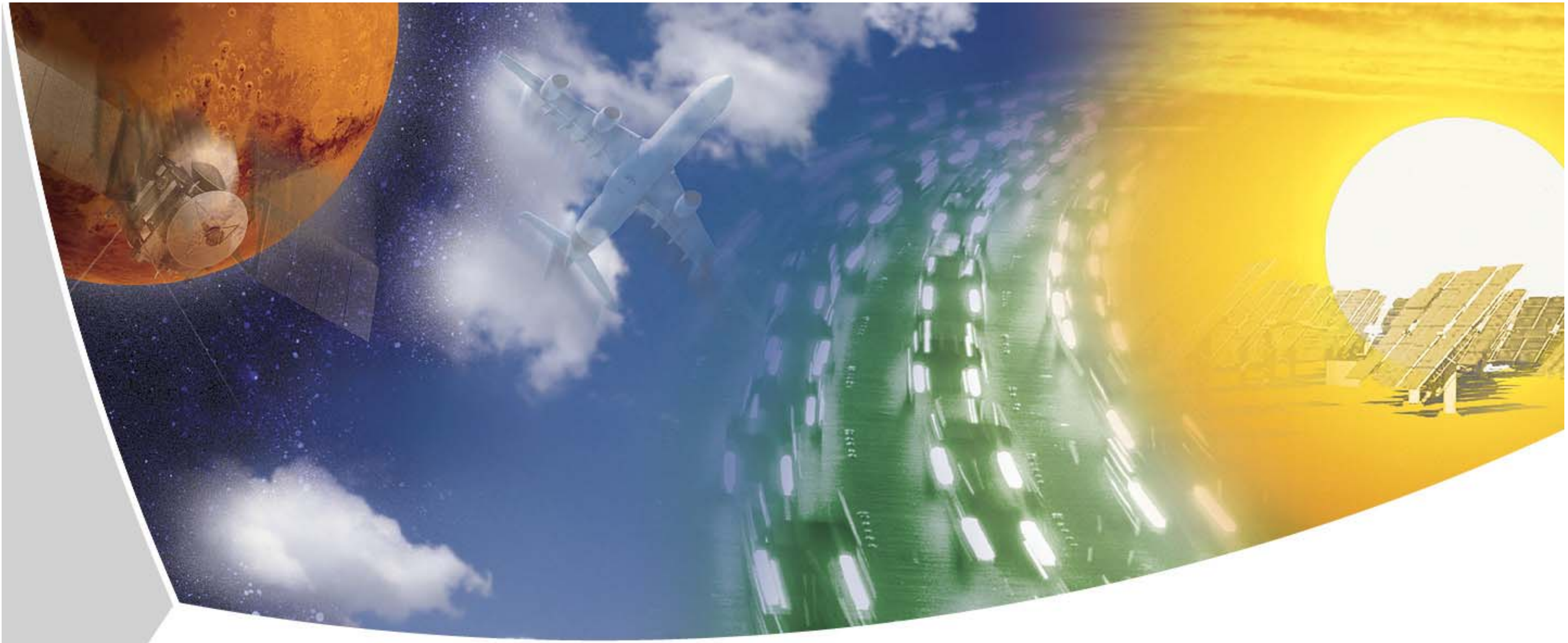


Increasing Transmit Diversity at the Cell Border with Smart Antennas

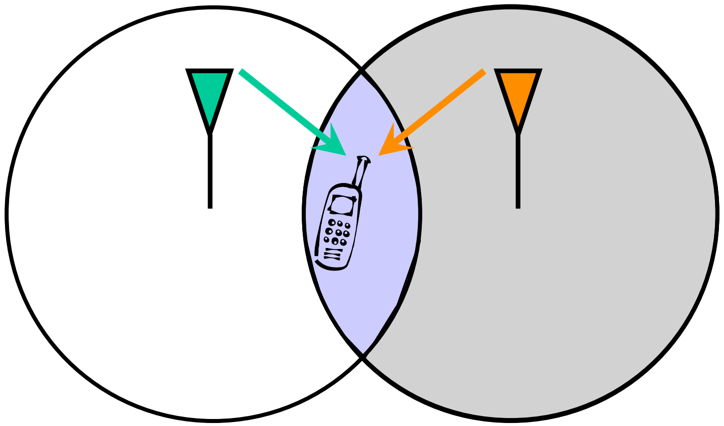
Simon Plass

German Aerospace Center (DLR)

Novi Sad, March 23, 2006

Motivation

- Future communications systems should have frequency reuse of one
  - ⇧ high spectral efficiency
  - ⇩ large performance degradation at the cell border



- Mobile terminal at the cell border can be broadcasted by two base stations

  ➔ Can we increase the transmit diversity and decrease the inter-cellular interference?

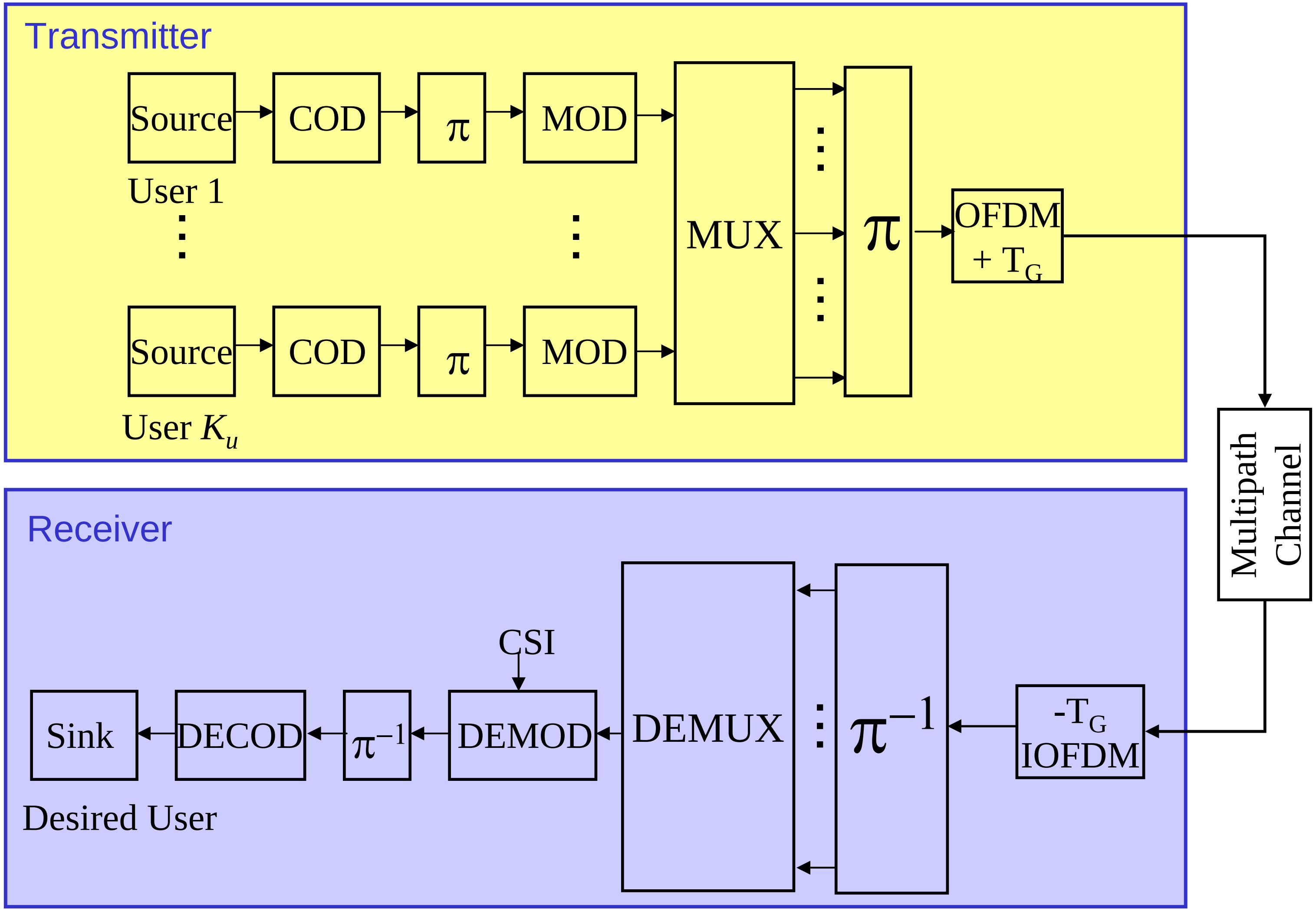
Outline

- OFDMA Downlink System
- Transmit Diversity Techniques
  - Delay Diversity (DD)
  - Cyclic Delay Diversity (CDD)

- Cellular Cyclic Delay Diversity (C-CDD)

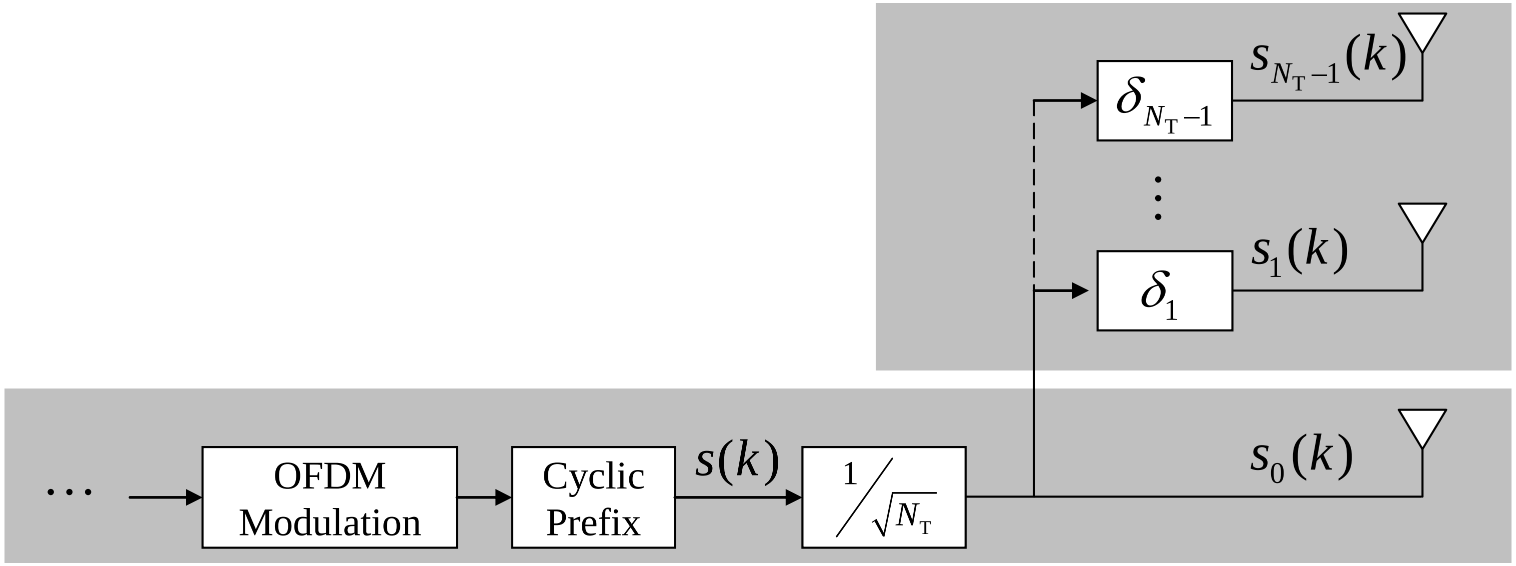
- Simulation Results
- Conclusions

OFDMA Downlink System



Delay Diversity (DD)

- Idea: Increase number of propagation paths
- Delay of TX-signal in time domain

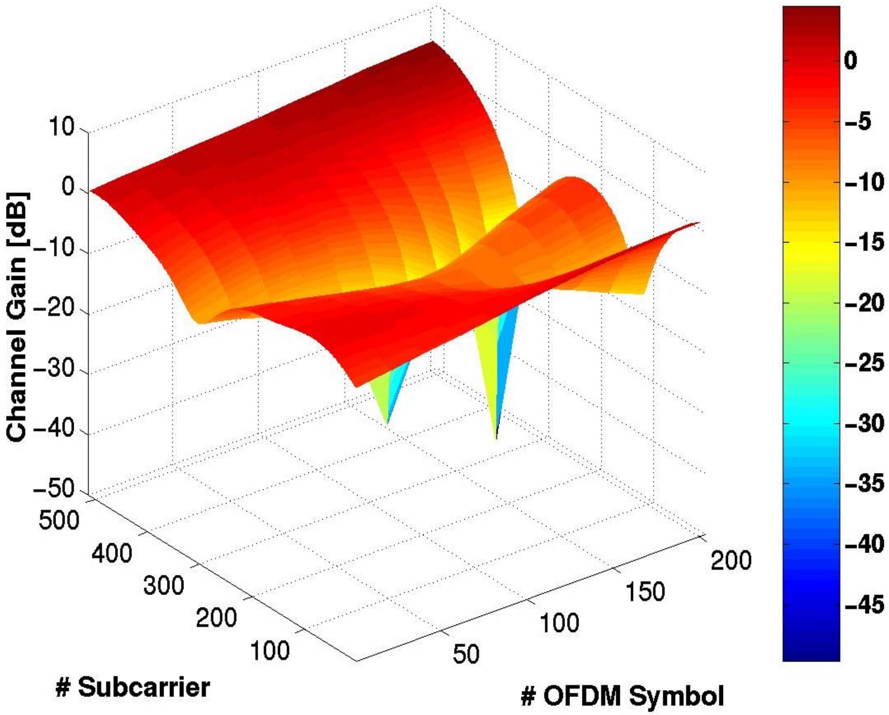


Advantage: ⇧ very low complexity, no additional complexity at mobile

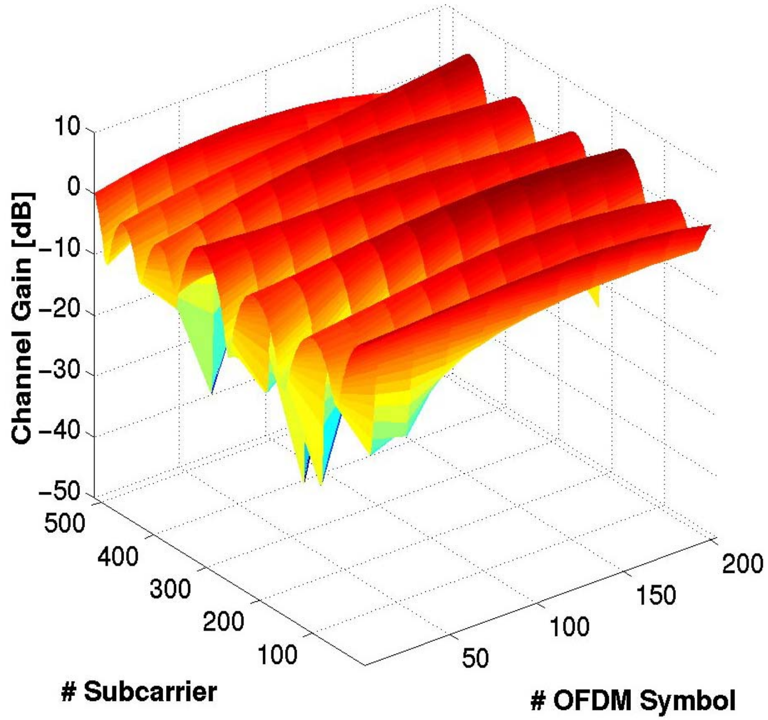
Drawback: ⇩ additional delay

Channel Transfer Function $|H(f,t)|^2$

Delay spread: $\Delta\tau \approx 0{,}750\ \mu s$

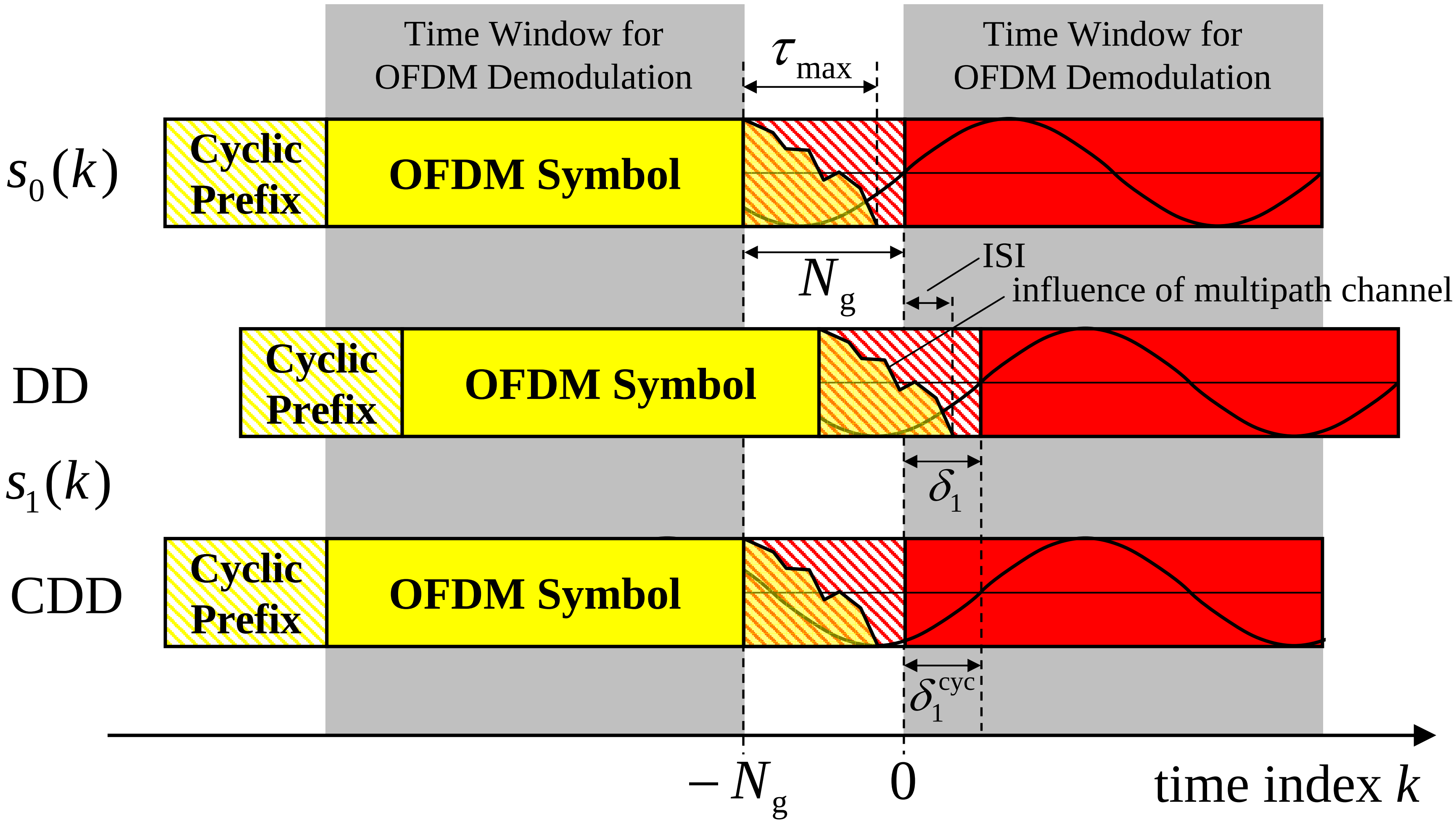


Delay-Diversity, $\Delta\tau \approx 1{,}850\ \mu s$



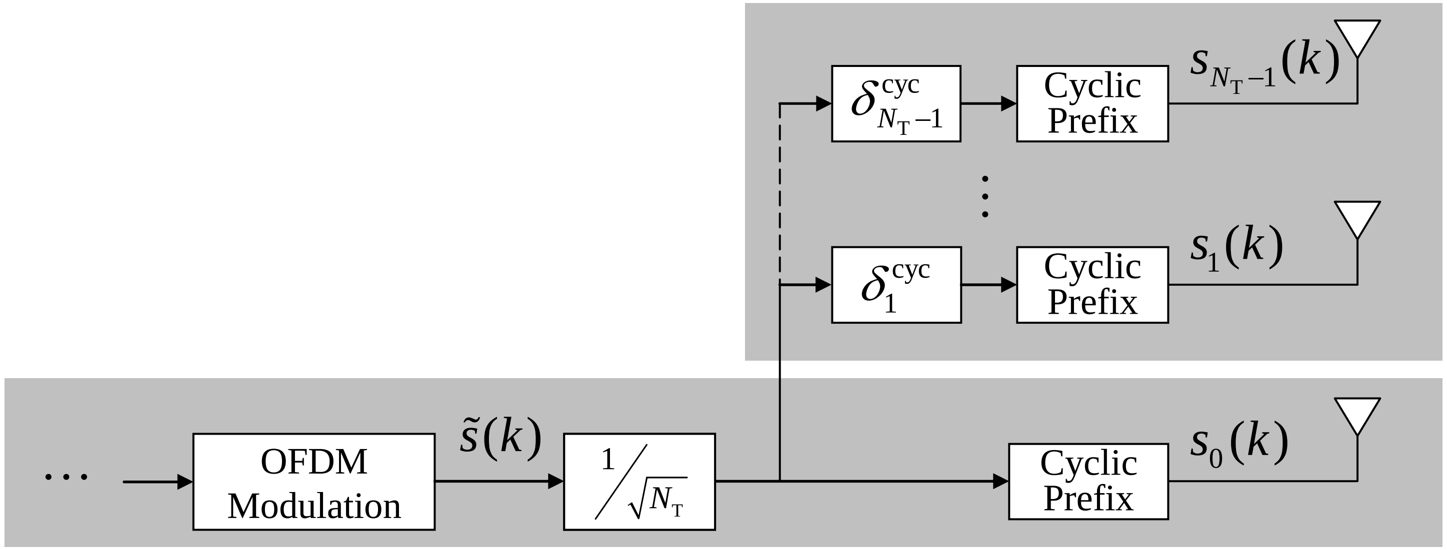
Symbol Duration $T_U = 224\ \mu s$, Carrier Spacing $\Delta f_C = 4{,}464$ kHz, $f_D = 10$ Hz

From Delay Diversity to Cyclic Delay Diversity (CDD)



Cyclic Delay Diversity (CDD)

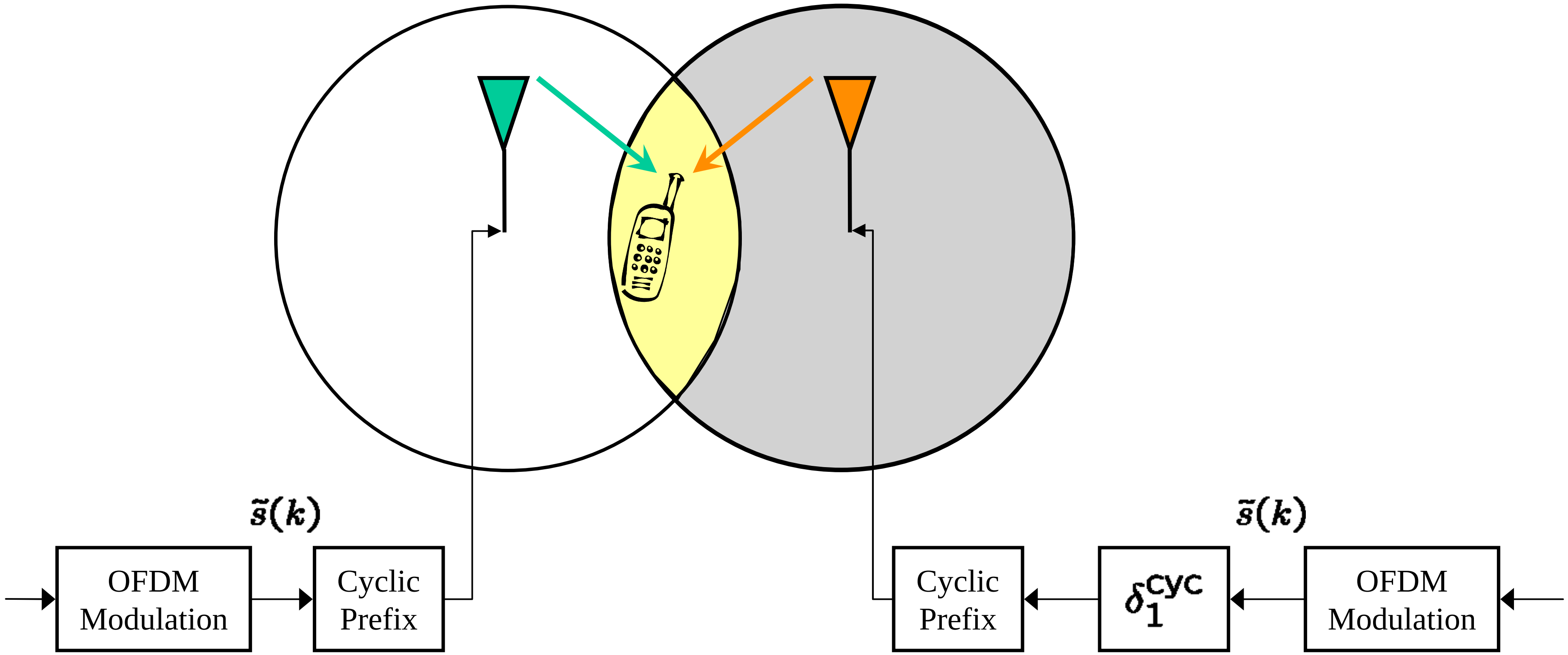
- Cyclic delay of OFDM-symbols in time domain



Advantage: ⇧ no additional inter-symbol interference
⇧ no additional complexity at mobile

Drawback: ⇩ higher complexity compared to DD

Cellular Cyclic Delay Diversity (C-CDD)



Cellular Cyclic Delay Diversity (C-CDD)

- Network has to distribute the same signal to both base stations
- Available sub-carriers are needed

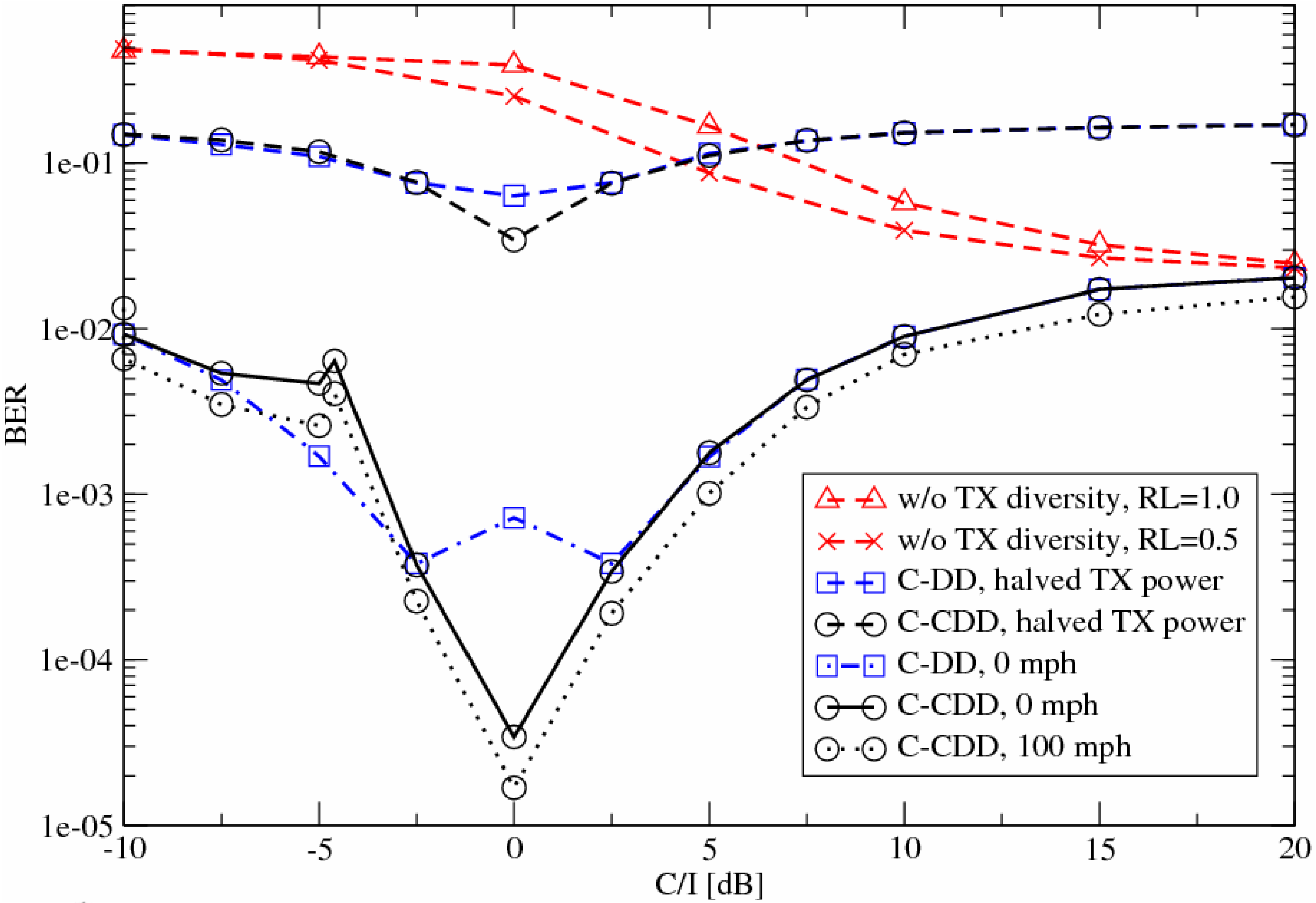
- No additional complexity at the mobile terminal
- Possibility of exploiting the unused ‘interfering’ sub-carriers
- Reduction of inter-cellular interference
- Inherent delay diversity

Simulation Results

System Parameters & Channel Model

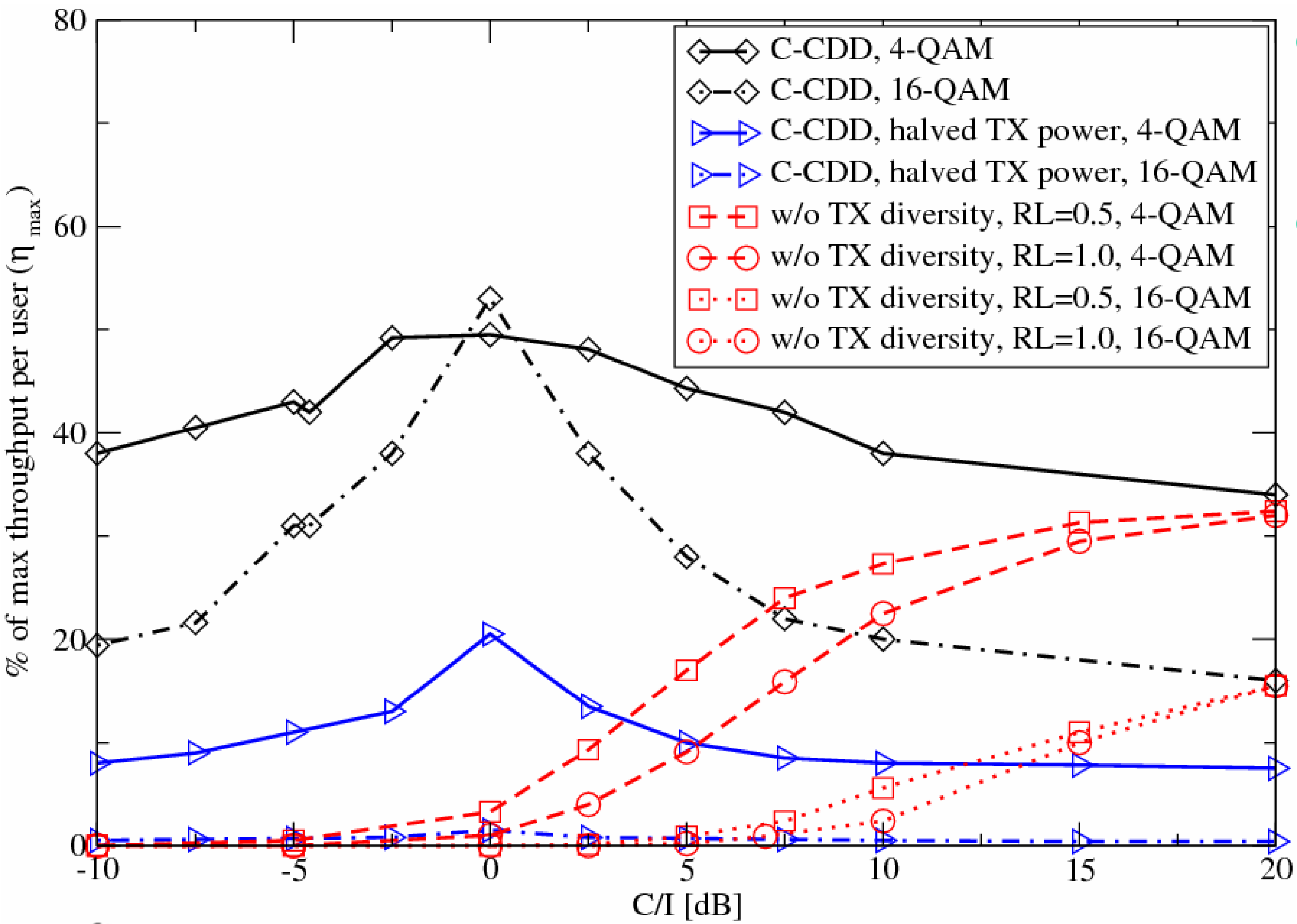
Carrier frequency	5 GHz
Bandwidth	100 MHz
FFT length	2048
OFDM symbols / Frame	16
Modulation	4-QAM or 16-QAM
Coding	Conv. Code, R=1/2
Cyclic delay	30 samples
Velocities	0 mph or 100 mph
Channel model	IEEE 802.11n C
Taps	14

Impact on Error Performance



- Robustness to high velocities
- Best performance with C-CDD at the cell border
- Performance gain and decreased interference with halved TX power

Impact on Throughput



- High throughput gains with C-CDD technique
- Reliable throughput throughout the cell for 4-QAM

Conclusions

- Introduction of new cellular transmit diversity technique for the severe cell border area:

  Cellular Cyclic Delay Diversity (C-CDD)

- C-CDD offers:
  - Increased transmit diversity at the cell border
  - No additional complexity for the mobile terminal
  - Robustness to different velocities
  - Reliable throughputs all-over the cell edge
  - Reliable handoff procedures