Geometry Based Stochastic Modelling of Millimeter Wave Channel

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Aims of project:

This project aims to develop a mathematical framework for characterizing the multipath components of a millimeter wave (MMW) point-to-point network in an urban area.

- To propose an explicit expression for modelling the power delay profile of the first order reflection components.

Introduction

- ❑ The tremendous growth of wireless services on hand-held devices have led to an insatiable demand for mobile data.
- ❑ MMW spectrum (30 GHz-300 GHz) is a potential solution to keep up with the ever-increasing data traffic growth.
- ❑ Dominant line-of-sight (LoS) component, fewer reflection paths and ignorable diffraction and scattering effects are the main properties of the MMW channel. (Differ from microwave band)
- ❑ An in-depth understanding of MMW propagation characteristics is vital for the design and operation of future wireless networks.
- ❑ Channel modelling for MMW is still an open work.

Channel Modeling Approaches

➢ Deterministic (Ray Tracing)

❑ produce precise predictions on radio wave propagation.

❑Needs substantial modeling effort and computational time when a huge network is considered.

➢Stochastic

❑based on a probability distribution function to model the channel behaviour.

❑ use a less number of channel parameters.

System Model

- ❑ Consider a communication link with a separation distance *D* between the transmitter and receiver.
- ❑ The communication link is surrounded by some buildings that are randomly distributed in the communication area.
- ❑ All buildings in the surrounding environment have the same shape (rectangle) and orientation but differ in size. (Fig.1)
- ❑ Only the first order specular reflections are considered.

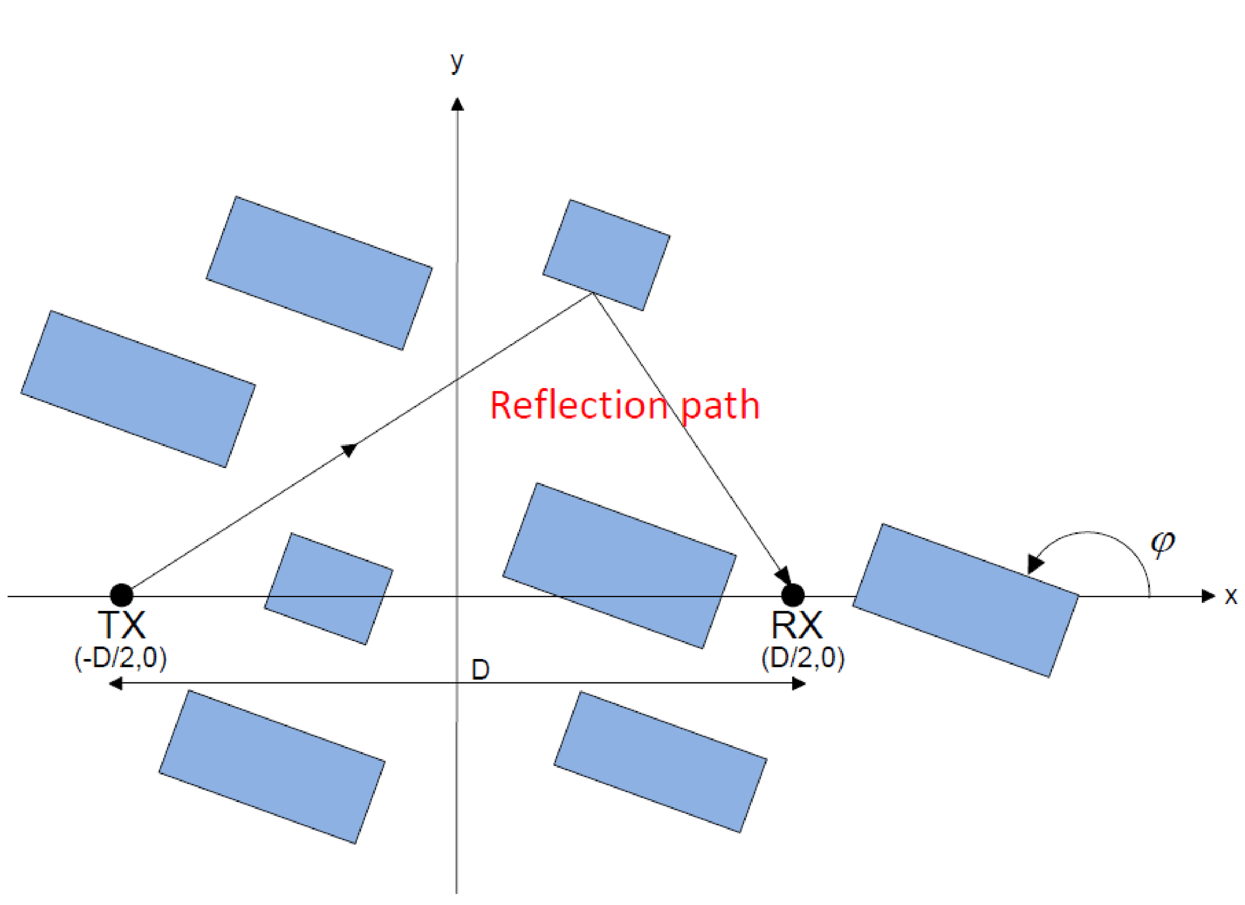

Fig.1: System Model.

Power Delay Profile

- ❑ For impenetrable scenario (signal totally blocked), some signal is absorbed and the remaining signal is either reflected, diffracted or scattered (refer as multipath).
- ❑ In multipath, the propagating signal is reflected from a number of objects in the physical environment.
- ❑ The multiple reflected copies of the transmitted signal arrive at the receiver after travelling over different paths with different time instants and different power levels (Fig.2).
- ❑ The characteristic of multipath component is described by Power Delay Profile.

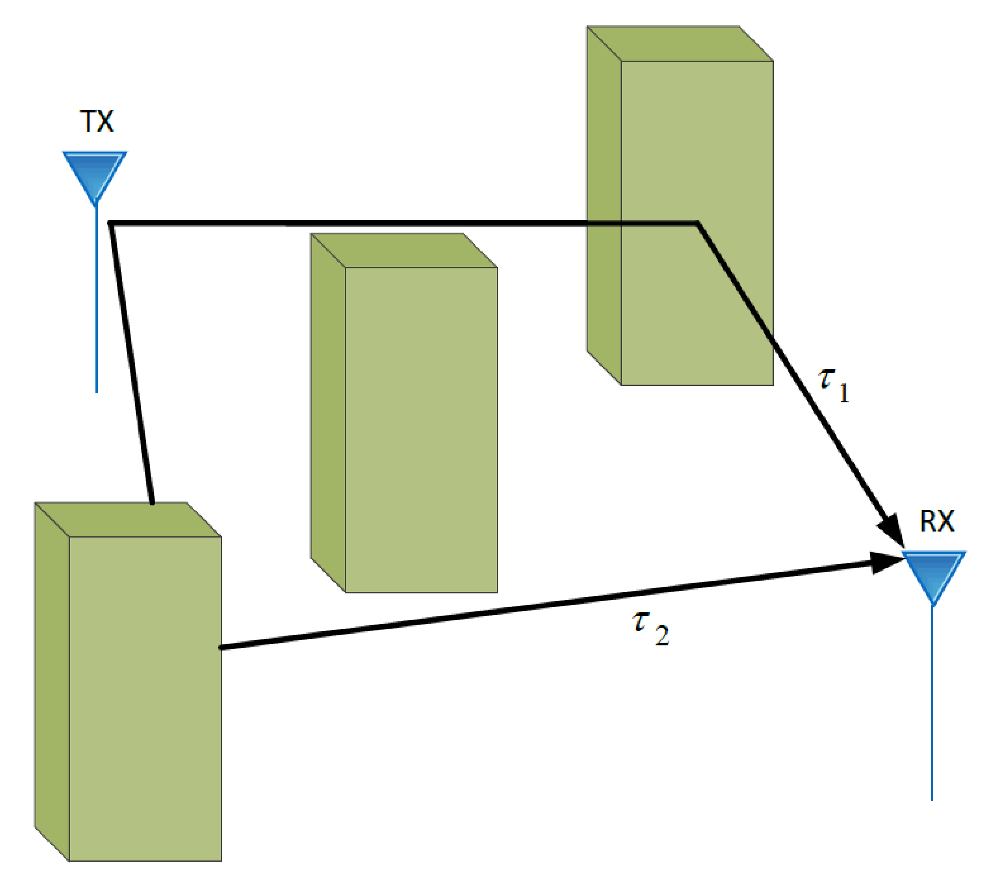

Fig.2: Multipath Propagation for impenetrable scenario.

Power Delay Profile
$$P(\tau) = \rho(\tau) f_{SR}(\tau)$$

Channel Power Decay
$$\rho(\tau) = \left(\frac{1}{4\pi f \tau}\right)^2 . \sigma$$

Density of Reflection
$$f_{SR}(\tau|\theta) = \int_0^{2\pi} f_{RF}(\tau|\theta) f_{NB}(\tau|\theta) d\theta$$

Proposed Model

- ❑ Ellipse Model (Fig.3) – To determine the possible location of reflecting point.
- ❑ Density of reflection components at a temporal delay.

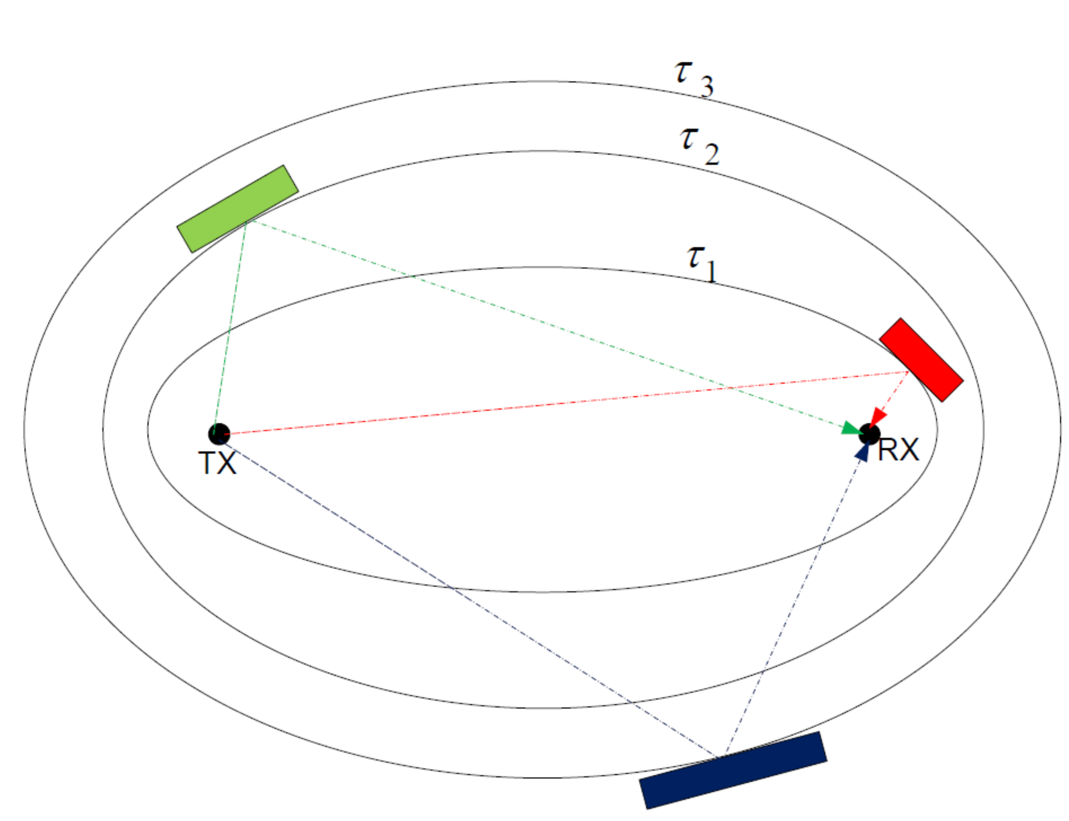

Fig.3: Ellipse Model.

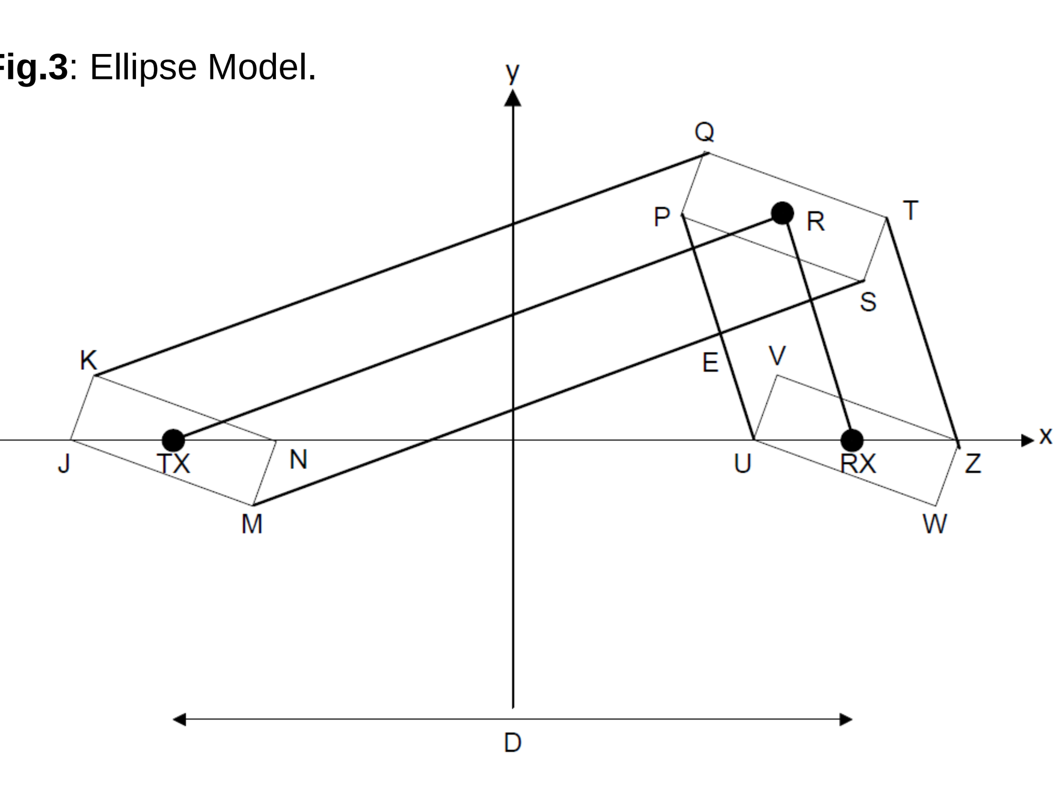

Fig.4: Non-blocking reflection component region.

Results

Parameter	Value
Distance, *D*	100 meters
Average Building Length, *L*	10 meters
Average Building Width, *W*	5 meters

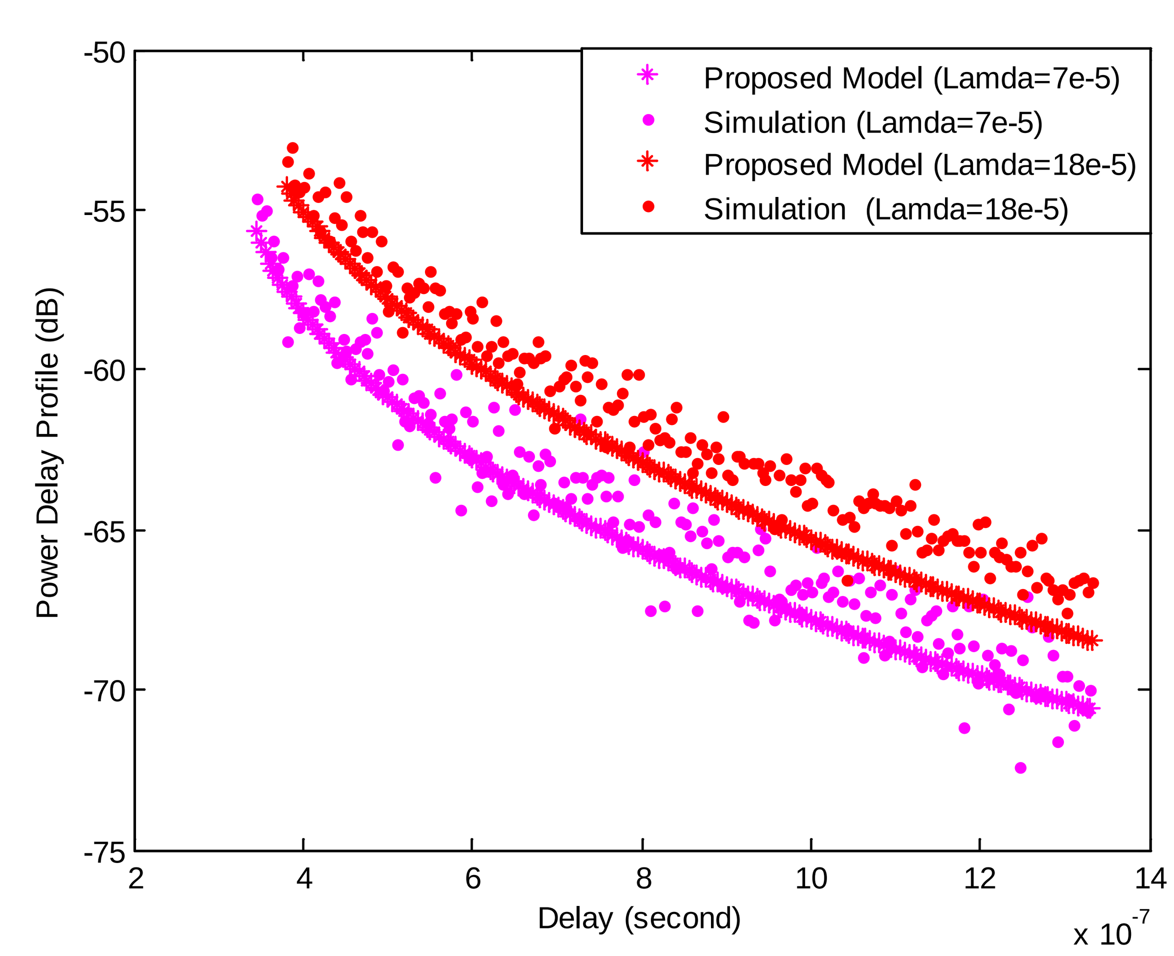

Fig.5: Power Delay Profile.

Parameter	Value
Distance, *D*	100 meters
Density of building	7×10^{-5}

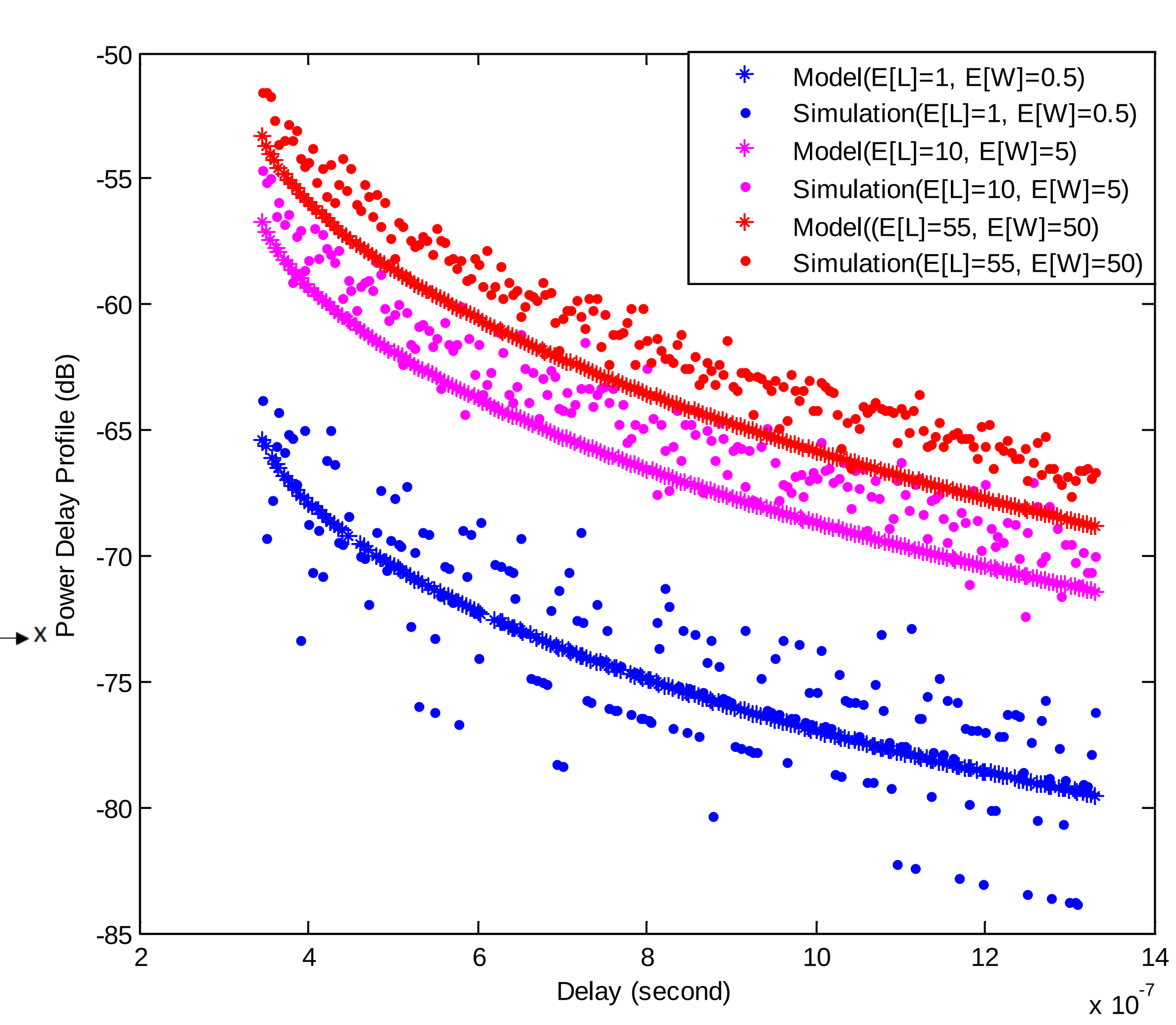

Fig.6: Comparison of density of reflection and size of building.