WIDEBAND PROPAGATION MODELING FOR AN OUT-OF-SIGHT MICROCELLULAR ENVIRONMENT OF BASESTATION ARRAY ANTENNAS

Hassan M. EL-Sallabi [1], Wei Zhang[2], Kimmo Kalliola[3], and Pertti Vainikainen[4]
Radio Laboratory, Institute of Radio Communications (IRC)
Helsinki University of Technology
P. O. Box 3000, FIN-02015 HUT, Finland
Tel: +358 9 451 2255, Fax: +358 9 451 2152
E-mail: [1] hel@radio.hut.fi, [2] WZH@radio.hut.fi, [3] kka@radio.hut.fi, [4] pva@radio.hut.fi

Abstract

This paper presents two-dimensional channel modeling for wideband propagation in an urban microcellular environment and its experimental validations. Comparison between predictions and measurements shows it feasible to use two-dimensional methods in the horizontal plane for propagation predictions in shadow zones. The modeling extends existing expressions for a single antenna and makes them applicable for an antenna array at the basestation. The results provide better understanding of the propagation mechanism.

Introduction

This paper presents the two-dimensional (2-D) modeling based on reflection and uniform geometrical theory of diffraction (UTD) which are important tools for the predictions of mobile radio propagation [1-9]. With the recent rapid growth in demand for wireless communications, it is becoming increasingly important to develop new systems for capacity requirements. The use of adaptive array antennas at the basestation is considered as a promising technique for increasing capacity and enhancing quality. This use also leads to better understanding of the propagation mechanisms, in particular time delays and the angles of arrival which give more information of the spatial selectivity of radio channels [9],[10].

The purpose of this work is 1) to model wideband propagation in an urban out-of-sight microcellular environment of antenna arrays at the basestation and 2) to verify 2-D techniques which do not need a building height database can provide acceptable accuracy for microcellular mobile radio propagation prediction in out-of-sight regions.

Measurement Setup

The measurements were carried out in the city center of Helsinki, Finland. The measurement system consists of a wideband channels sounder of a single receiver and a radio frequency (RF) switch that separates received signals from eight receiving antennas. Figure 1 shows block diagram of the system [11]. The spacing between antennas is a half wavelength. The prototype antenna hardware was made in such a way that measurement can be carried out appropriately in every 60-degree sector. To obtain full 360^o azimuth coverage, the measurement can be performed in six 60^o sectors as shown in Fig. 2. In Fig. 2, Rx represents the basestation and Tx1 and Tx2 represent two mobile transmitter locations. The measured impulse responses from eight antennas are used to estimate parameters of wideband propagation. The transmitter and receiver antennas are nearly at the same height. The carrier frequency of the sounder is 2.154 GHz. The chip frequency is 53.85 MHz. Polarization is vertical.

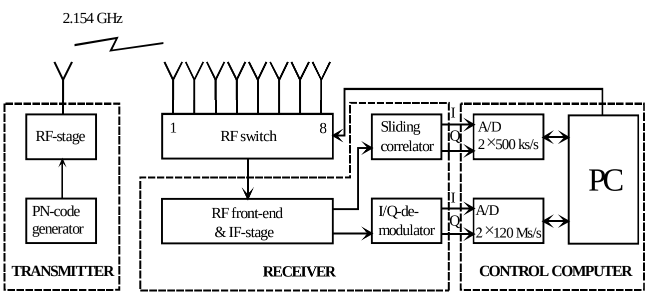

Fig. 1. Block diagram of the measurement system.

Directional Channel Transfer Function

A narrowband multi-antenna channel transfer function is derived. Let $\mathbf{H}(f,\varphi)$ be the channel transfer function, f be the frequency and φ be an azimuth angle. The inverse Fourier transform of $\mathbf{H}(f,\varphi)$ can give the time delay information. As a contribution, $\mathbf{H}(f,\varphi)$ is derived as

$$\mathbf{H}(f,\varphi) = \sum_{i=1}^{M} \mathbf{H}_i(f,\varphi_i) \qquad (1)$$

where M is the number of dominant propagation paths. This work uses M=17 for Tx1 and M=10 for Tx2 which appear adequate for model prediction for the environment shown in Fig. 2. This work selects the M rays used from the rays tested based on their compatibility with the