Serious game engineering for 5G concepts representation

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Outline

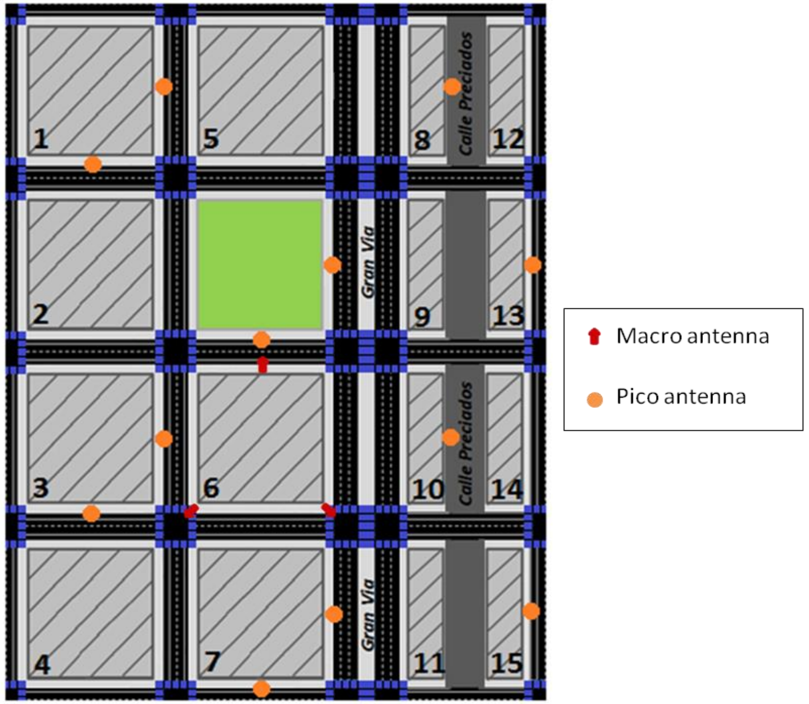
- Simulation insights
- Realistic scenario for evaluations: Madrid-grid
- Visual representation: serious game engineering
- Concept example: Multi AIV Comm. for V2V
- Light intensity based path loss model

Simulation insights

- System simulations are typically used to test different technological components of wireless systems.
  - Simpler and cheaper than direct prototyping
  - Use of simplified scenarios
- Based on past experience in 3GPP, some conclusions reached with statistical simulations have turned out to be incorrect once applied to the field.
- In this sense, it seems beneficial to use realistic scenarios that allow a proper evaluation of the potential of some new technological concepts.

Madrid-grid realistic scenario

- An extension of the Manhattan grid and defined by METIS Project partners
  - 387 m (east west) x 552 m (south north)
  - Blocks of buildings of different sizes and heights
  - An open green area
  - Multi-lane roads with sidewalks and pedestrian areas
  - Macro/micro antennas deployed



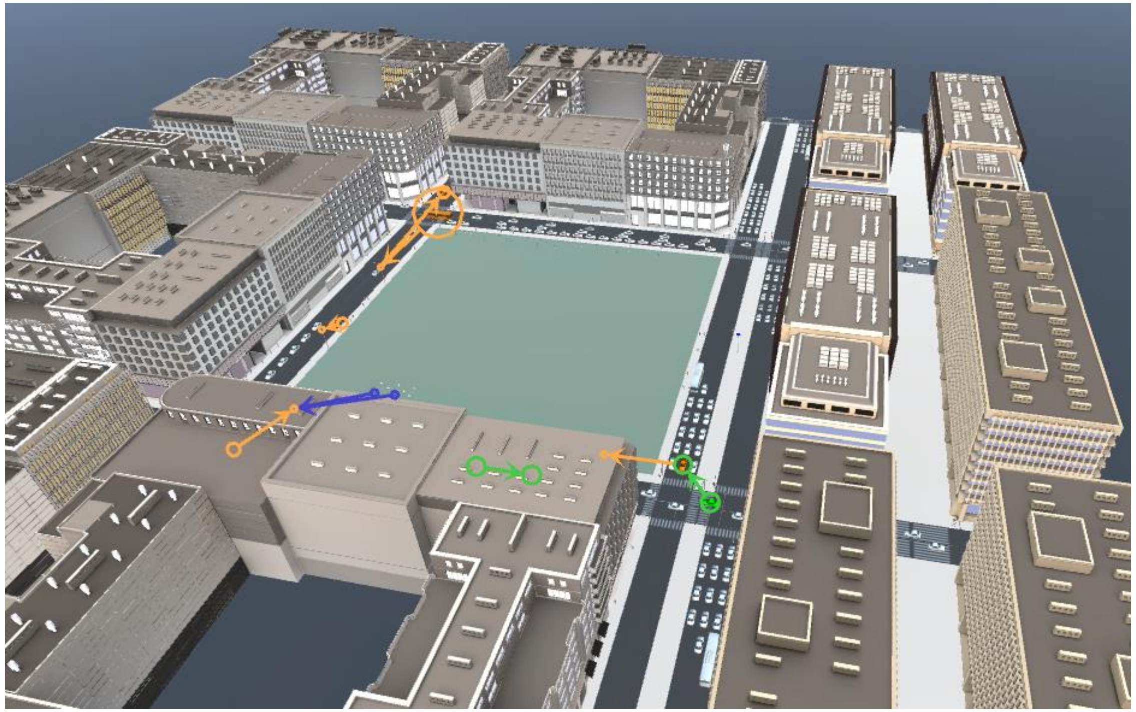
Madrid-grid realistic scenario

- Vehicular traces
  - Configurable number of cars and buses
  - Independent routes simulated in **S**imulation of **U**rban **MO**bility (SUMO)
  - Configurable traffic light phases
- Pedestrian traces

Why serious game engineering?

- Benefits compared with graphs
  - More stylish
  - Visual impact
  - Concepts are understood faster and clearer
  - User – tool interactivity

- Applications of serious game engineering
  - Representation of simulated results
  - In-tool simulation



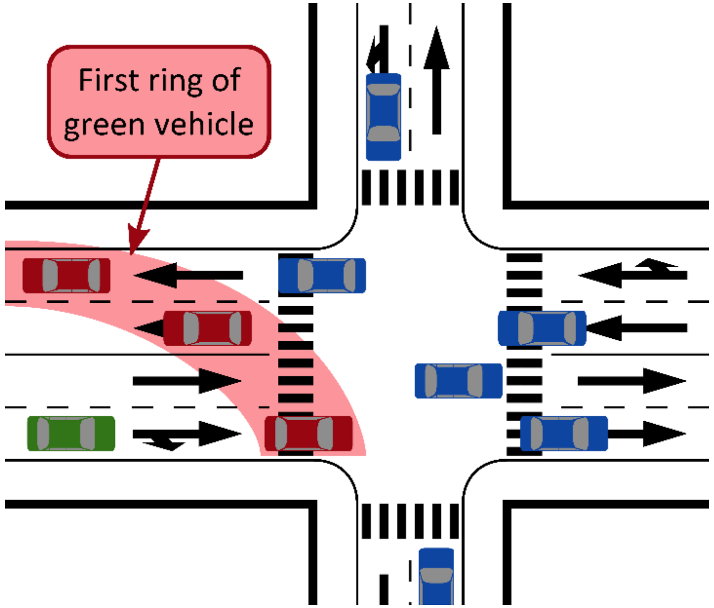
Serious games for information display

- Some view options to display simulation data:
  - Global view
    - Coverage by transmitter
    - Service area analysis
    - Throughput distributions (user and global)
    - Link quality distributions (user and global)
    - Connectivity
  - Focus on mobile station
    - Throughput, SINR, latency, reliability, signal level…
  - Focus on cell / base station
    - Connected devices, cell throughput, coverage…
  - First person view (drive mode)

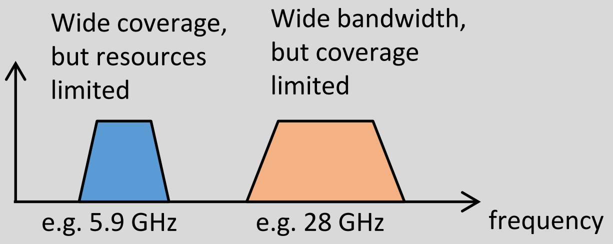
Concept #1: Multi AIV Comm. for V2V

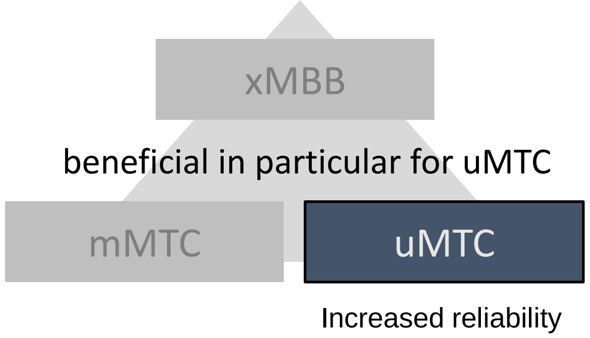
Vehicles send periodic messages with key information about location, speed, direction, etc.

- Closest vehicles (1st ring) need to receive one of those messages every ~10ms.Fast response is needed to avoid collisions.
- Rest of vehicles can receive one every ~100ms. These only need to be aware of the vehicle presence



Multi-AIV communication can be solution to increase reliability

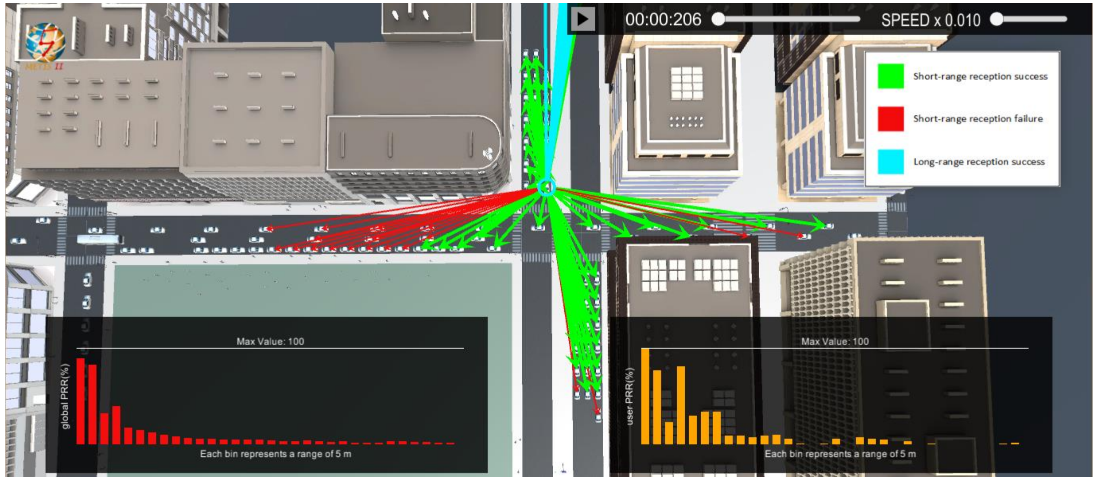




Concept #1: Multi AIV Comm. for V2V

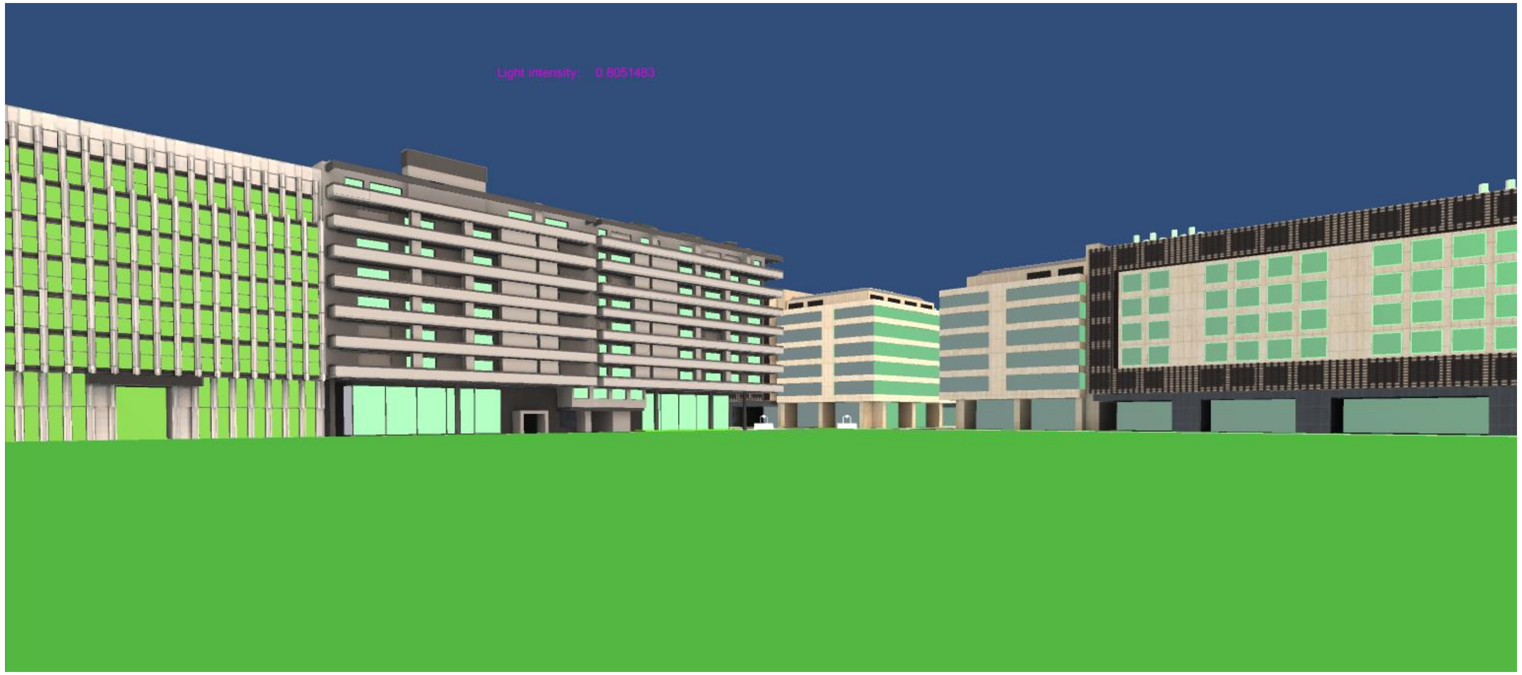
Millimeter wave band (AIV #2)

Centimeter wave band (AIV #1)



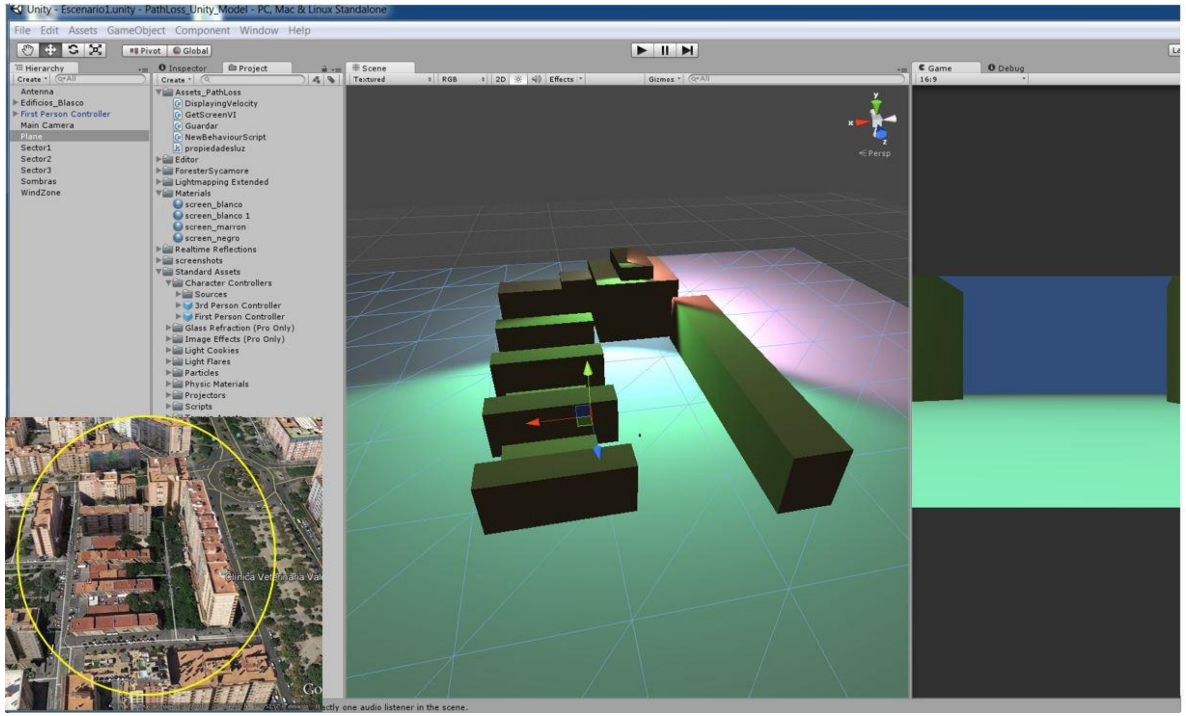
Light intensity based path loss model

- Concept: To associate path loss to light intensity values in the virtualized scenario
  - Game development platform like Unity3D has powerful light engines
  - Light modelled at GPUs → light intensity values available immediately



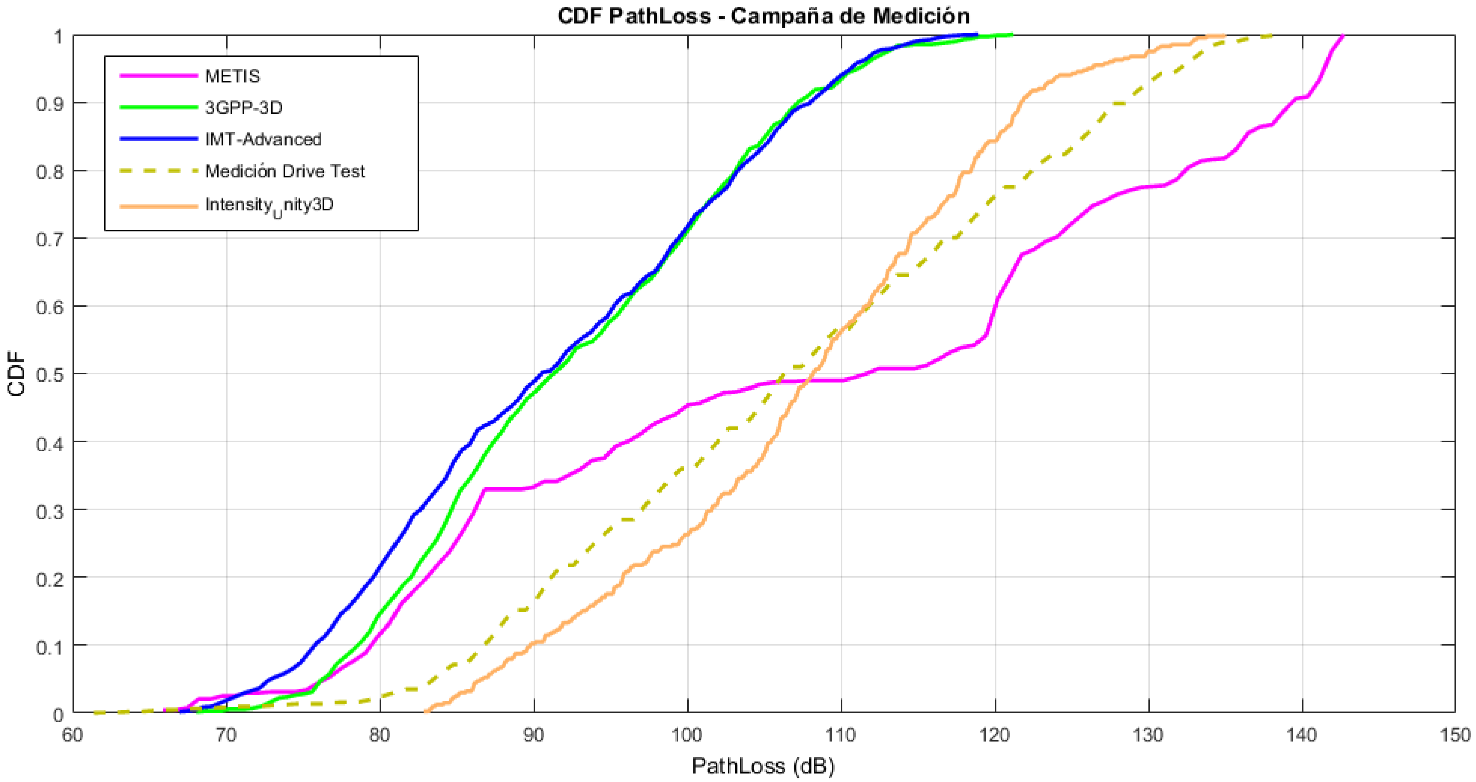
Light intensity based path loss model

- Proof of concept
  - Measurement campaign in a small area in Valencia
  - Virtual reproduction of the of the measurement area
  - Place light sources at base stations
  - Relate real propagation loss with light intensity in the virtual scenario
  - Approximate cloud of points with a non-linear function (mean square error method)



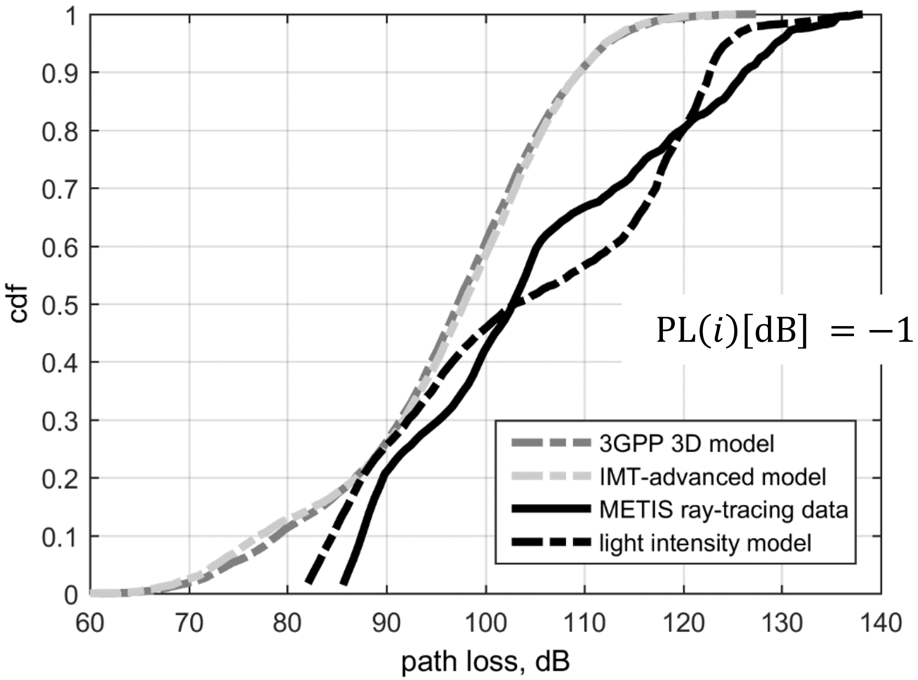
Light intensity based path loss model

- Promising initial results
  - Calibrated vs calibration data for Valencia scenario
  - Low frequency: 800 MHz



Light intensity based path loss model

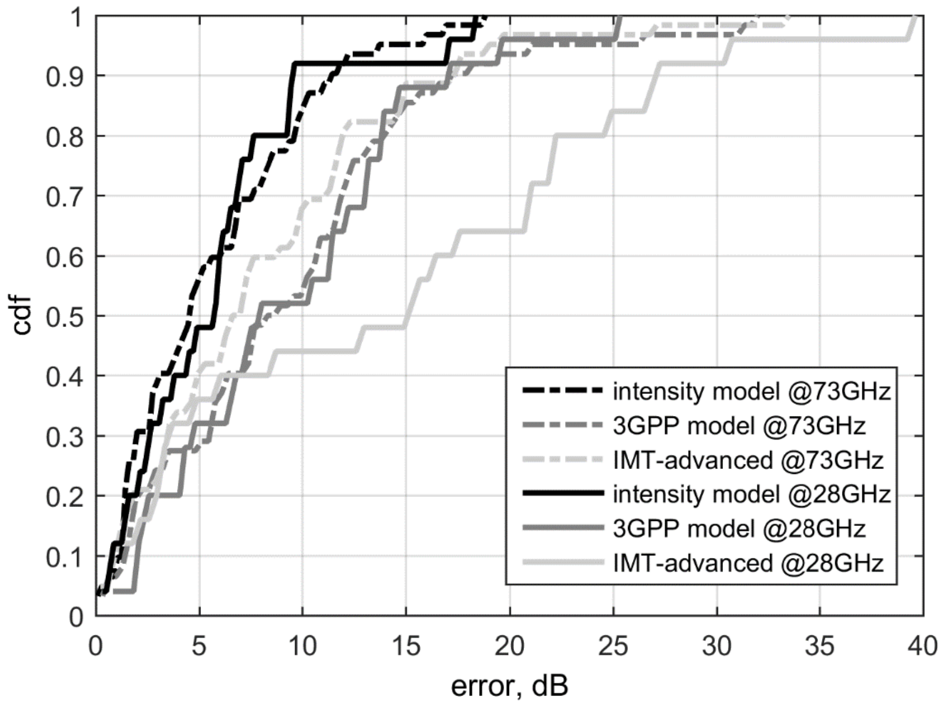
- Light intensity model in madrid-grid scenario
  - Calibration against METIS ray-tracing data (took 1 month to obtain the data)
  - Central frequency: 800 MHz
  - Light model provides better accuracy than 3GPP 3D and IMT-advance



$$\mathrm{PL}(i)[\mathrm{dB}] = -1398 \cdot i^5 + 2553.1 \cdot i^4 - 1488.6 \cdot i^3 + 413.16 \cdot i^2 - 159.18 \cdot i + 136.81$$

Light intensity based path loss model

- Even better accuracy as the frequency increases
  - At higher frequencies, the wave behaves more similar to light



28 GHz

$$PL(i)[dB] = 1946.4 \cdot i^4 - 4769 \cdot i^3 + 4017.5 \cdot i^2 - 1397.3 \cdot i + 397.5$$

Polynomial order decrease

73 GHz

$$PL(i)[dB] = -90.921 \cdot i^3 + 177.36 \cdot i^2 - 161.01 \cdot i + 174.96$$

Model	800 MHz	28 GHz	73 GHz
3GPP 3D model	14.24 dB	9.46 dB	9.43 dB
IMT-Advanced model	14.30 dB	14.10 dB	8.19 dB
Light intensity model	6.83 dB	5.78 dB	5.63 dB

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