Propagation of signals from indoor small cells and optimization of cell positions

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Who are we?

PhD Student

H. Wragg
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Supervisors

Primary Supervisor:
C. Budd
Professor of Applied Mathematics at the University of Bath and Professor of Mathematics at the Royal Institution of Great Britain.

Secondary Supervisor:
R. Watson
Senior Lecturer in the Dept of Electronic and Electrical Engineering at the University of Bath.

Industrial Supervisors

K. Briggs
A research mathematician, for BT TSO at Adastral Park.

M. Fitch
A research engineer for BT TSO at Adastral Park.

The Project

AIM

- **Create an accurate model and reduce the time it takes to simulate indoor-to-indoor WiFi propagation in a domestic environment.**
- **Use the model to optimize the location low powered base stations.**

Proposed method

- Use intelligent algorithms and adaptive mesh techniques to decrease execution time.
- Compare simulation results to PDE models and to measured results from BT.
- Develop a stochastic model for the environment.
- Optimize the location of the transmitter using the developed model.

High frequency

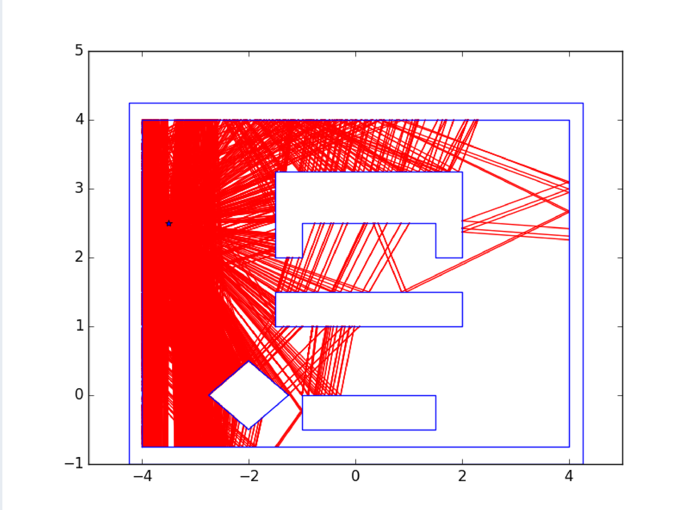


Figure : The rays propagating from the transmitter.

- Since the waves we are looking at are at a high frequency (typically of the order of 3GHz, but sometimes going higher) we can model them using ray-tracing.
- This is very computationally costly to run and requires lots of input information.

- The signal strength can be calculated along the trajectory of the ray.
- This takes into account the loss from the distance travelled, and from the interactions with the furniture.

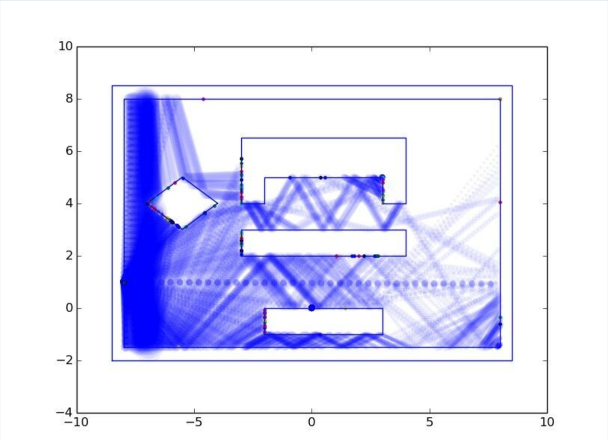
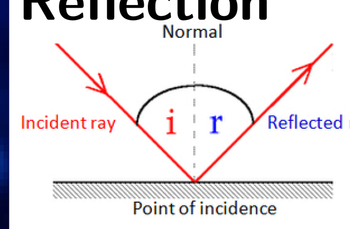


Figure : The signal strength along the ray trajectories.

Collisions

Colliding with an object causes a loss in the signal power.

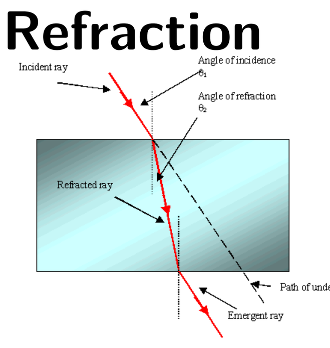
Reflection



[1]

After colliding with an object at some angle of incidence i, a ray is then reflected at an angle of reflection r.

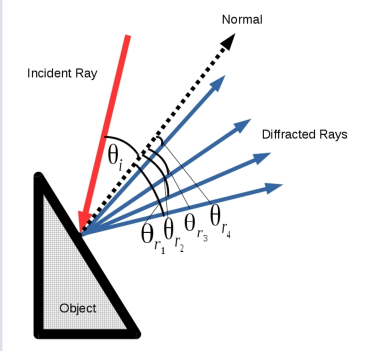
Refraction



[2]

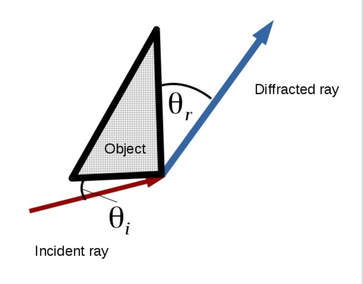
When a ray travels through an object, it is refracted slightly towards the normal.

Scattering



When colliding with a rough surface, a ray can scatter. This can be unpredictable, and can be computationally costly to simulate. [3]

Diffraction



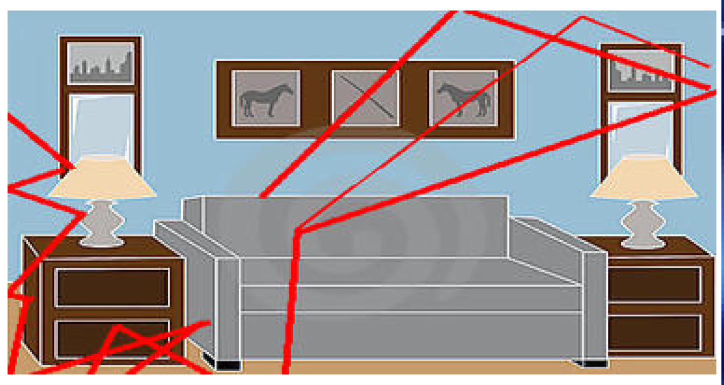
Collision with the corner of an object, causes the ray to diffract which is also difficult to predict.

Where?

Adastral Park

Adastral Park is home to the research labs for BT.

Domestic environment



- A domestic environment is very cluttered, which reduces the number of line-of-sight paths.
- Each collision results in the wave having a combination of reflections, diffractions, and refractions.

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