Virtual Drive Verification Urban Car - Car

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Inter-vehicle Channel Measurements

Transmitter

Receiver

\[ f_0 = 5.2\, \text{GHz} \]

signal \[ BW = 120\, \text{MHz} \]

\[ P_{\text{Tx}, \text{EIRP}} = 33\, \text{dBm} \]
Measurement Scenario in the City of Karlsruhe

receiver starting scenario

receiver (10km/h)

transmitter

receiver end scenario
Deterministic Simulation of Urban Wave Prop.
Comp. Urban Measurement/Simulation (urban)

Measurement

Simulation

relative received power in dB

fast fading
slow fading

0 10 20 30 40 50 time in s

-65 -75 -85 -95 -105 -115

0 10 20 30 40 50 time in s

-65 -75 -85 -95 -105 -115
Comp. Urban Measurement / Simulation (narrow-band)

mean path loss (long-term fading)

Simulation error: mean error = -0.8 dB, standard deviation = 2.8 dB
Short-term Fading Properties

- **CDF**: Cumulative Distribution Function
- **LCR**: Level Crossing Rate
- **AFD**: Average Fade Duration

![Graph showing short-term fading properties with axes labeled](image)
Comp. Urban Meas. / Simulation (narrow-band)

Cumulative Distribution Function (CDF)
(short-term fading)

-20 -15 -10 -5 0 5
0.5
0.4
0.3 0.2 0.1
0
 Simulation
Measurement

cumulative probability

short-term fading amplitude in dB
Comp. Urban Meas. / Simulation (narrow-band)

Level Crossing Rate (LCR)
(short-term fading)

-20 -15 -10 -5 0 5

short-term fading amplitude in dB

10
1
0.1
0.01
0.01

LCR in 1/s

measurement
simulation
Average fading duration (AFD) (fast fading)

deviation from the local average in dB

average fading duration in s

-20 -15 -10 -5 0 5

-0.001 -0.01 -0.1 -1 -10 -100

measurement simulation
Comp. Urban Meas. / Simulation (wide-band)

Power Delay Profile (PDP)

Measurement:
- PRx/Pmax in dB
- Excess delay in μs
- Measurement time in s

Simulation:
- PRx/Pmax in dB
- Excess delay in μs
- Measurement time in s
Delay Spread: Comp. Urban Meas. / Simulation

delay spread (wide-band)

![Graph showing time average delay spread with measurement and simulation results.

Time average delay spread:

\[ \overline{\sigma}_{\tau,M} = 40.2 \text{ ns} \quad \overline{\sigma}_{\tau,S} = 43.2 \text{ ns} \]