Non-Orthogonal Multiple Access employing Multiple Power Levels for 5G Wireless Communication Networks

Shimamoto Laboratory

Global Information and Telecommunication Studies
Waseda University
JAPAN
Introduction

Background

OFDMA issues in 5G:
- Synchronization
- Orthogonality
- Distortions
- Bursty Traffics
- Spectral Mask (CP)

Network densification
Methods

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- Single User
- Successive Interference Cancellation
- Modulation scheme
- Energy-Spectral Efficiency
- Multi User
- Imperfect Cancellation

Methods

Orthogonal between users

Non orthogonal

Power allocation

Decoding-demodulation $x_1$
Decoding-demodulation $x_4$

$Y$

$Y$

$P_1$
$P_2$
$P_3$
$P_4$

Frequency

Power Level

$P_1$
$P_2$
$P_3$
$P_4$

$f_0$
$f_1$
Methods (cont'd)

For $b \in B$
Group into $G_1$ and $G_2$

$P_{G1} \in [0.6, 0.8] \times P_{MAX}$
$P_{G2} \in [0.2, 0.4] \times P_{MAX}$

$P_{G1} + P_{G2} \leq P_{MAX}$

Y

For $G_1$
$p_1 = P_{G1} - \delta_1$
$p_2 = P_{G1} - p_1$

$P_{G2}$
$p_3 = P_{G2} - \delta_2$
$p_4 = P_{G2} - p_3$

end

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Results

- 16QAM and 64QAM with splitting method having worse performances compared to non-splitting method in four data blocks scheme.
- Power allocation optimization needed.

- For 16QAM with splitting method offered better performances compared to non-splitting method.
- Under different power ratio coefficient 16QAM offered better performances compared to 64QAM.
Results (cont’d)

- System capacity under error cancellation is still higher compared to non-cancellation method.
- High power allocation on the first data block leads to smaller throughput for second data block.
Spectral and Energy Efficiency

Spectral Efficiency
“Total (average) number of delivered bits per unit bandwidth”

\[ \eta_s = \frac{R}{B} \]

Energy Efficiency
“Ratio between system rate to the overall transmit power including circuit power which can be modelled as linear function”

\[ \eta_E(R) = \frac{R}{P + P_{circuit}} \]
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Spectral and Energy Efficiency (cont’d)

Shannon Theory \([1]\)

\[ R = m \left( \frac{B}{n} \right) \log_2 \left( 1 + \frac{p|H|^2}{BN_o + I} \right) \]

- \( m \) = spatial multiplexing factor
- \( B \) = system bandwidth
- \( n \) = number of users sharing the Base Station
- \( p \) = signal power
- \( H \) = channel power gain
- \( N_o \) = noise spectral density
- \( I \) = interference

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Results (cont’d)

- Non-orthogonal have higher energy efficiency compared to orthogonal OFDMA.

- Low transmit power region produce higher efficiency in non-orthogonal scheme compared to Orthogonal OFDMA scheme.

- Error cancellation have minimal contribution to non-orthogonal performance.
Results (cont’d)

![Graph showing SE for Multiple Power Level]

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Future Research

Define cell area as **CCZ (Center Cell Zone)** and **ECZ (Edge Cell Zone)** with eNB and F_{BS} in ECZ. Consider Co-channel, inter-cell interference, power allocation for macro-user in ECZ.