Advances in Site-Specific Radio Propagation Studies

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Points of Interest

1. Point cloud for site-specific propagation simulations

2. Antenna-human-channel interaction

Tiny things can make difference! 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

![Specular + Diffuse = Overall channel](image)
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

Specular only
Pathloss = 63 dB

Specular + diffuse scattering
Pathloss = 60 dB
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 Interaction

- Also more noticeable *self-body blockage* effects

A patch antenna on a mobile phone-sized ground plane

Simulations at 28 GHz
Small-Cell Coverage Analysis

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

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

J. Jarvelainen et al., IEEE TAP, 2016 and J. Vehmas et al., VTC Fall2016.
What We Do Not Know Adequately

- Cellular coverage under intervention of mobile users

Red: omni-pathloss w/o body
Black: pathloss of mobile w/ body and finger

Haneda et al., VTC Spring 2018.
Thank You!

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