 3GPP TS 36.942
- ▶ three sector array 3GPP TR 38.901
- ▶ six sector

CELL ASSOCIATION AND PRECODING

users can be associated according to:

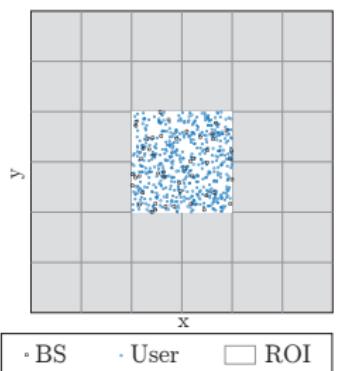
- ▶ macroscopic SINR
- ▶ macroscopic receive power

implemented precoders:

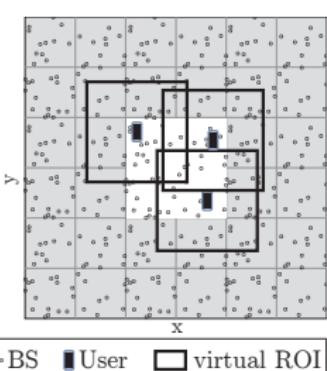
- ▶ LTE
- ▶ 5G
- ▶ Kronecker
- ▶ random

BORDER EFFECT MITIGATION STRATEGIES (BEMS)

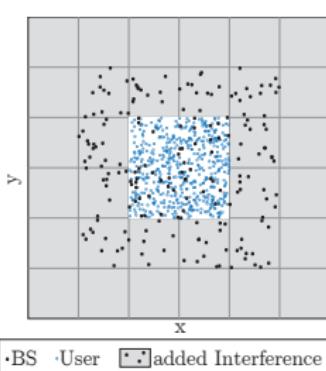
No BEMS



Wraparound



Interference Region



PROPAGATION MODELS

small scale fading:

- ▶ defines the duration of a slot

large scale fading:

- ▶ path loss
- ▶ shadowing
- ▶ geometry: LOS/NLOS, indoor/outdoor
- ▶ antenna pattern

SMALL SCALE FADING MODELS

PDP Models:

- ▶ Pedestrian A
 - ▶ Pedestrian B
 - ▶ Extended
 - ▶ Pedestrian B
 - ▶ Vehicular A
 - ▶ Vehicular B
 - ▶ Typical Urban
 - ▶ Rural Area
 - ▶ Hilly Terrain

Other Models:

- ▶ Rayleigh
 - ▶ AWGN
 - ▶ Quadriga (license!)

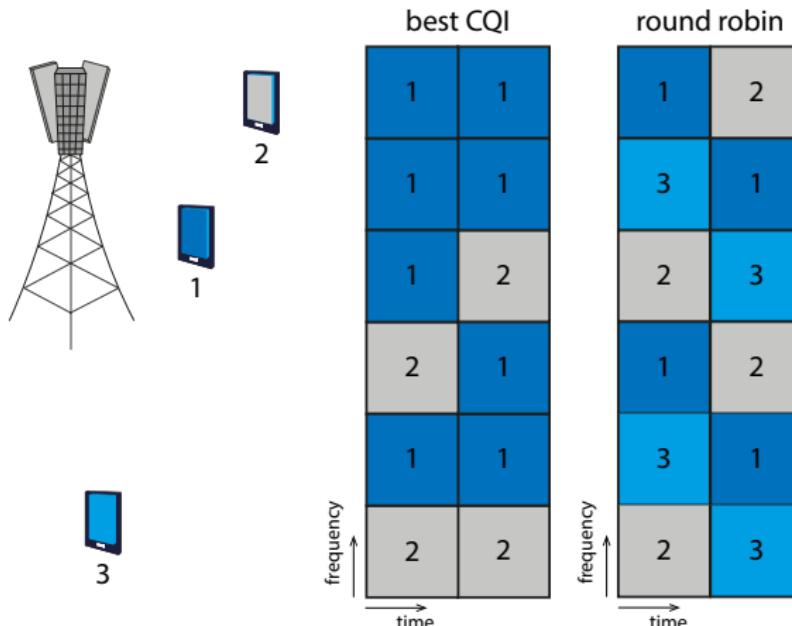
Planned:

- ## ► 3GPP TR 38.901 3D Model

PATH LOSS MODELS

- ▶ fixed
- ▶ free space
- ▶ indoor 3GPP TR 25.952
- ▶ urban COST-231
- ▶ urban 3D 3GPP TR 36.873
- ▶ urban 3GPP TS 36.942
- ▶ urban 3GPP TS 38.901
- ▶ suburban COST-231
- ▶ rural TS 36.942
- ▶ rural 3GPP TS 38.901
- ▶ micro COST-231
- ▶ micro 3D 3GPP TR 36.873
- ▶ micro 3GPP TS 38.901

SCHEDULING



additional options: dynamic spectrum scheduling, NOMA

FEEDBACK

optimum feedback of:

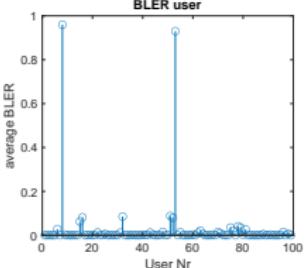
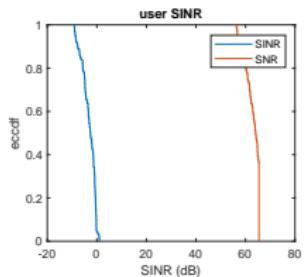
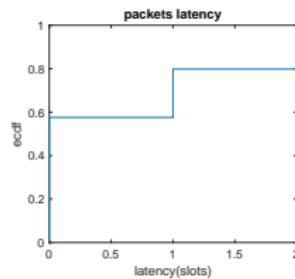
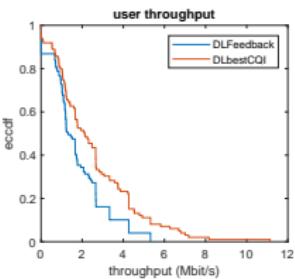
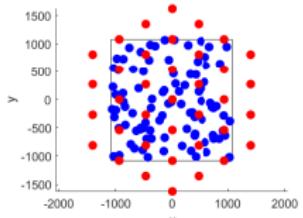
- ▶ CQI
- ▶ RI
- ▶ PMI
- ▶ adjustable feedback delay

CQI: Channel Quality Indicator

RI: Rank Indicator

PMI: Precoding Matrix Indicator

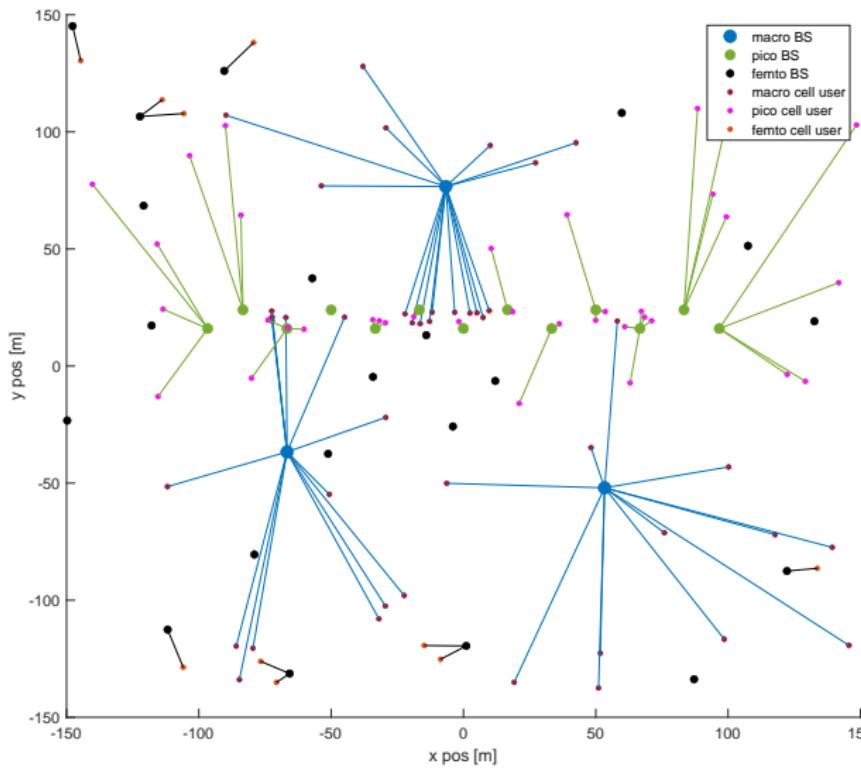
SIMULATION RESULT



- ▶ *lite simulation*
- ▶ *additional results*

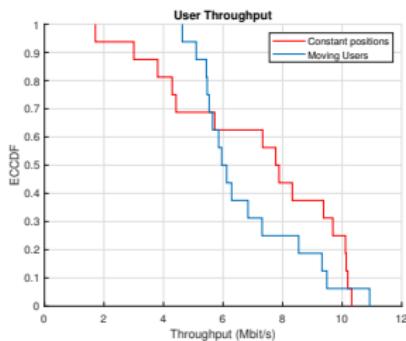
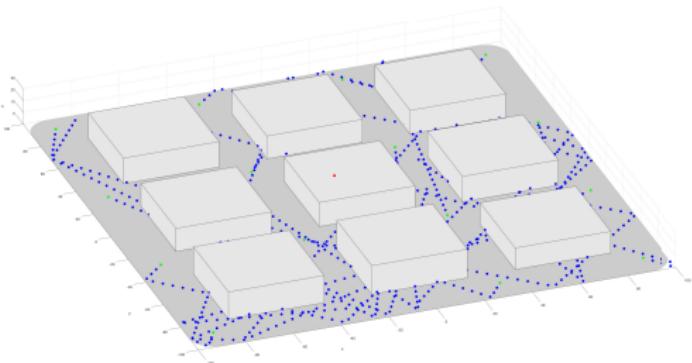
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EXAMPLE - HETEROGENEOUS NETWORK



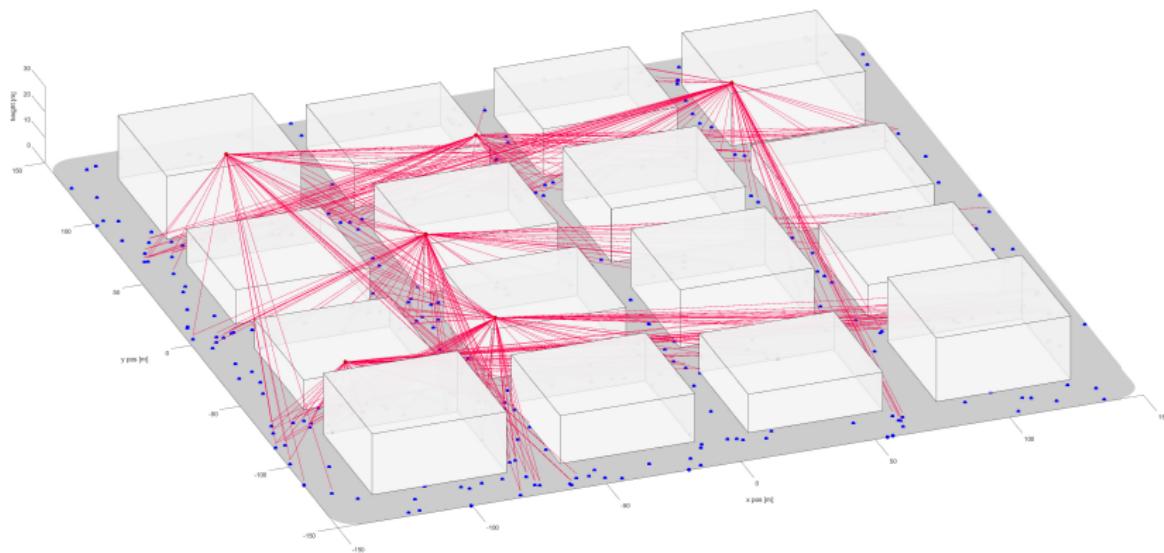
EXAMPLE - SCENARIOS.USERMOVEMENTMANHATTAN

Manhattan City with users moving in a random direction. The starting position is colored green.



EXAMPLE - SCENARIOS.MANHATTANGRIDSCENARIO

Manhattan City with users distributed along the streets



TODO - THINGS TO ADD/UPDATE IN THIS PRESENTATION

- ▶ update path loss model list
- ▶ update traffic model list
- ▶ add NOMA
- ▶ add INI, dynamic spectrum sharing, mixed subcarrier spacings
- ▶ (add MU-MIMO) not yet released
- ▶ add feedback (some explanation)?