Indoor Millimeter-Wave Channel Modeling at 45GHz Band by Ray Tracing Techniques

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Full 3D models of three typical indoor scenarios (Conference room, Living room, Cubicle office) are built with high fidelity to the real site. An Omni-isotropic transmitting antenna (Elevation Half Power Width (HPW) is 9.2 degree) is used in the ray tracing model. It is simulating the 45 GHz channel sounder measurement antenna (Elevation and azimuth HPW are 9.6 degree and 10.5 degree respectively) rotates 36 times (10 degree step).

The far field electric fields is computed with the Shooting and Bouncing Ray (SBR) method. The SBR method is first employed to trace ray paths through the two-dimensional building geometry without regard for the location of specific field points. Rays are first traced from the source points with the rays reflecting specularly from the building walls. The rays that hit building walls are reflected specularly and continue to be traced up to the maximum number of reflections, or when the rays hit the study area boundary. For most of semi-infinite lossy dielectric half space, assuming that the incident field is propagating in free space, the Fresnel formulas are used to calculate the reflection and refraction coefficients at the surface. The uniform Geometry Theory of Diffraction (GTD) is used to calculate the diffraction coefficients.

A high performance vector network analyzer and a well-designed and mentored low loss arch supporter are used to do in-situ measurements of the reflection coefficients of indoor construction and finishing materials. The dielectric constants and conductivities of materials are derived and used to describe the 3D model for ray tracing more accurately.

Same schemes for different receiver points as channel sounding measurements are set to compute Received Power, Path Loss, Time of Arrival (mean), Delay Spread, Power Delay Profile, Direction of Arrival (mean), Direction of Departure (mean), and Impulse Response by processing the electric field data from ray tracing. Large scale fading parameters or path loss parameters are studied with the results of reference path loss, attenuation rate and the variance of shadow fading. Then small scale fading properties are discussed. A few common distributions are used to check the power fading in a small area. At last, the inter cluster parameters are researched, including delay distribution and angular characteristics. There are good agreements between the channel models extracted from the deterministic ray tracing method and from channel sounding measurement data.