Prediction and Validation of Propagation Loss in Urban Micro-cell Environment by using Ray Tracing Simulation

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Background

Adaptive equalizer

MLSE (Maximum Likelihood Sequence Estimation)

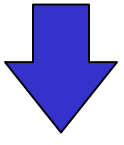
advantage Provide a performance gain due to the path diversity effect

disadvantage The higher transmission rates, the greater the calculation

Adaptive array

advantage Suppress the long delayed path

disadvantage Can’t provide path diversity gain



Adaptive array + MLSE

Characteristic of the Array Antenna

Array formation arrangement
Propagation environment
Scattering distribution
Distance to mobile station

Prototype development and field trial

need much time and cost

Purpose

- Evaluate the characteristic of Adaptive array antenna

  Relation between antenna characteristic and angular spread, distance between elements, AOA parameters

  ⇒ Evaluate the antenna in the real environment, and theoretically analyze the antenna

- Theoretical approach :

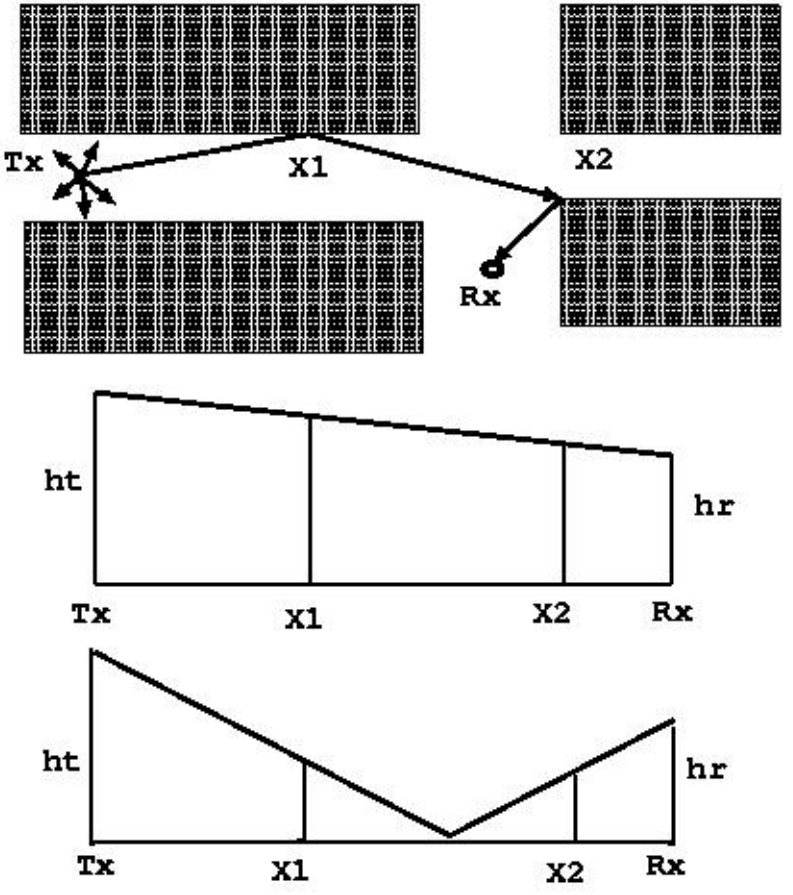
  Ray-tracing simulation

Ray-tracing Simulation

- 2D/3D hybrid Ray-tracing method (micro-, pico- cell)

. Rays are launched in a 2D horizontal plane with equal angle separation

. The location of the reflection and diffraction points and the formulation of reflected and diffracted rays are carried out based on geometrical optics, laws of reflection and diffraction

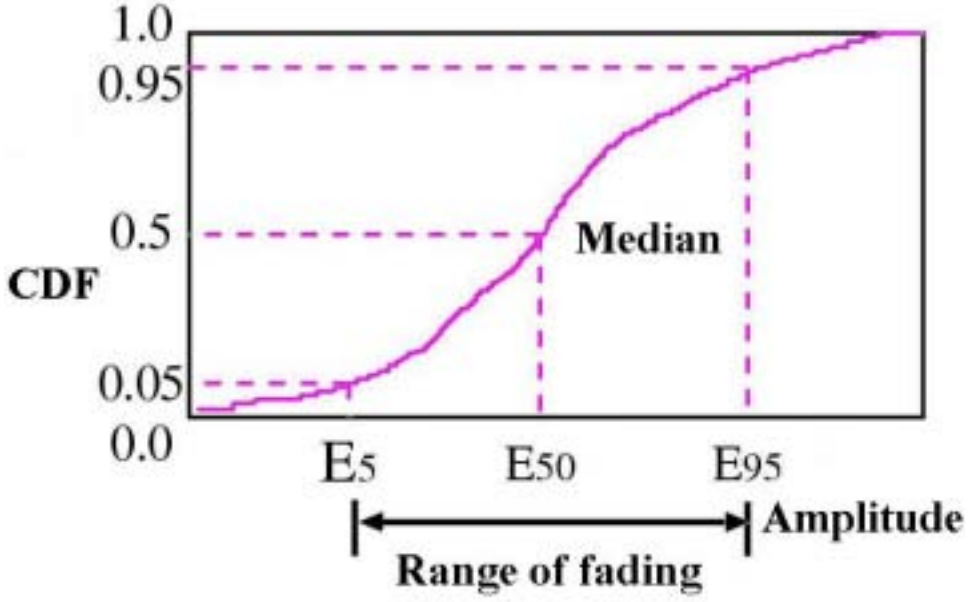


Random phase approach

To address this two points….

Inaccurate phases caused by uncertainty of building databases

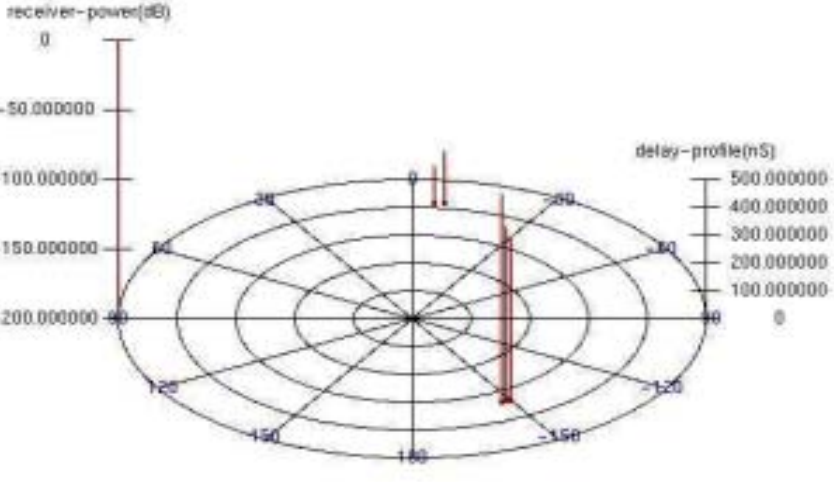
Efficient prediction of fading statistics of path loss, delay profiles,etc



50% received power CDF ……. Median

5 – 95% received power CDF …. Range of fading

‘GUI (Graphic User Interface)



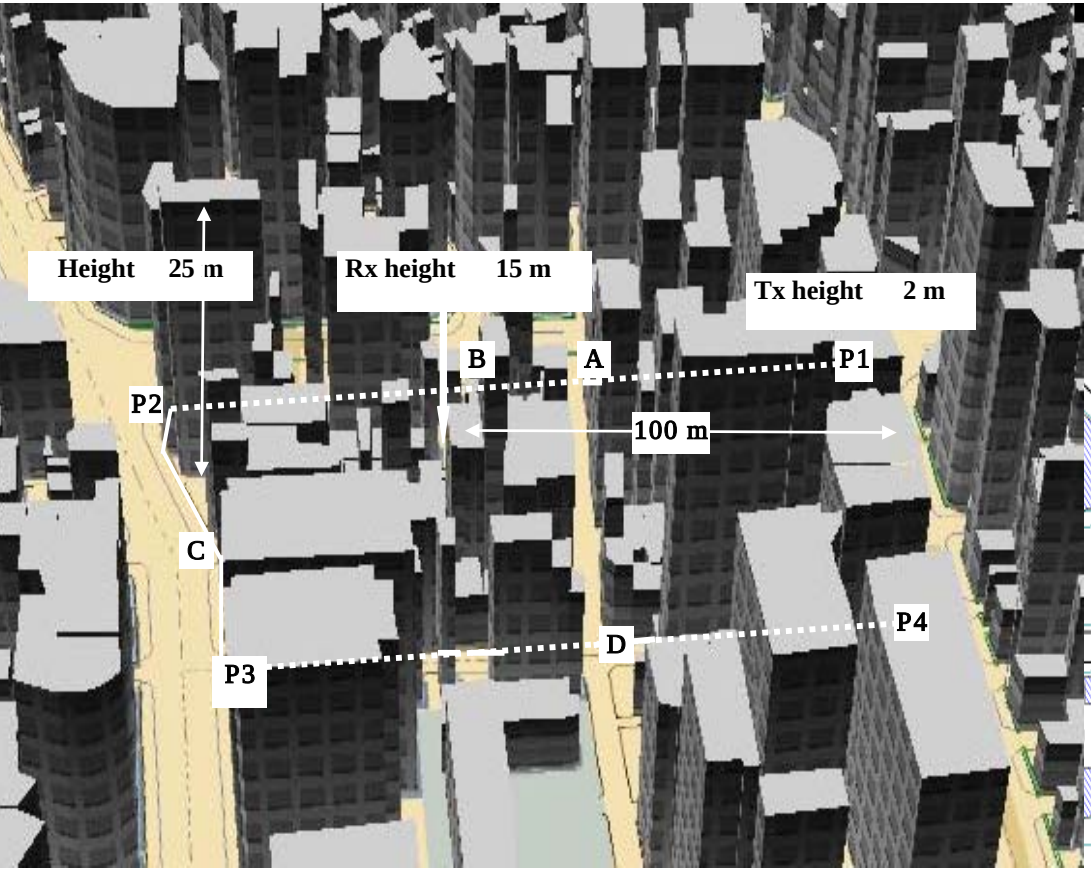
Field test

Place: Central Tokyo area

Kanda Jinbo-cho 2 cho-me

(near the Jinbo-cho station)

Field Test Environment

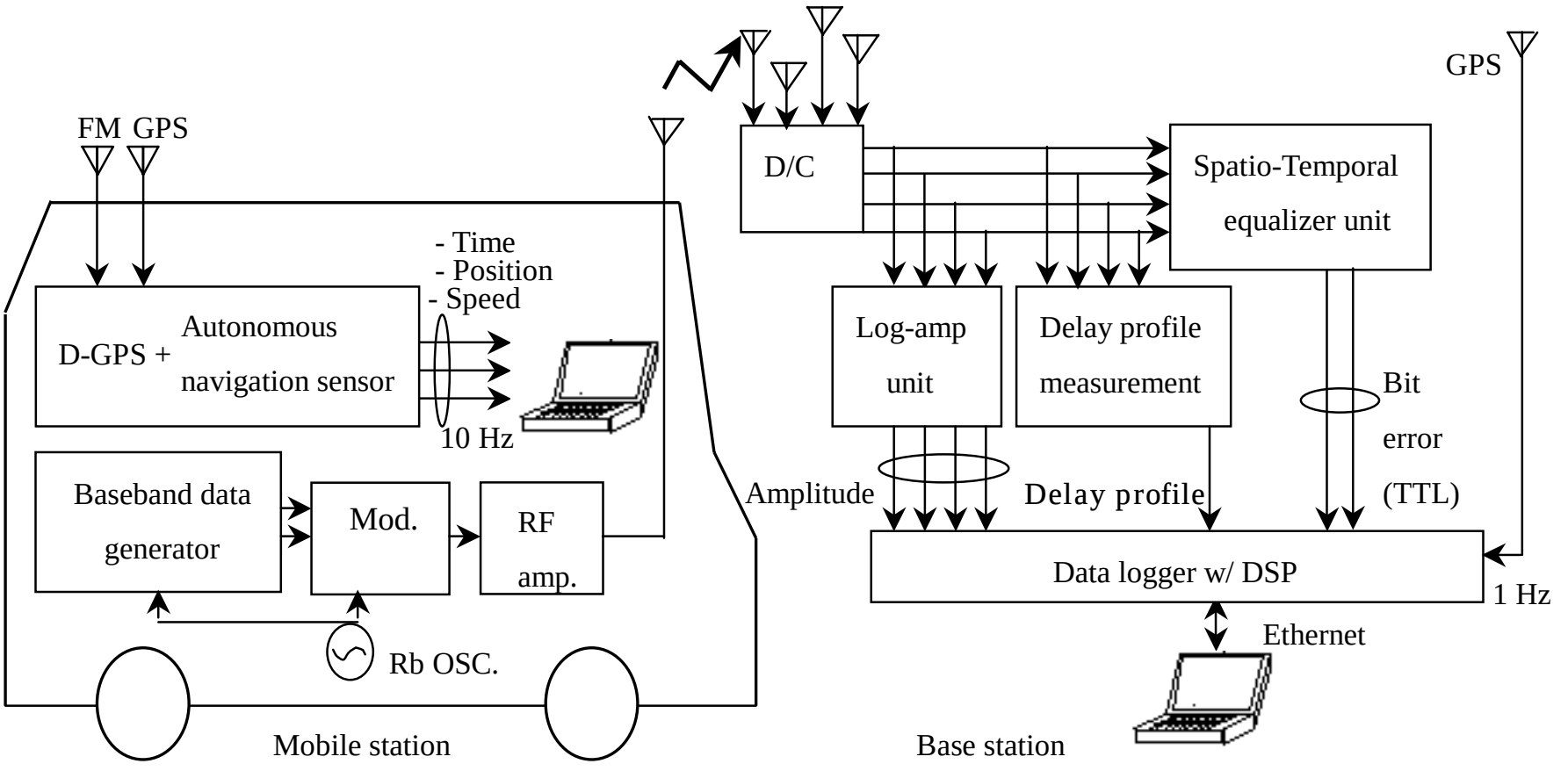


Conditions of Field Test

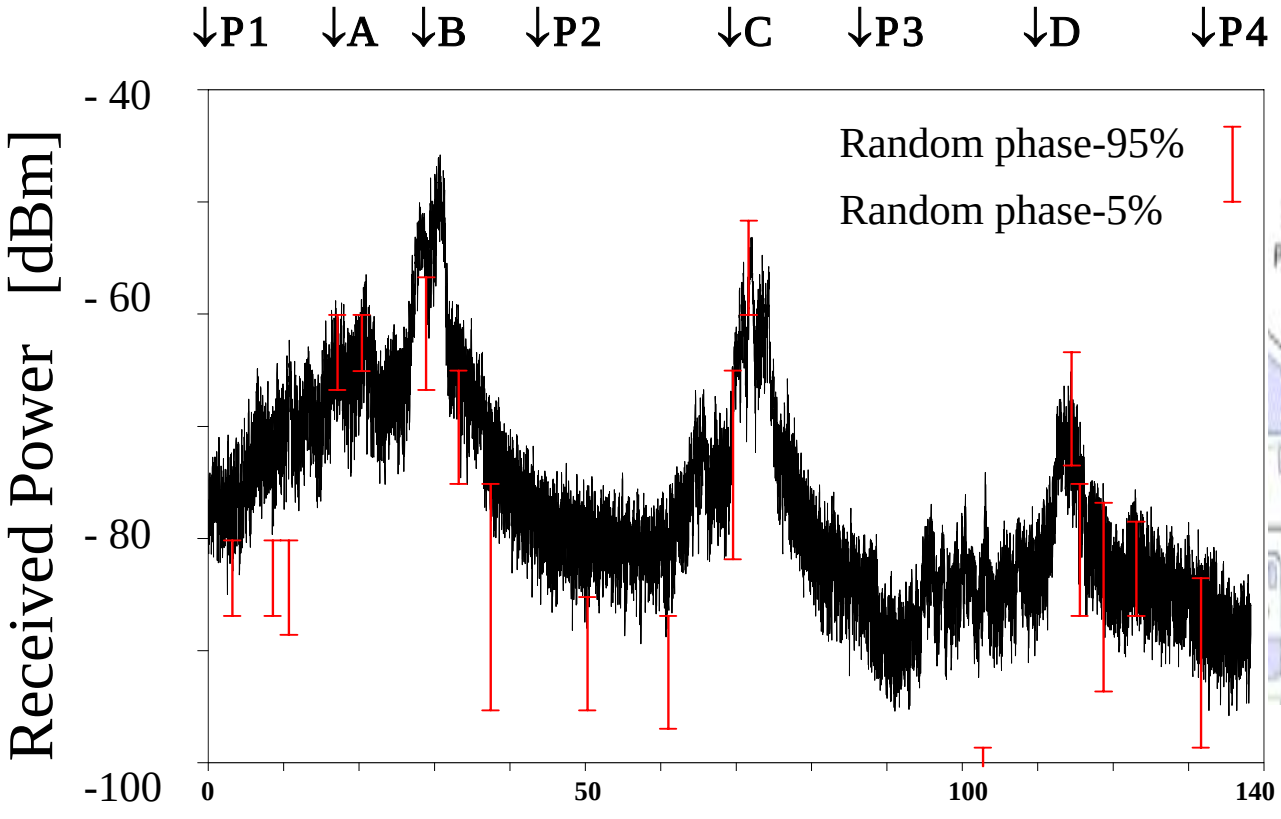
Radio frequency	**3.35 GHz**
Modulation	**QPSK**
Transmission rate	**4.096 Mb/s**

T_x. Antenna	**Omni-directional**
R_x. Antenna	**Four-elements uniform circular array**
Dist. between T_x and R_x	**30 - 100 m**
Average height of major buildings around Rx	**20 - 25 m**
Delay spread	**less than 0.32 μsec**

Field trial system



Comparison of Average Received Power



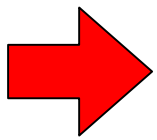
— Experiment results

— Simulation results

Conclusion

- Ray-tracing simulation results are compared with measured ones with respect to the received power at the antenna in an urban microcell environment
- The simulation results provide good approximation in LOS sections and the slightly shadowed NLOS
- In deeply shadowed NLOS area, it gives large error

- penetration through the building
- vertical path over the building
- non-specular reflection

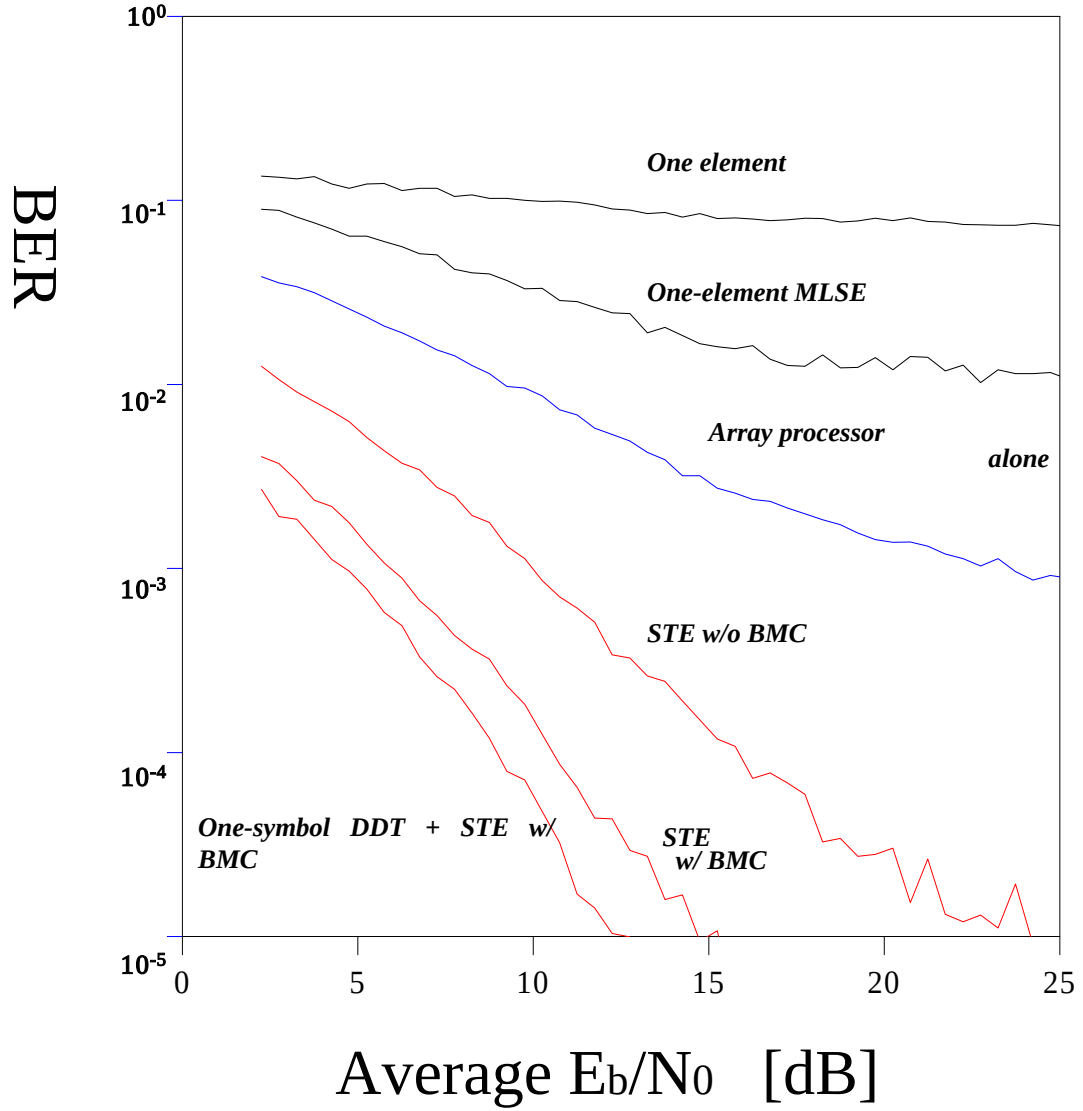


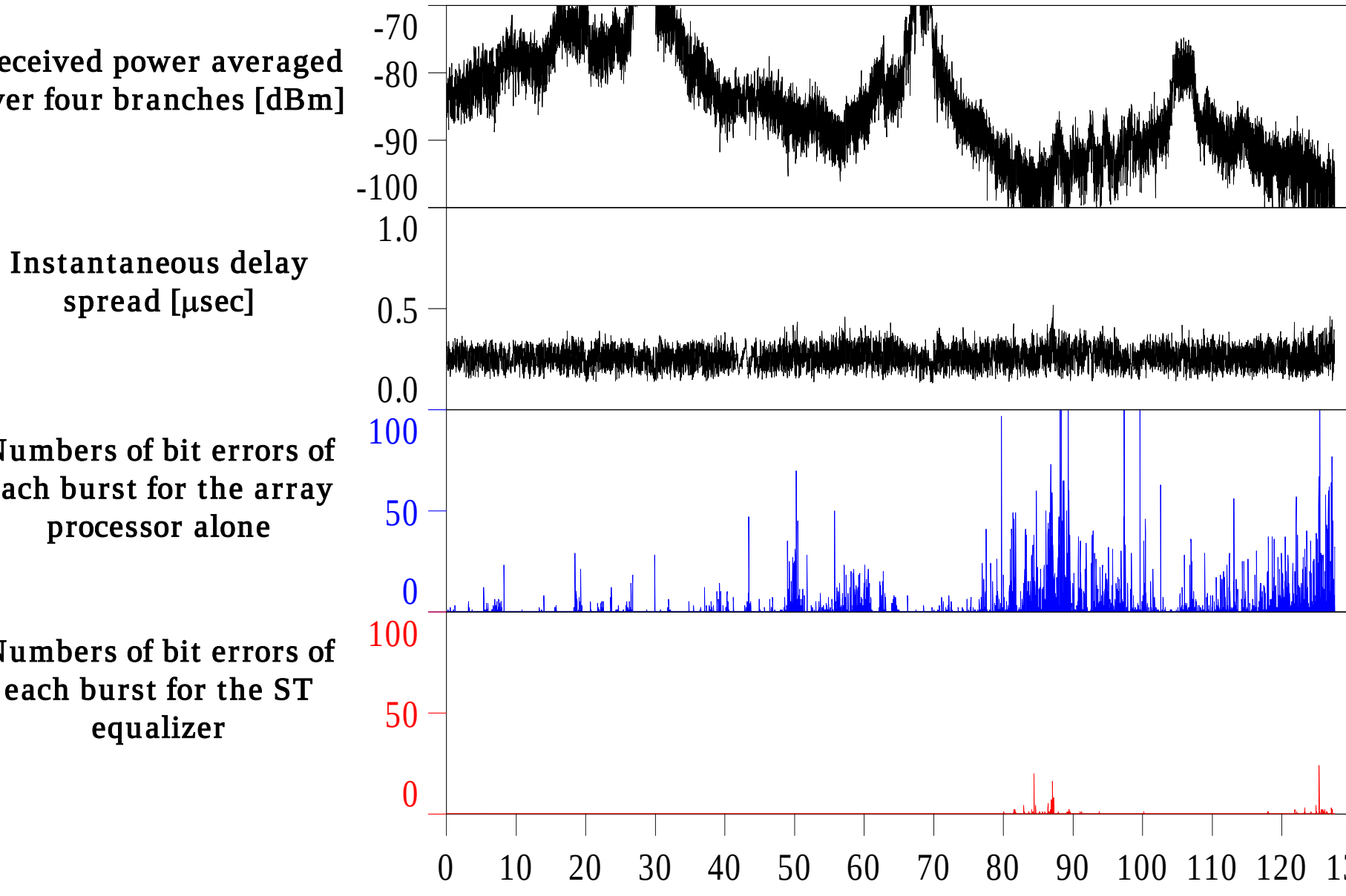
shall be considered

Future works

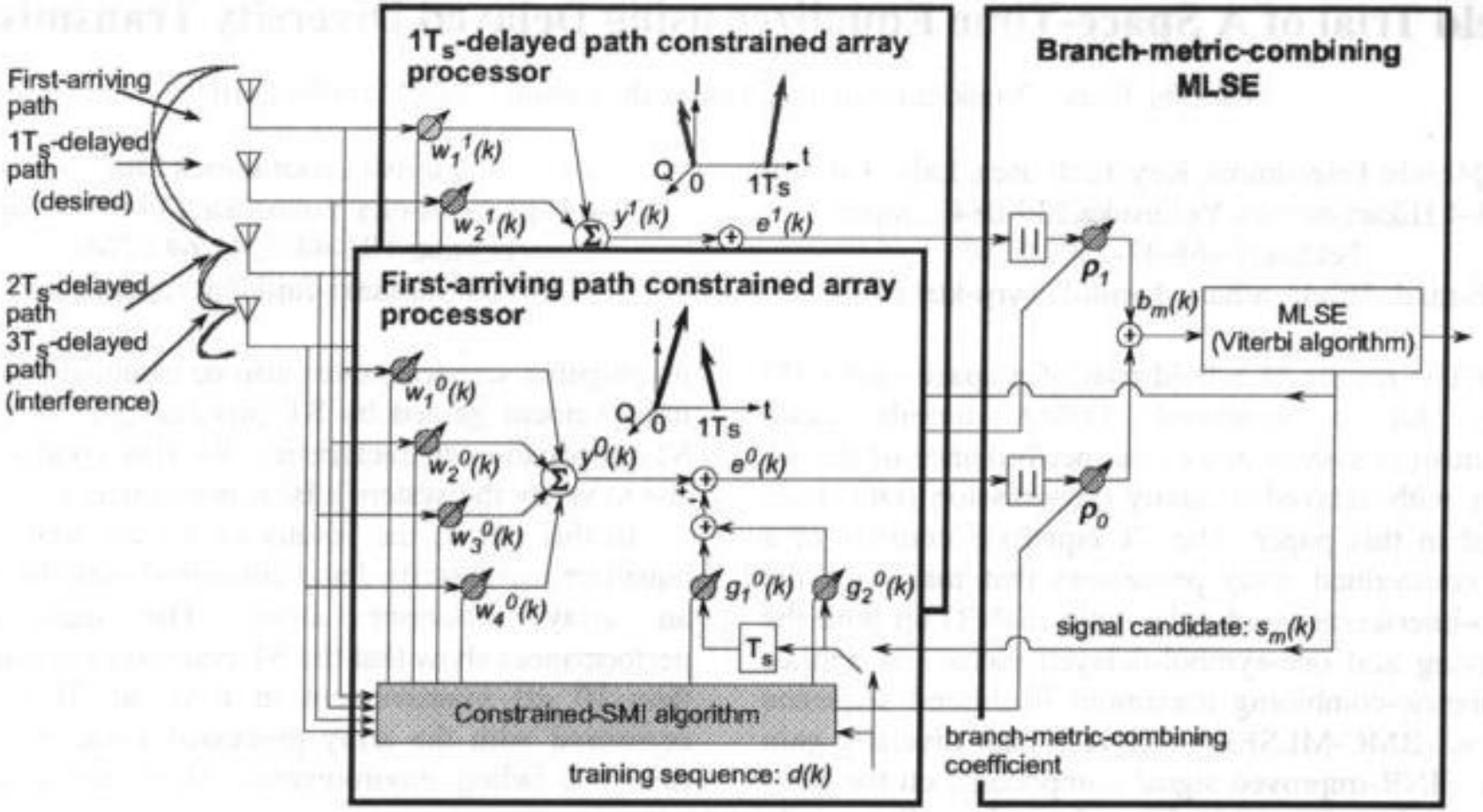
- Comparison of received power and Delay Profile
- Characteristic of Delay Spread at LOS and NLOS areas
- Characteristic of BER
- Evaluation of Spatio-Temporal Equalizer characteristic
- Improvement of Ray-tracing simulator

BER performances for ST processing




eceived power averaged
er four branches [dBm]
-70
-80
-90
-100
Instantaneous delay
spread [µsec]
1.0
0.5
0.0
Numbers of bit errors of
ach burst for the array
processor alone
100
50
0
Numbers of bit errors of
each burst for the ST
equalizer
100
50
0
0
10
20
30
40
50
60
70
80
90
100
110
120

Spatio – Temporal equalizer



Conditions of Field Test

Radio frequency	**3.35 GHz**
Modulation	**QPSK**
Transmission rate	**4.096 Mb/s**
Pulse shaping	**Root rolloff filter (α=0.5)**
TDM frame format	**Training: 48/data: 208 symbols (32 symbols for correlation)**
Tx. Antenna	**Omni-directional**
Rx. Antenna	**Four-elements circular array**

Mobile antenna height (Transmitter)	**2 m**
Array antenna height (Receiver)	**15 m**
Rx element-space	**8λ**
Dist. between Tx and Rx	**30 - 100 m**
Average height of major buildings around Rx	**25 m**
Delay spread	**0.2 – 0.45 μsec average: 0.23**

System specifications