

Extracting channel information from ray tracing simulators

Admar Schoonen

Overview

Overview

- Why channel models?
- How to get channel models?
- Overview of channel models
- Channel models for received power
- Channel characteristics for Cafe Linsen
- Conclusions

Why channel models?

Channel characteristics:

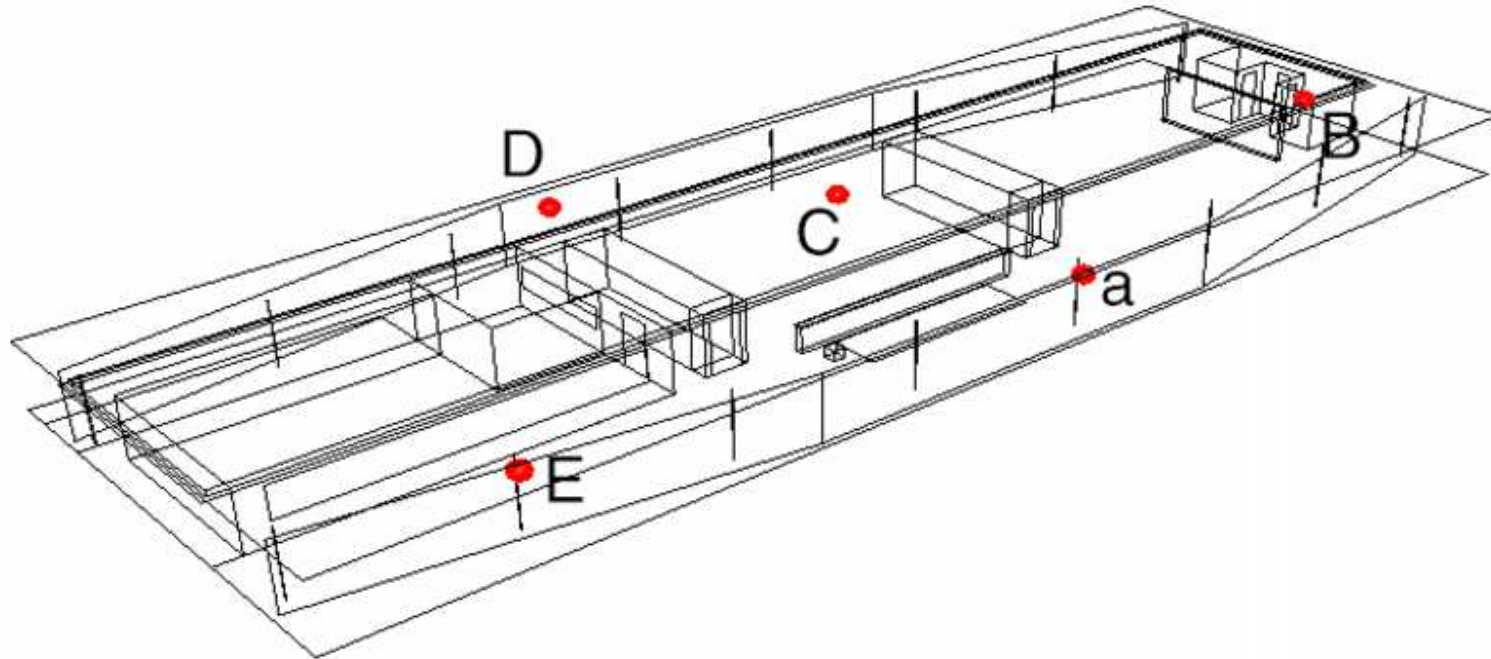
- received power
- delay spread (due to multipath)
- coherence distance
- phase
- angle of arrival
- ...

A good channel model gives good approximations of the channel characteristics that can be expected.

How to get channel models?

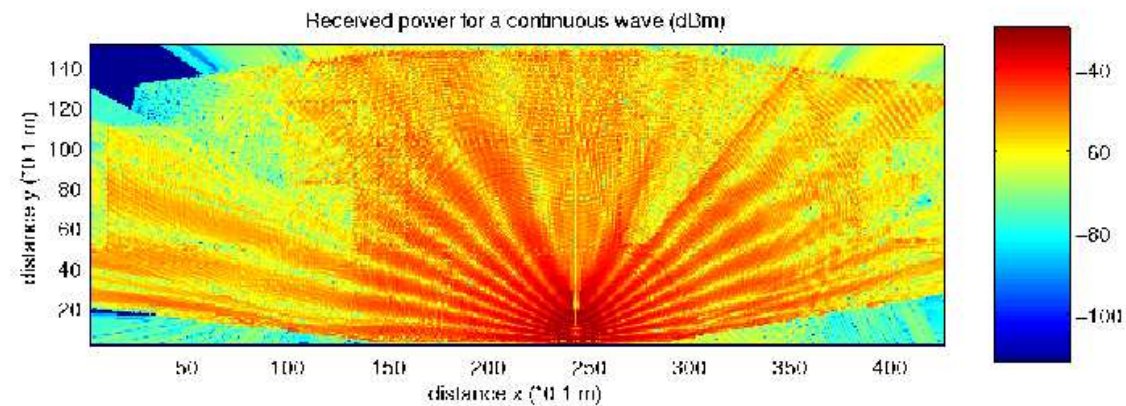
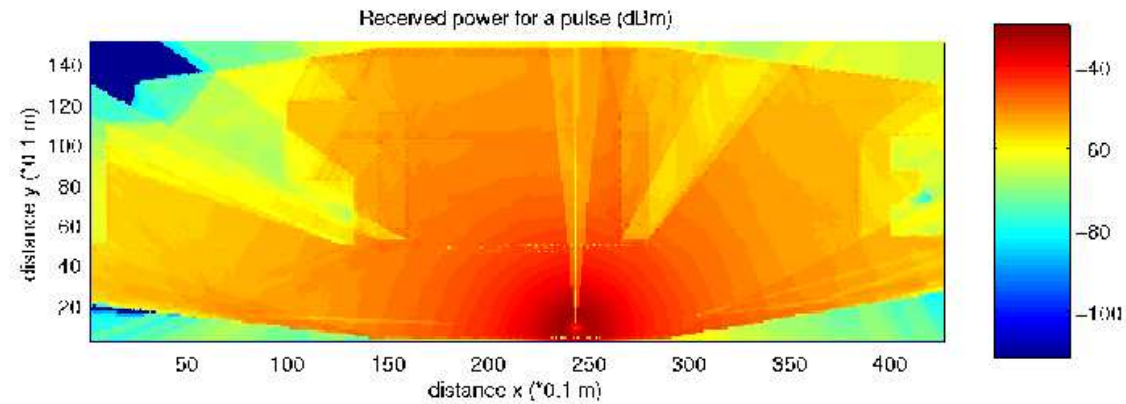
- measurements
 - expensive
 - time consuming
- simulations (ray tracing)
 - model of environment is an approximation
 - ray tracing is an approximation
 - limited computing resources

Ray tracing simulator



End result after simulation is a channel impulse response for every RX antenna.

Channel models - received power



Channel models - large scale fading

Friis free space model (free space loss)

$$P_r = \frac{1}{d^2} G_s P_t \quad [\text{Watt}] \quad (1)$$

$$G_s = \frac{G_t G_r \lambda^2}{16\pi^2}$$

Channel models - large scale fading

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$$P_r = P_{t,dBm} + G_{s,dB} - 20 \log_{10}(d/[1 \text{ m}]) \quad [\text{dBm}] \quad (2)$$

Log distance model (free space loss in building)

$$P_r = P_{t,dBm} + G_{s,dB} - n \log_{10}(d/[1 \text{ m}]) \quad [\text{dBm}] \quad (3)$$

Channel models - medium scale fading

Log normal shadowing (shadowing due to objects)
Power loss (in dB) due to objects can have normal distribution:

$$p(x) = \frac{1}{\sqrt{(2\pi)\sigma_x}} \exp\left(-\frac{1}{2}\left(\frac{x - \mu_x}{\sigma_x}\right)^2\right) \quad (4)$$

Channel models - small scale fading

Received amplitude in non-LOS rich scattering environment can have **Rayleigh** distribution:

$$p(x) = \frac{x}{\sigma^2} \exp\left(-\frac{x^2}{2\sigma^2}\right) \quad (5)$$

Received amplitude in LOS rich scattering environment can have **Ricean** distribution:

$$p(x) = \frac{x}{\sigma^2} \exp\left(-\frac{a^2 + x^2}{2\sigma^2}\right) I_0\left(\frac{ax}{\sigma^2}\right) \quad (6)$$

Channel models - LOS and non-LOS

LOS/non-LOS information estimation based on channel impulse response.

Seems to work fairly well. However, for the test environment, overall Rayleigh proved to be a good model (due to the highly reflective walls?)

Channel models - Cafe Linsen

Channel parameters for Cafe Linsen:

Large scale	log distance	$P_r(1\text{ m}) = -29\text{ dBm}, n = -2.4$
Medium scale	log normal	$\mu = -0.86\text{ dB}, \sigma = 4.54\text{ dB}$
Small scale	Rayleigh	$\sigma = 0.69$
RMS delay spread		40 ns
Coherence distance		0.0212 m

Conclusions / Future work

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Future work

- comparison with real world measurements
- better medium scale model
- extend programs for MIMO systems (currently, angle of departure and arrival are ignored)