Aalto University
School of Electrical
Engineering

Advances in Site-Specific Radio Propagation Studies

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ISART 2018 panel "Driving Forward: Advances in Propagation Modeling"

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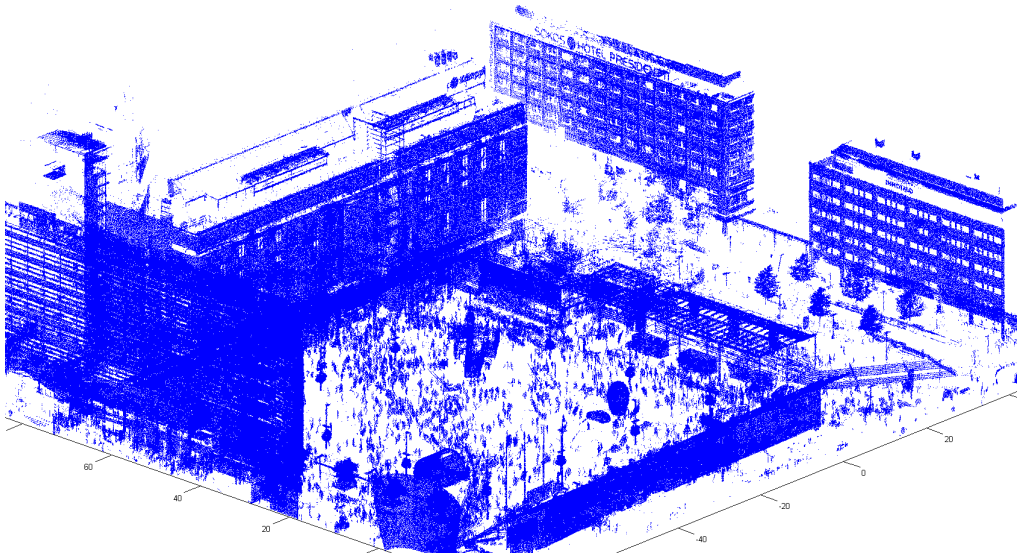
Points of Interest

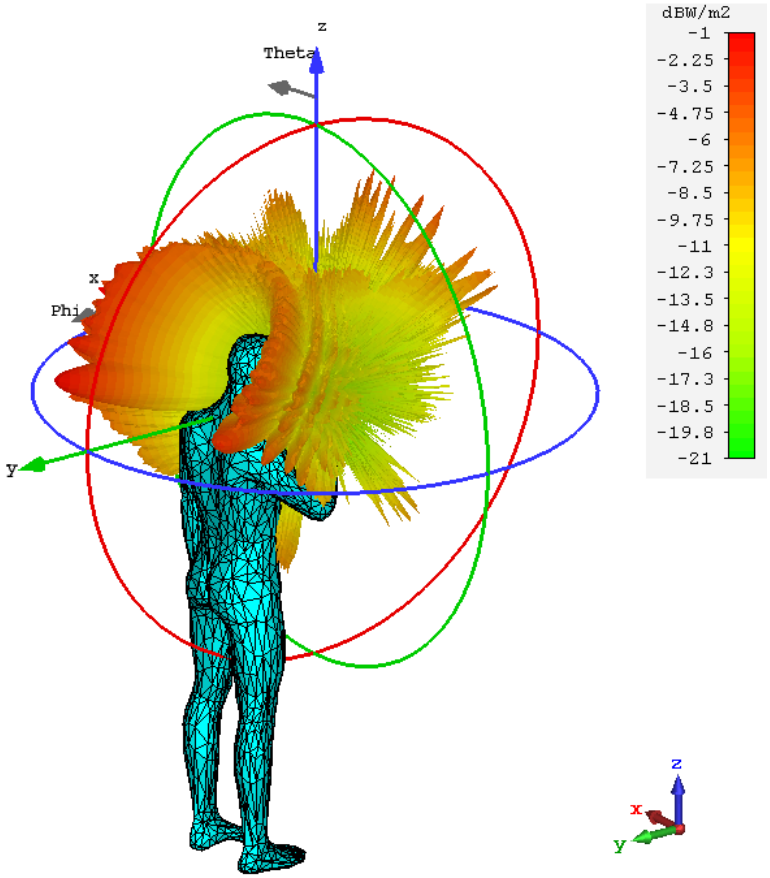
1. Point cloud for site-specific propagation simulations

Tiny things can make difference!



2. Antenna-human-channel interaction

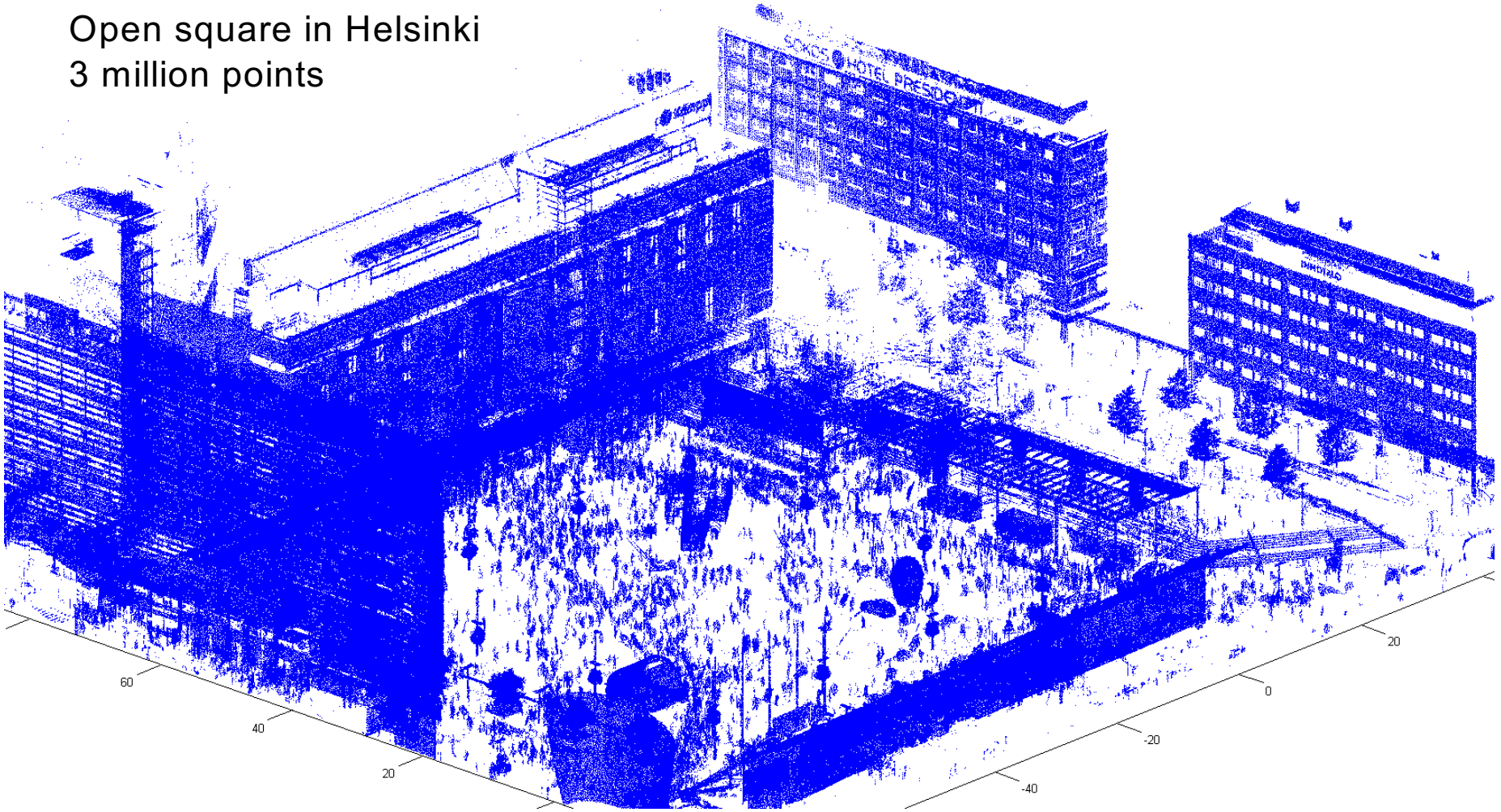
The interaction can diminish coverage!



Point Cloud for Site-Specific Propagation Simulations

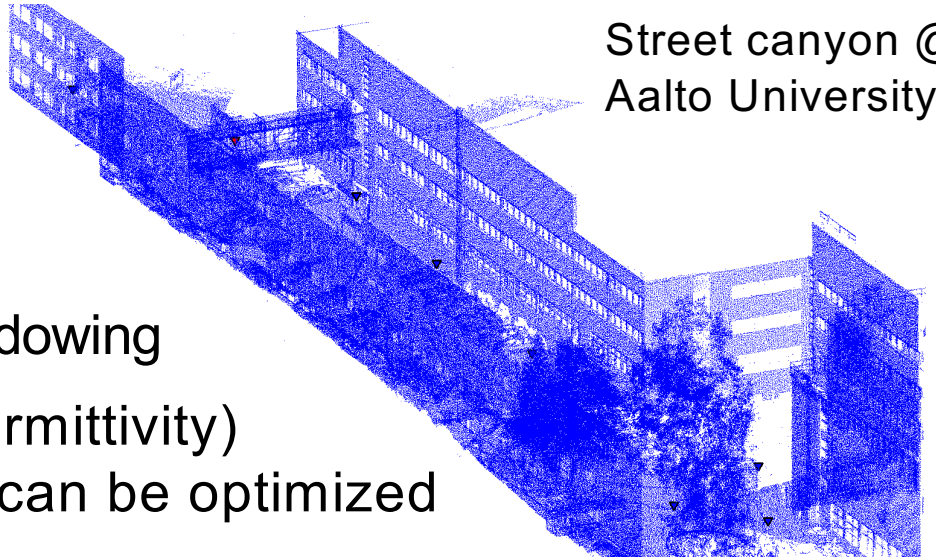
High Frequency Channel Simulations Using Optical Measurements of the Environment

Open square in Helsinki
3 million points



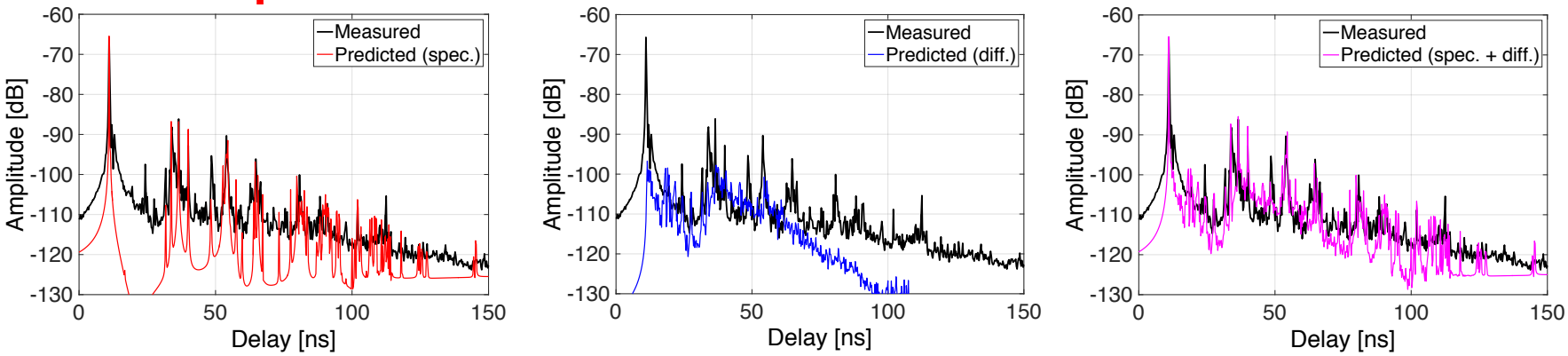
High Frequency Channel Simulations

- Points in the point cloud produce
  - Specular reflections
  - Diffuse scattering
  - Attenuation loss due to shadowing
- Material parameters (e.g. permittivity) taken from ITU-R P.2040 or can be optimized as variables



Street canyon @ Aalto University

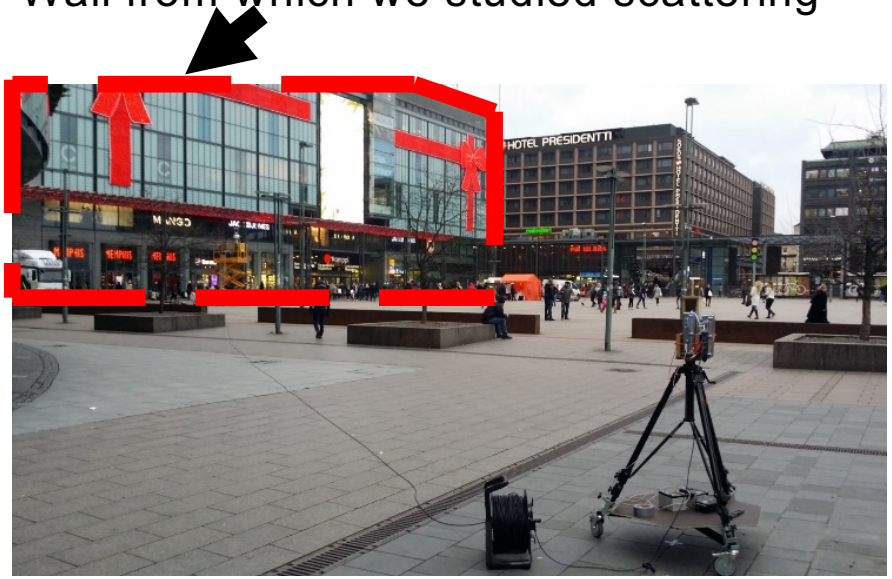
Specular + **Diffuse** = **Overall channel**



What We Know

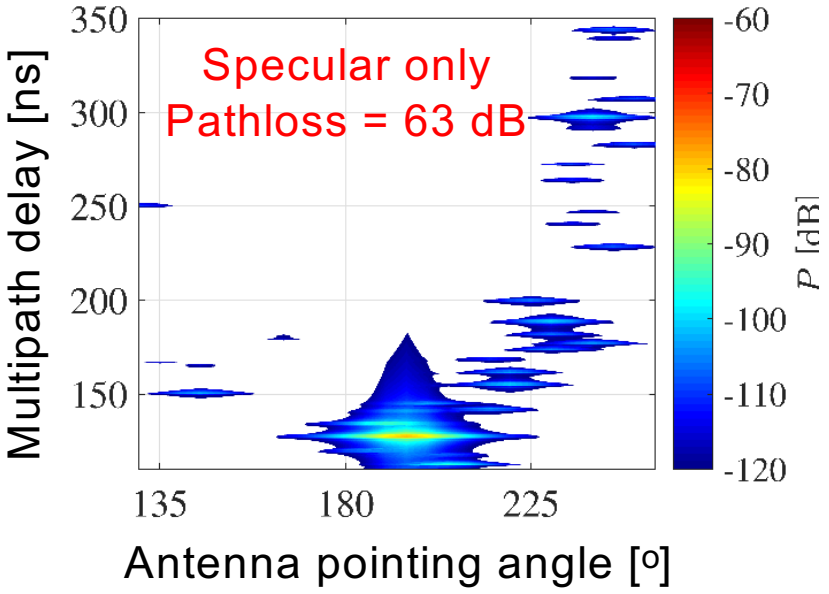
- Wave scattering is as strong at millimeter-wave as legacy cellular frequencies, i.e., below-6GHz

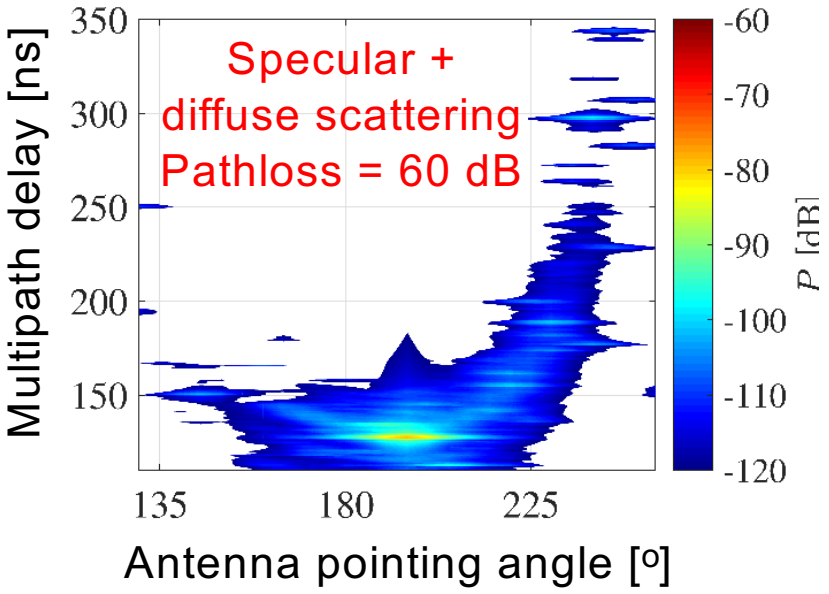
Wall from which we studied scattering



Koivumäki et al., PIMRC ’18.

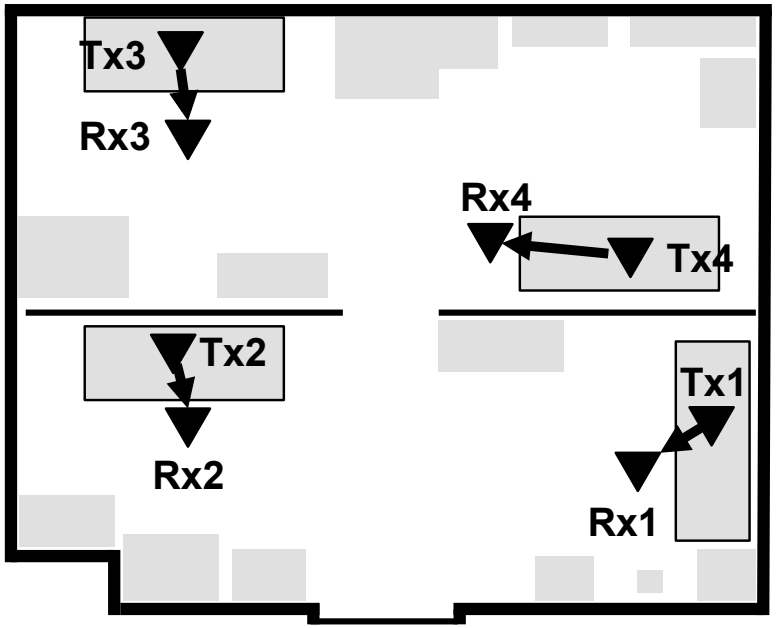
Study at 28 GHz

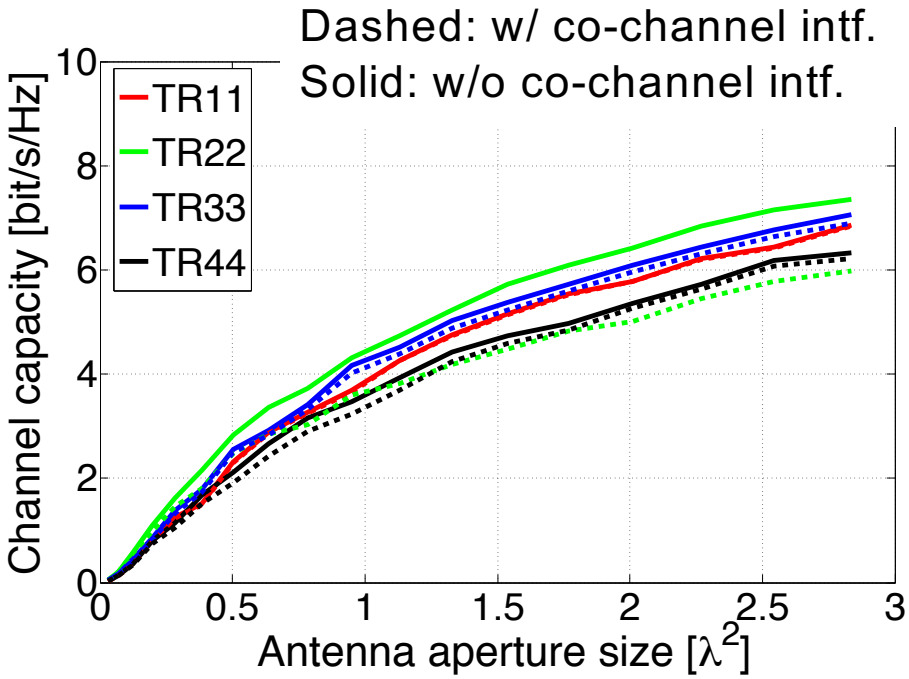




What We Do Not Know Properly

- Implication of scattering on small-cell link performance
  - Example: four co-channel links operating in a small room



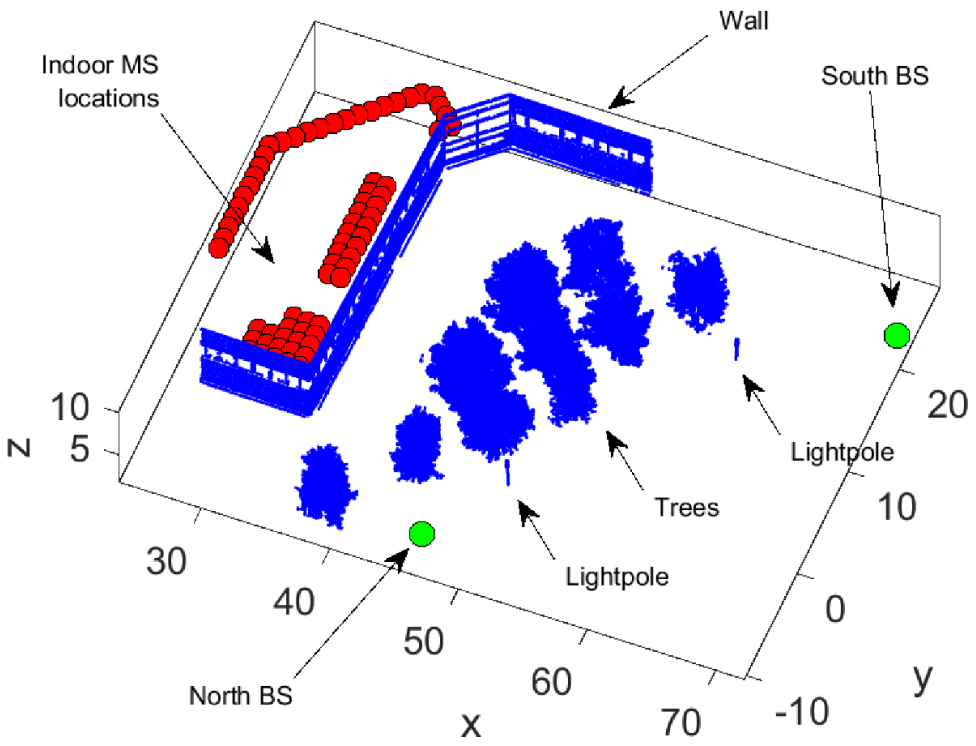


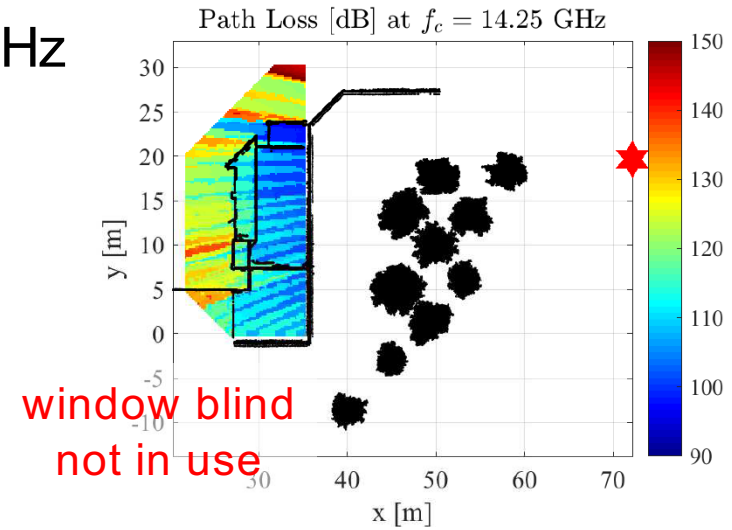
Haneda *et al.*, VTC-Spring 2015.

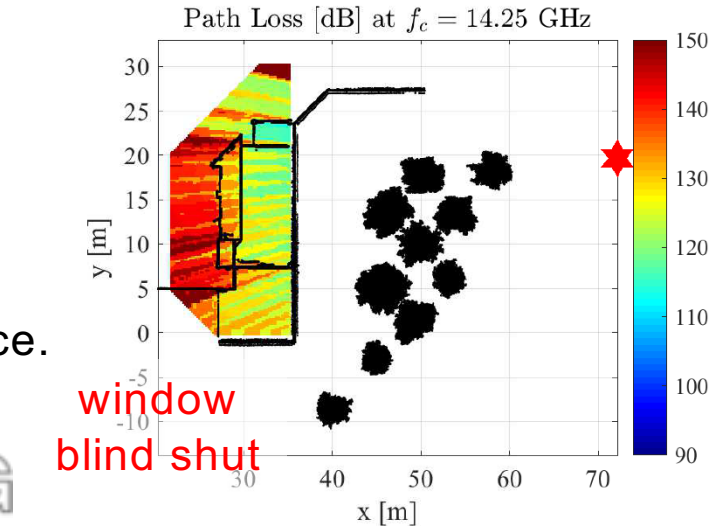
What We Do Not Know Adequately

- Feasibility of indoor coverage by outdoor base stations

Example: Measurement-based study at 14 GHz







Details are presented in my poster of this conference.

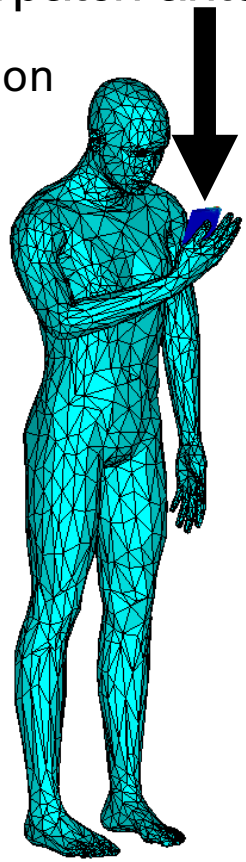
Antenna-Human-Channel Interaction

Antenna-Human Interaction

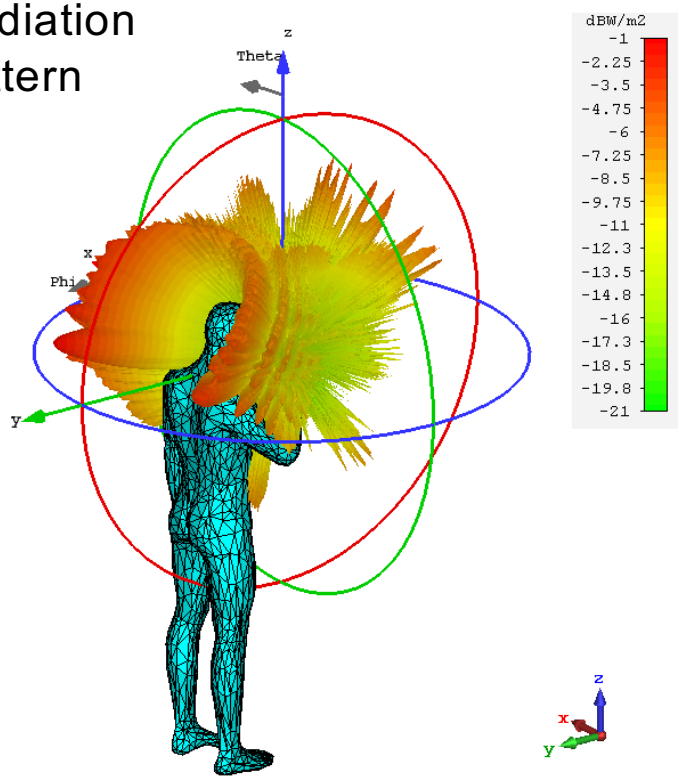
- Also more noticeable *self-body blockage* effects

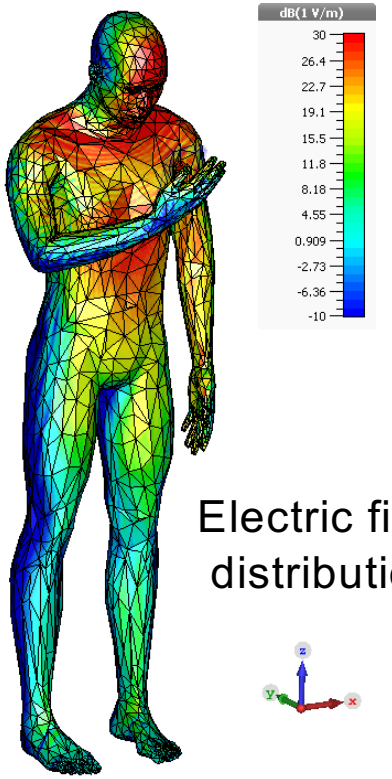
A patch antenna on a mobile phone-sized ground plane

Simulation model



Radiation pattern



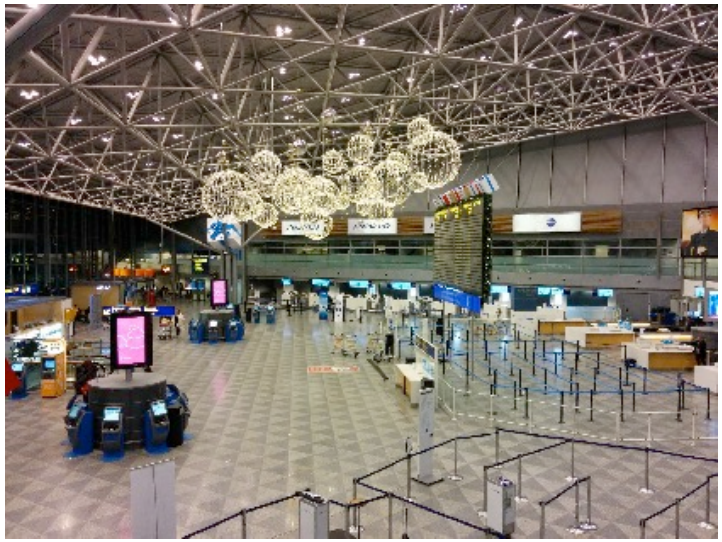


Electric field distribution

Simulations at 28 GHz

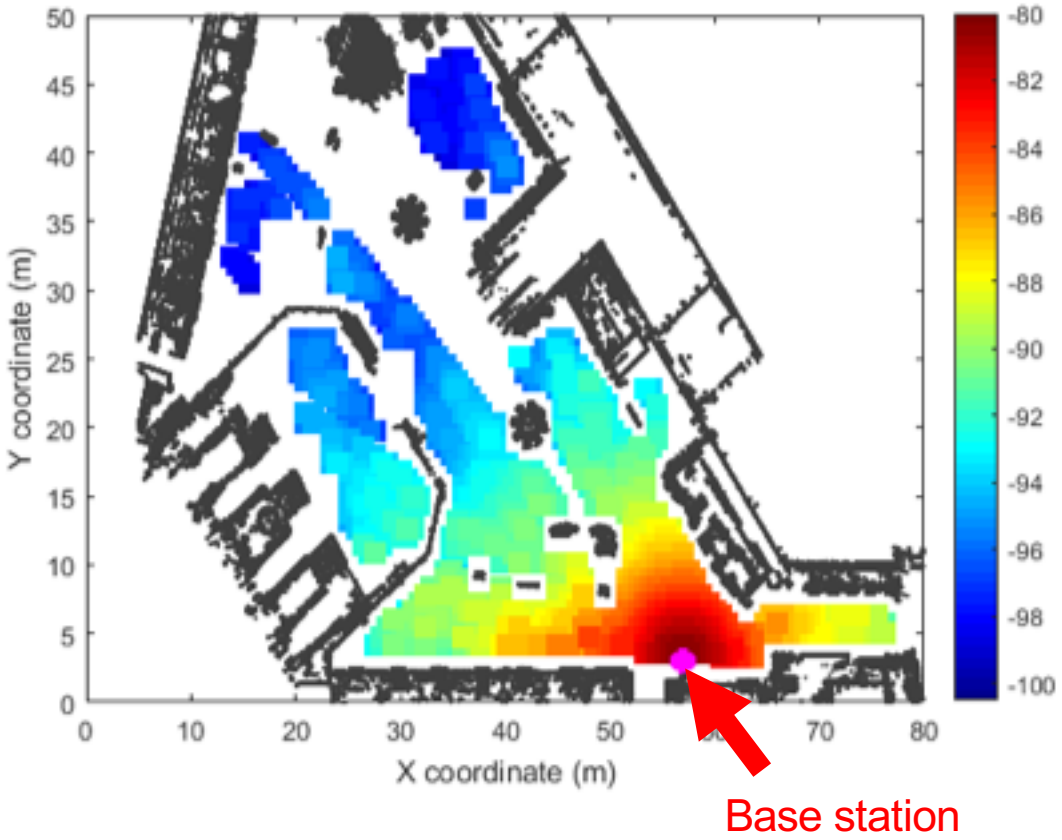
Small-Cell Coverage Analysis

- Example: Helsinki airport check-in hall (terminal 2)



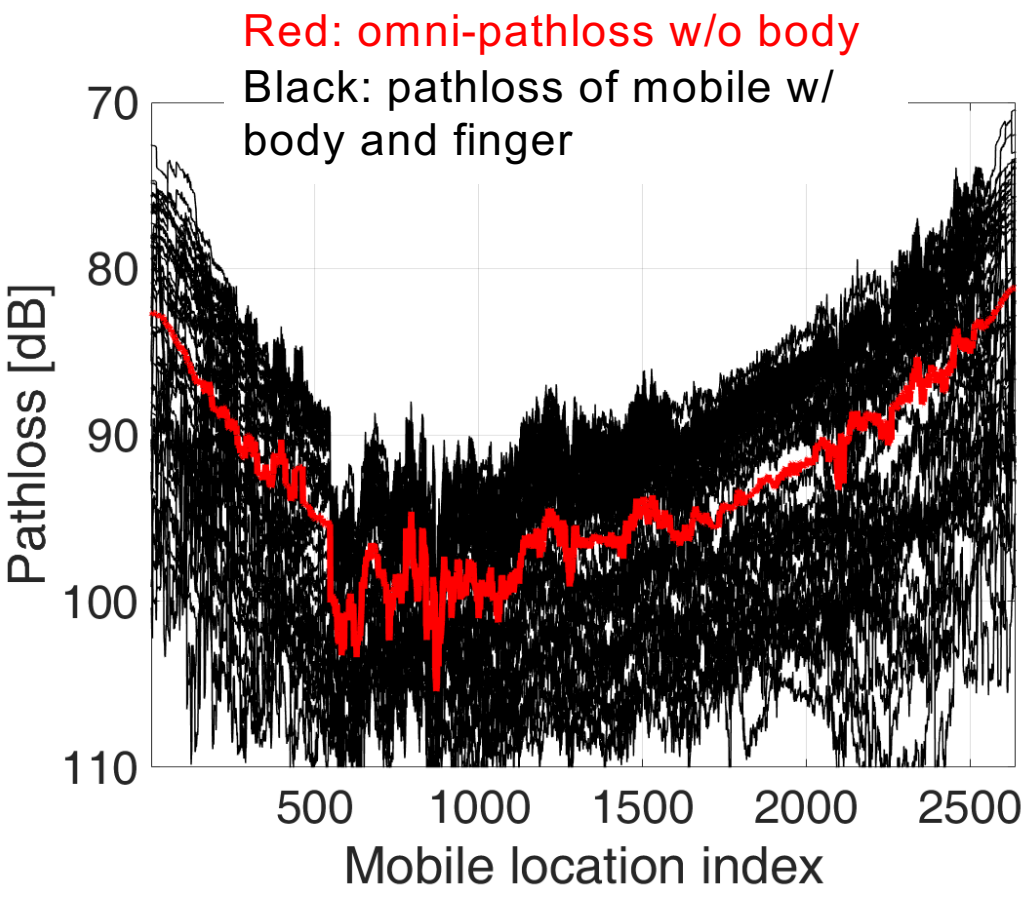
J. Jarvelainen et al., IEEE TAP, 2016 and J. Vehmas et al., VTC Fall2016.

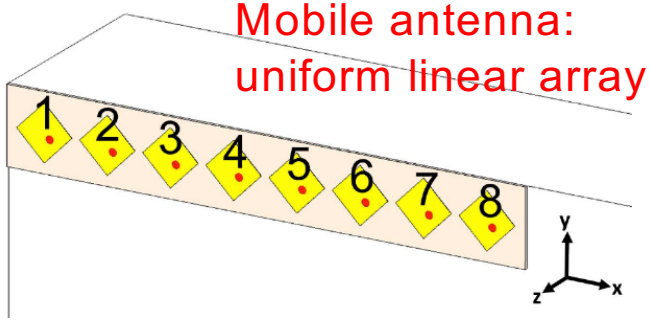
Coverage map with *idealistic* omni-directional mobile antennas at 60 GHz

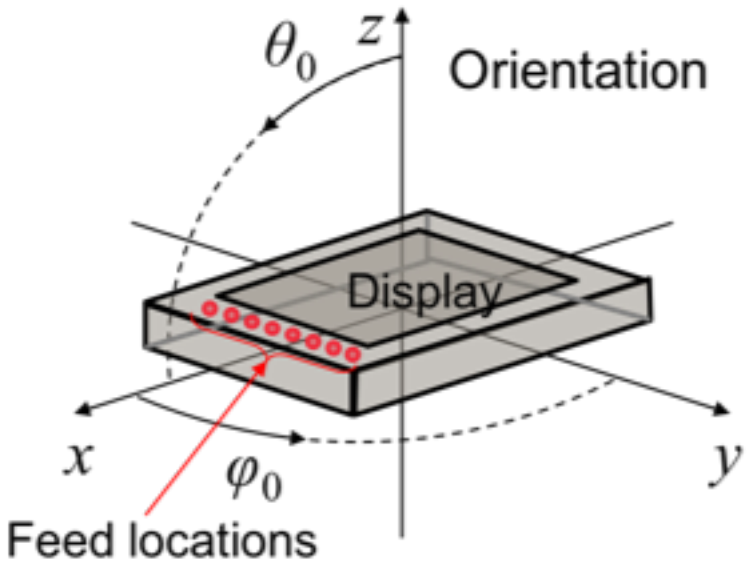


What We Do Not Know Adequately

- Cellular coverage under intervention of mobile users







φ_0 = 0, 45, …, 315 deg

θ_0 = 0, 45, 90 deg

Haneda et al., VTC Spring 2018.

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Thank You!

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