[1] F. A. Agelet, F. P. Fontan, and A. Formella. Indoor and outdoor channel simulator based on ray tracing. In *IEEE Vehicular Technology Conference*, May 1997. [bib | .html]

> An efficient algorithm that dynamically calculates all possible ray paths in outdoor (macro- and micro-cells and land mobile satellite, LMS) and indoor environments is presented in this paper. The algorithm is based on the sweep line technique. Additionally a quadtree (bounding box [2]) division of the study environment is used to reduce search time. For indoor and microcellular environments wall reflections and transmissions as well as diffractions on vertical edges are considered up to the order specified by the user. 2D ray-path search algorithms have been extended to 3D in order to model macrocellular and land mobile satellite environments. For such cases, apart from multiple refelctions, transmissions and vertical diffractions, the propagation simulator also takes into account single diffractions on horizontal edges and corners directly visible both from the transmitter and the receiver. Combinations of propagation mechanisms (RRR, RDR, DTR, ...) have also been considered in the simulator.

[2] G. Athanasiadou, A. Nix, and J. McGeehan. A ray tracing algorithm for microcellular and indoor propagation modelling. In *IEE Conference on Antennas and Propagation*, number 407, pages 231-235, Apr. 1995. [bib]

[3] K. Cheung, J. Sau, and R. Murch. A new empirical model for indoor propagation prediction. *IEEE Transactions on Vehicular Technology*, 47(3):996-1001, Aug. 1998. [bib | .html]

> n this paper a new empirical model for indoor propagation prediction is presented. The inspiration for our model is to enhance existing empirical models for indoor propagation prediction by incorporating additional phenomena suggested by electromagnetic techniques such as the Uniform Theory of Diffraction but still retain the straightforwardness of the empirical approach. The advantage is that computation time for indoor propagation prediction is low without greatly compromising prediction accuracy. Comparisons of our predicted results to measurements indicate that improvements in accuracy over conventional empirical models are achieved.

[4] S. Fortune. Algorithms for prediction of indoor radio propagation. Internal report, Bell Atlantic a subsidiary of Lucent Technologies, Jan. 1998. [bib | .html]

> The design of indoor wireless communication networks requires prediction of radio propagation inside a building. Radio propagation inside a building is complex, because each building wall can act both as an obstruction, attenuating a propagation path, and as a mirror, providing an additional reflecting path. We describe two algorithms that simulate radio propagation, a ray tracing algorithm that uses a discrete sample of propagation directions and a beam tracing algorithm that enumerates reflection cones defined by building walls. The two algorithms are compared experimentally and analytically. With a triangulation-based spatial data structure, both algorithms are fast enough to provide propagation simulations in a few minutes of computing time, even for large buildings.

[5] J. Keenan and A. Motley. Radio coverage in buildings. *British Telecom Technology Journal*, 8(1):19-24, Jan. 1990. [bib | http]

[6] M. Nidd, S. Mann, and J. Black. Using ray tracing for site-specific indoor radio signal strength analysis. In *IEEE Vehicular Technology Conference*, pages 795-799, May 1997. [bib | .html]

> A variation of cone-tracing is used to predict the signal strength in wireless networks. Differences between light and radio waves necessitate certain changes to the basic ray/cone tracing algorithm, as does the information required of the solution. The new algorithm is compared to a previous algorithm for signal strength prediction, and verified on some examples.

[7] S. Y. Seidel and T. S. Rapport. 914 MHz path loss prediction model for indoor wireless communications in multifloored buildings. *IEEE Transactions on Antennas and Propagation*, 40(2):207-217, Feb. 1992. [bib | http]

[8] G. Wölfle, P. Wertz, and F. Landstorfer. Performance, accuracy and generalization capability of indoor propagation models in different types of buildings. In *10th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*, Sept. 1999. [bib | .html]

In the last years different prediction models for indoor environments were developed for the frequency range between 500 MHz and 5 GHz. Each of these models has its own advantages and disadvantages.

In this paper four of the most popular models are com-pared to one another and to measurements in different buildings. The comparison is limited to the prediction of the received power because two models are only able to pre-dict the power. Two models are also able to predict the de-lay spread and one model is additionally able to predict the standard deviation of the instantaneous field strength (fast fading) related to the median field strength. For this last model a comparison of the results for the delay spread and the fast fading is also presented in this paper.

Three different buildings were used for the comparison of the models. A new office building with concrete walls at the University of Stuttgart (Germany), an old office build-ing with brick walls in Vienna (Austria) and the villa of Marconi, which is a very old building (brick and wood) in Bologna (Italy).
