Polarization Diversity Measurements and Propagation Characteristics in Deep Indoor Environment

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The polarimetric characteristics of the radio channels such as penetration loss, delay spread and angular spread, strongly influence the performances of the link between an outdoor base station (BS) and a mobile (MS) moving inside a building, especially in the case of a MIMO link. Measurement results have been recently published in the literature and they present either attenuation in the range 800 MHz to 18 GHz (R. Ignacio et al., *Proc. of IEEE Vehicular Techno Conf.*, 14-17 Sept. 2014, pp. 1-5), or an analysis and modeling of the characteristics of diffuse scattering in indoor and outdoor radio propagation at 3.6 and 3.8 GHz (Y. Azar et al., *Proc. of Int. Conf. on Future Generation Techno.*, 13-15 Aug. 2014, pp. 50-54). The objective of our work is to get a better insight on the changes of the channel properties when MS moves inside a building from a room situated in the Line of Sight (LOS) of the transmitter (Tx) to deep indoor (DI), i.e. in a room where there are at least 2 walls separation from the illuminated side of the building.

A measurement campaign was performed on the campus of the University of Lille (France) at a frequency around 1.3 GHz and within a 20 MHz band corresponding to existing wireless network bandwidths or which can be obtained by aggregating contiguous bandwidths. A 4-element virtual uniform linear array (ULA) and a 3x3 rectangular array (URA) were used as transmitting (Tx) and receiving (Rx) antenna respectively. Each Rx array element is a patch antenna whose orientation is successively changed with a 90° step, allowing to also virtually simulate an omnidirectional radiation pattern. These antennas were connected to a vectorial network analyzer (VNA) owing to optical fibers and RF/optical interfaces to avoid a strong attenuation in the connecting cables. Rx and Tx were put at the 1st floor of two buildings, B1 and B2, facing each other, as shown in Fig. 1. The various positions (black squares) of the Rx array are also indicated. The Tx array is in the Line of Sight (LOS) of the front side of B1. However, one position of the Rx array, noted "Rx obstructed" in Fig. 1, deals with an OLOS (Obstructed LOS) configuration, the window of the room facing dense vegetation (trees). All antennas were horizontally (H) or vertically (V) polarized.

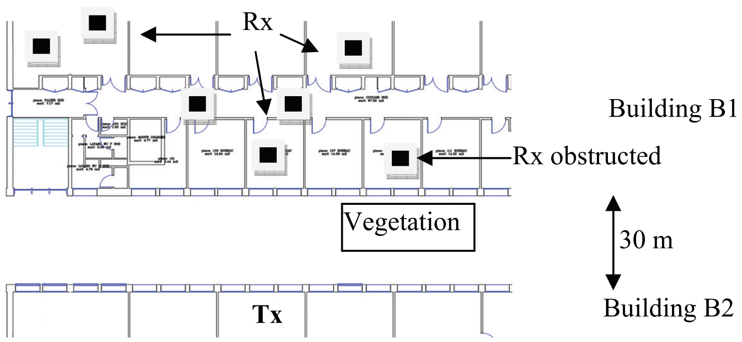

Figure 1. Geometrical configuration of the measurement campaign

The different paths of any propagation channel were obtained by applying a High Resolution Algorithm (HRA), as RiMax, on the measured data. The angular spread and delay spread for co- and cross polarization are then deduced from the estimated characteristics of these paths (or rays). As an example, the cross-polar discrimination factor (XPD) varies from 12 dB to -2 dB when Rx moves from LOS to DI configuration. Similarly, the rms angular spread of the direction of arrival (DoA) and direction of departure (DoD) of the rays increase from 10-20° to 50-60°. A statistical analysis has thus been performed on these multidimensional channel characteristics depending on the position of Rx inside the building.