Modelling Inter-Floor Radio-Wave Propagation in Office Buildings

A. C. M. Austin*, M. J. Neve and G. B. Rowe

Department of Electrical and Computer Engineering
The University of Auckland, Auckland, New Zealand

Motivations

- Performance and capacity of wireless systems limited by interference
- Interfering power levels are heavily influenced by the environment
- Propagation in indoor environments is not well understood
- Coverage/interference prediction tools are required

Identifying the Mechanisms

- A 2D implementation of the Finite-Difference Time-Domain algorithm is used to determine the mechanisms governing inter-floor propagation
- A vertical slice through the problem is analysed at 1.0GHz for TM polarization
- The concrete floors are modelled as dielectric slabs:
  - \( \varepsilon_r = 6.0 \)
  - \( \sigma = 50 \text{ mS/m} \)
  - Floor thickness: 0.30 m
  - Floor-ceiling separation: 2.70 m
- External building features, e.g. windows and hanging panels have also been modelled

Results – 1.0 GHz TM\(_z\) Polarization

- The received power is averaged across small sectors to remove multipath fading

Visualization

- The steady-state electric field phase at 1.0GHz is extracted with a Fourier transform

Effects of Nearby Buildings

- Nearby buildings can reflect significant levels of power back onto lower floors
- The increase is up to 22 dB over the case where no nearby building is present

Mechanistic Model

- Results suggest external reflection offers a low loss propagation mechanism
- Diffraction dominates the total power after 5-6 floor penetrations
- This finding agrees well with previously unexplained experimental results

Conclusions

- Direct penetration through the floors dominates the total received power for less than five floor penetrations
- The dominant mechanism changes to diffraction after six floor penetrations
- Results suggest a simple two-component model will be appropriate to predict area coverage
- Nearby buildings must also be considered, as preliminary results show the received power can be increased by 22 dB