3GPP TSG-RAN WG1 #72bis
Chicago, USA, April 15 – April 19

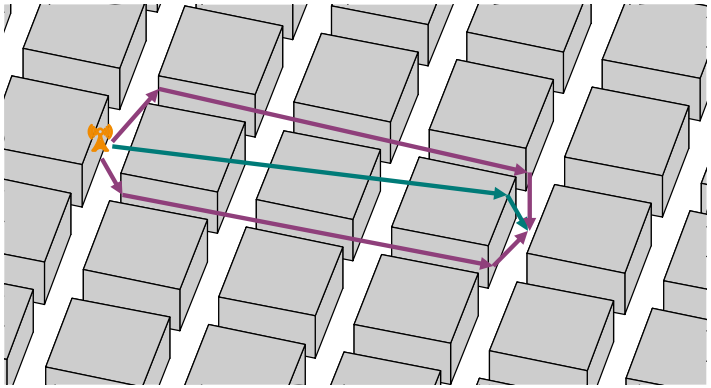
R1-131334

IMPORTANT CHANNEL CHARACTERISTICS

Ericsson, ST-Ericsson

3D-CHANNEL MODELING
OVERVIEW

- Vertical domain missing in present 2D-models
  - Signals assumed to propagate in a 2D horizontal plane (particularly inaccurate for smaller cells)
  - All UEs placed 1.5 m above ground level



- In reality NLOS signals propagate along two *routes*
  - above rooftops **and**
  - around buildings

Dual propagation route approach

- Introducing vertical domain has many implications
  - NLOS path-loss
  - LOS/NLOS state
  - Elevation angle of departure
  - …

More important channel characteristics

So much more than "just introducing angular spread" in vertical domain!

UE HEIGHT IMPACT

- Multi-floor UE dropping in buildings agreed in Malta meeting
  - So UEs are indeed located at different heights
- Path-loss and LOS/NLOS modeling greatly affected!
  - In addition, elevation angles also depend on UE height

UEs are no longer all on ground level

↓

Path loss and LOS/NLOS will be greatly affected

↓

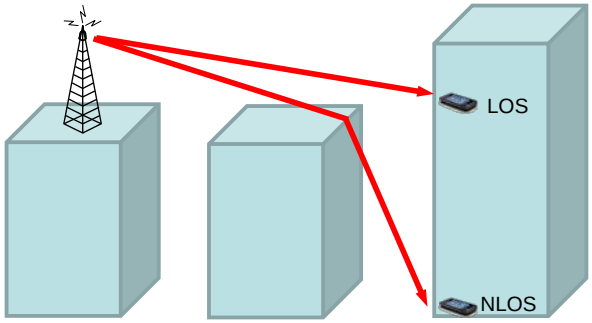
Path loss and LOS/NLOS modeling have to be modified for multi-floor UE dropping to make sense!

Channel models tend to stick for a **long** time → Important that models are reasonably accurate to make the right technology choices in the future

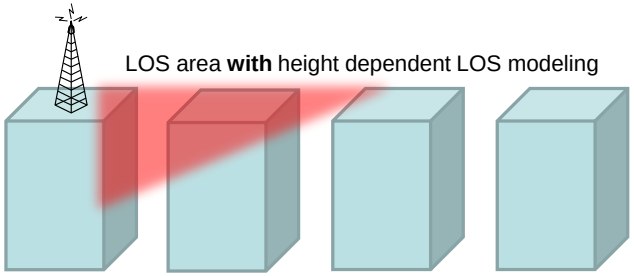
LOS/NLOS VS UE HEIGHT

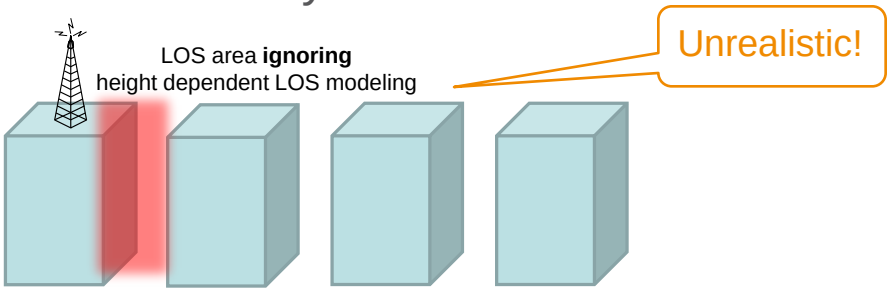
ABOVE ROOFTOP PROPAGATION ROUTE

- LOS/NLOS model depends on UE height
  - Obvious from geometrical considerations



- Higher floors are more likely to be in LOS even far away from eNodeB



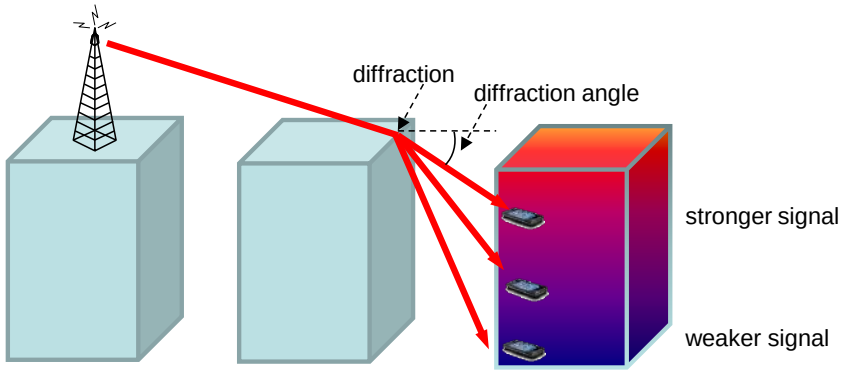


UE height has large impact on LOS/NLOS modeling!

PATH LOSS VS UE HEIGHT

ABOVE ROOFTOP PROPAGATION ROUTE

- NLOS path-loss decreases with increasing UE height!
  - Attenuation increases with diffraction angle
  - Often 1-5 dBs per floor according to measurements



- Well-known in literature
  - Lack of measurements no argument for leaving NLOS path-loss untouched!

- J. Medbo, J. Furuskog, M. Riback, and J.-E. Berg, "Multi-frequency path loss in an outdoor to indoor macrocellular scenario," in Antennas and Propagation, 2009. EuCAP 2009, pp. 3601-3605, March 2009.
- E.F.T. Martijn, M.H.A.J. Herben, "Characterization of Radio Wave Propagation Into Buildings at 1800 MHz", IEEE Antennas and Wireless Propagation Letters, vol. 2, 2003.
- A. F. de Toledo, A.M.D. Turkmani, J. D. Parsons "Estimating Coverge of Radio Transmissions into and within Buildings at 900, 1800 and 2300 MHz", IEEE Personal Communications, April 1998.
- J. M. Durante, "Building penetration loss at 900 MHz," in IEEE Veh.Technol. Conf. Proc., 1973, pp. 1–7.
- R. Hoppe, G. Wolfle, F. M. Landstorfer, "Measurement of building penetration loss and propagation models for radio transmission into buildings", VTC 1999 - Fall. IEEE VTS 50th Volume 4, Date: 1999, Pages: 2298 - 2302 vol.4

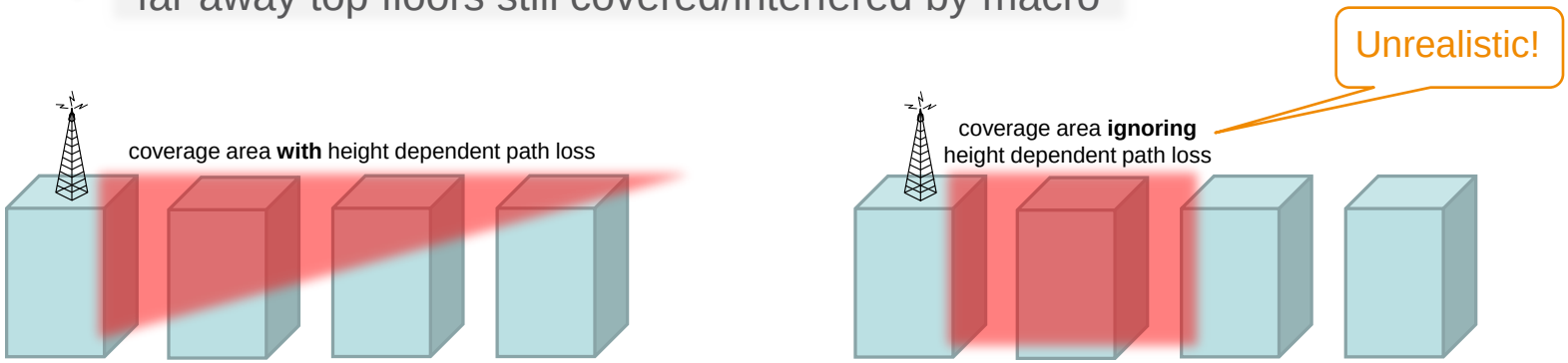
UE height has large impact on NLOS path loss!

UE HEIGHT IMPACT

CELL SHAPES AND INTERFERENCE LEVELS

- Above rooftop eNodeB (macro)
  - Lower NLOS path-loss and higher LOS probability for higher floors

stronger received signal for higher floors
far away top floors still covered/interfered by macro



- Below rooftop eNodeB (micro)
  - Above rooftop propagation route is height dependent similar to macro case
  - Above rooftop dominates over around building propagation when UE height is large

important for interference modeling

UE height must affect NLOS path-loss and LOS/NLOS model or else cell shapes and interference levels become seriously wrong!

PROPOSAL

- 3D-channel model shall at least introduce
  - UE height dependent LOS/NLOS state
  - UE height dependent NLOS path-loss
  - UE height dependent elevation angles of departure

ERICSSON