URSI/Remote Sensing Club of Finland/IEEE
XXIII National Convention on Radio Science and Remote Sensing Symposium

MODELING OF WIDE-BAND PROPAGATION IN OUT-OF-SIGHT REGIONS OF URBAN MICRO-CELLULAR ENVIRONMENTS

Wei Zhang, Hassan El-Sallabi, Kimmo Kalliola, Pauli Aikio, and Pertti Vainikainen
Helsinki University of Technology, Institute of Radio Communications, Radio Laboratory
P. O. Box 3000, FIN-02015 HUT, Finland
E-Mail: WZH@radio.hut.fi

Abstract –The summary reports wide-band propagation modeling in the shadow, i.e., out-of-sight, regions of urban micro-cellular environments and comparisons of model predictions with measurements. The results show it feasible to use two-dimensional ray methods in the horizontal plane for propagation predictions in side and parallel street environments. It is important to select proper rays whose relative phases and amplitudes are on the orders considered.

The new work has a two-fold purpose: 1) to model wide-band propagation in urban micro-cellular environments and 2) to verify fast two-dimensional ray methods used which do not require a building height database [1], since the design and development of future broadband communication systems require efficient propagation prediction tools. The techniques of wide-band measurements and modeling can also provide better understanding of mobile radio propagation and check the validity of ray methods that are important tools for the propagation predictions. The wide-band modeling method [2] used here needs the narrow-band channel transfer function as an important input element, that can be derived by using the ray techniques.

As reported in [3] and seen in Fig. 1, wide-band propagation measurements were performed for the receiver in side streets referring to transmitter locations T_{XA} and T_X, as well as in a parallel street referring to the transmitter location T_{XB}. Predictions for this propagation environment are made in every aspect [2]. Comparisons of wide-band model predictions with measurements are made in both time and frequency domain. Both measurements and predictions account for the directions of arrival (DOA), since the DOA knowledge is instructive for the potential use of adaptive antennas at the base station.

For the receiver antennas aiming at both street junction B and point A, some results for transmitter location T_{XB} are presented in Fig. 2. The results demonstrate the significant difference of the directions of arrival. In the directions towards the irregular street junction B, apparently the received power arrives in a wider angle range. In addition to the short path $T_{XB} \rightarrow T_X \rightarrow R_X$, a long propagation path $T_{XB} \rightarrow T_{XA} \rightarrow A \rightarrow R_X$ is evidenced for the receiver antennas aiming at point A. The ray-trace techniques existing in the technical literature appear unable to reduce up to 20-dB difference between measurements and predictions for such a parallel street propagation environment. An equivalent source technique [1] is introduced and used here. It makes the parallel street propagation predictable by using a simple yet accurate method which has been successful for side-street environments.

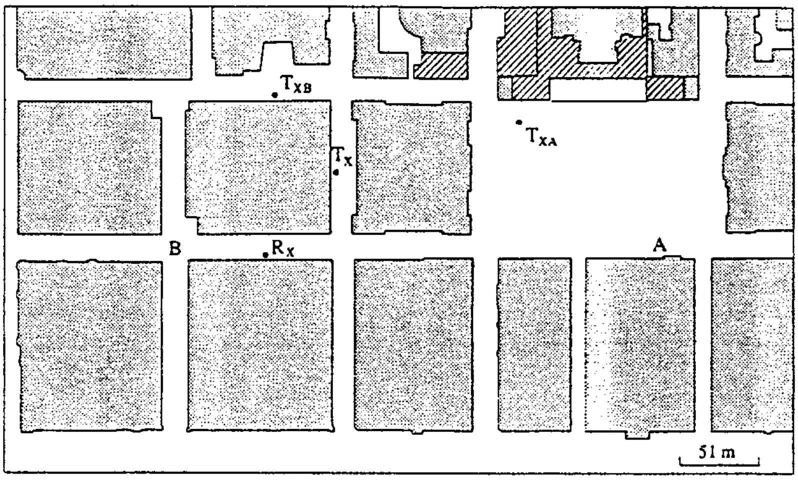

Fig. 1. Top view of an urban area of Helsinki city center, showing mobile-transmitter locations T_{XA}, T_{XB}, and T_X, as well as base station receiver location R_X.

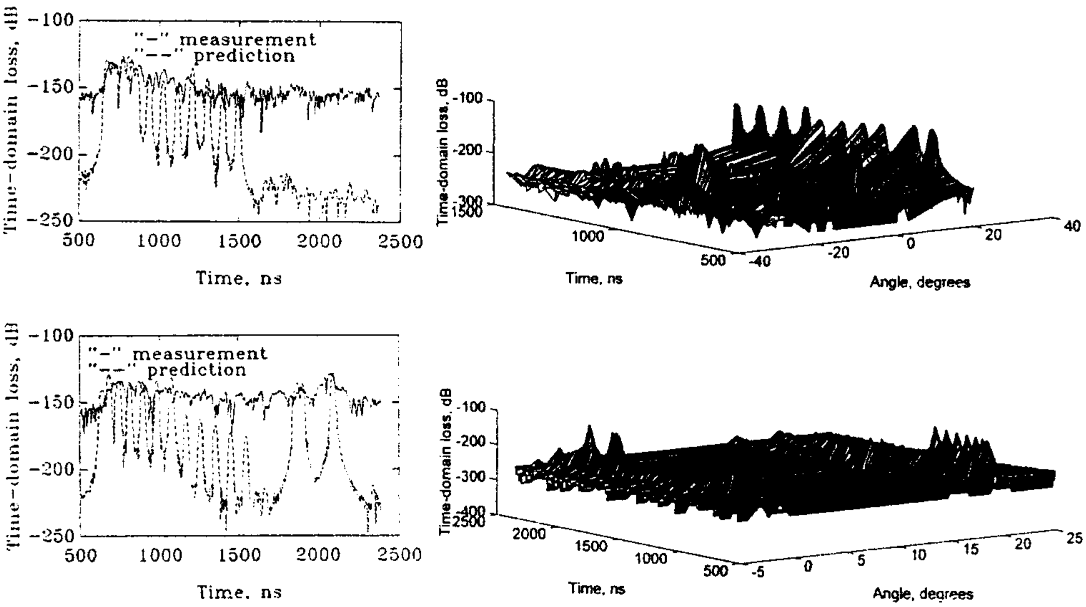

Fig. 2. Time-domain measurement and predictions accounting for the directions of arrival: up part for the receiver antennas aiming at street junction B and down part for the receiver antennas aiming at point A, taking positive angle anti-clockwise off the receiver antenna pointing direction.

REFERENCES

[1] W. Zhang, J. Lähteenmäki, P. Vainikainen, and H. El-Sallabi, "Fast two-dimensional diffraction modelling for mobile radio propagation prediction in urban micro-cellular environments," to be presented and included in *Proc. 28th European Microwave Conf.*, Amsterdam, The Netherlands, Oct. 1998.

[2] W. Zhang, "A wide-band propagation model based on UTD for cellular mobile radio communications, " *IEEE Trans. Antennas Propagat.*, vol. 45, pp. 1669-1678, Nov. 1997.

[3] K. Kalliola and P. Vainikainen, "Characterization system for radio channel of adaptive array antennas, " in *Proc. 8th IEEE International Symposium PIMRC'97,* Helsinki, Finland, Sept. 1997, pp. 95-99.