Software and Systems Engineering

CPE3202

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PAPR Reduction Method for OFDM Signal by Using Permutation Sequences

- Introduction
- System Model
- Proposal of Permutation Sequences Method
- Performance Evaluation
- Conclusions

Advantages

- ❑ Efficient usage of frequency bandwidth
- ❑ Robustness to multi-path fading
- ❑ Easy to use Multi-QAM

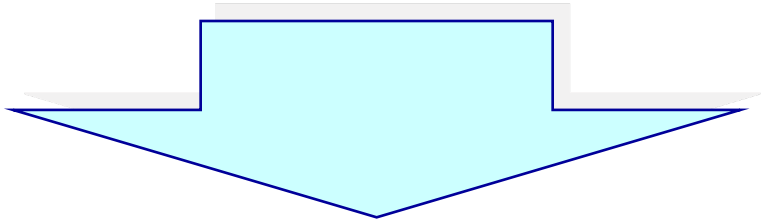
Disadvantages

- One of the limitations of using OFDM technique is the large peak to averaged Power ratio (PAPR).
- The larger PAPR signal would cause the severe degradation of bit error rate (BER) performance due to the inter-modulation noise at Non-linear Amplifier
- The PAPR reduction techniques can be categorized into two major method

  1.) distortion and 2.) distortion-less

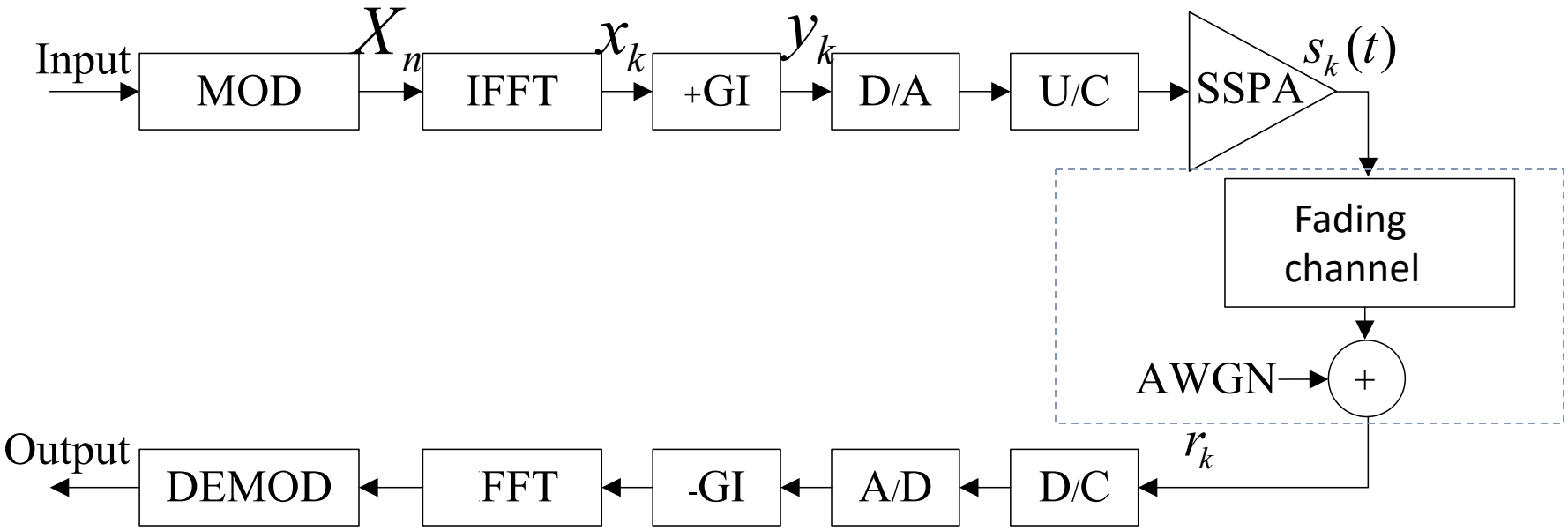
Objective of Research

Improve PAPR and BER performances with keeping higher transmission efficiency



This paper proposes the Permutation Sequence (PS) Method for OFDM Signal with embedded very few Side Information

System Model



Conventional OFDM system in non-linear channel

OFDM and Evaluation equation

OFDM time domain signal

$$x_k = \sum_{n=0}^{M-1} X_n e^{j\frac{2\pi nk}{N}} \qquad 0 \le k \le N-1$$

PAPR Performance

$$PAPR = \frac{\max_{0 \le k \le N} |x_k|^2}{E\left[|x_k|^2\right]}$$

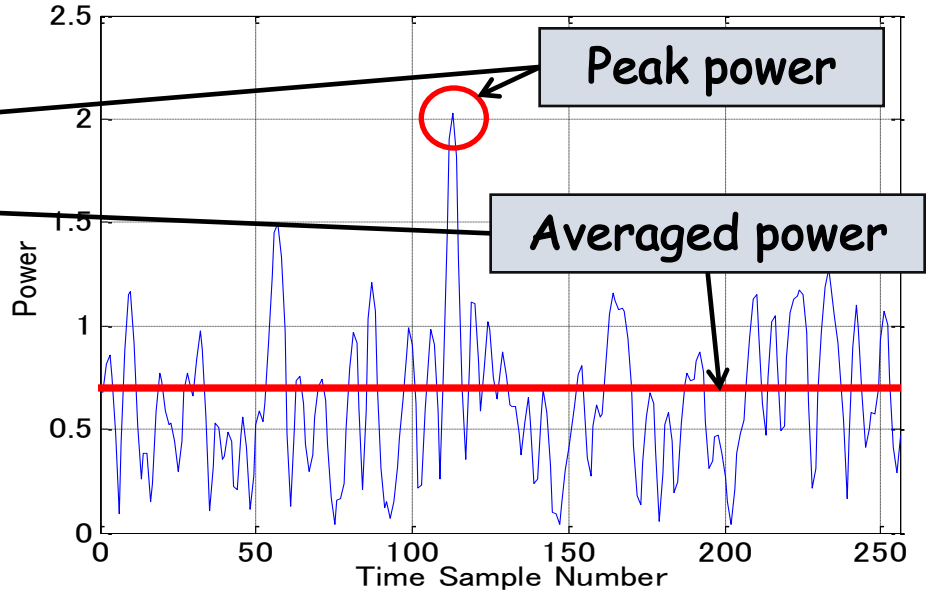
CCDF (Complementary Cumulative Distribution Function)

$$CCDF(PAPR_0) = P_r(PAPR > PAPR_0)$$

PAPR problem in OFDM Signal

High PAPR of its time domain signal

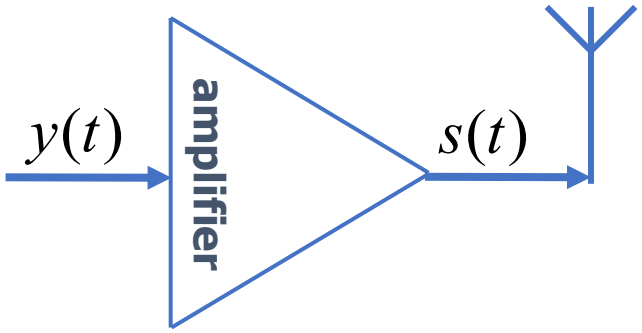
$$PAPR = 10\log_{10}\frac{\max|x(n)|^2}{E|x(n)|^2}$$



High PAPR causes

- Degradation of BER performance
- Frequency spectrum re-growth in non-linear channel

Non-linear amplifier



Output signal of non-linear amplifier

$$s(t) = F[|y(t)|]e^{j\{\arg[y(t)]+\Phi[|y(t)|]\}}$$

Model of AM/AM and AM/PM conversion characteristics

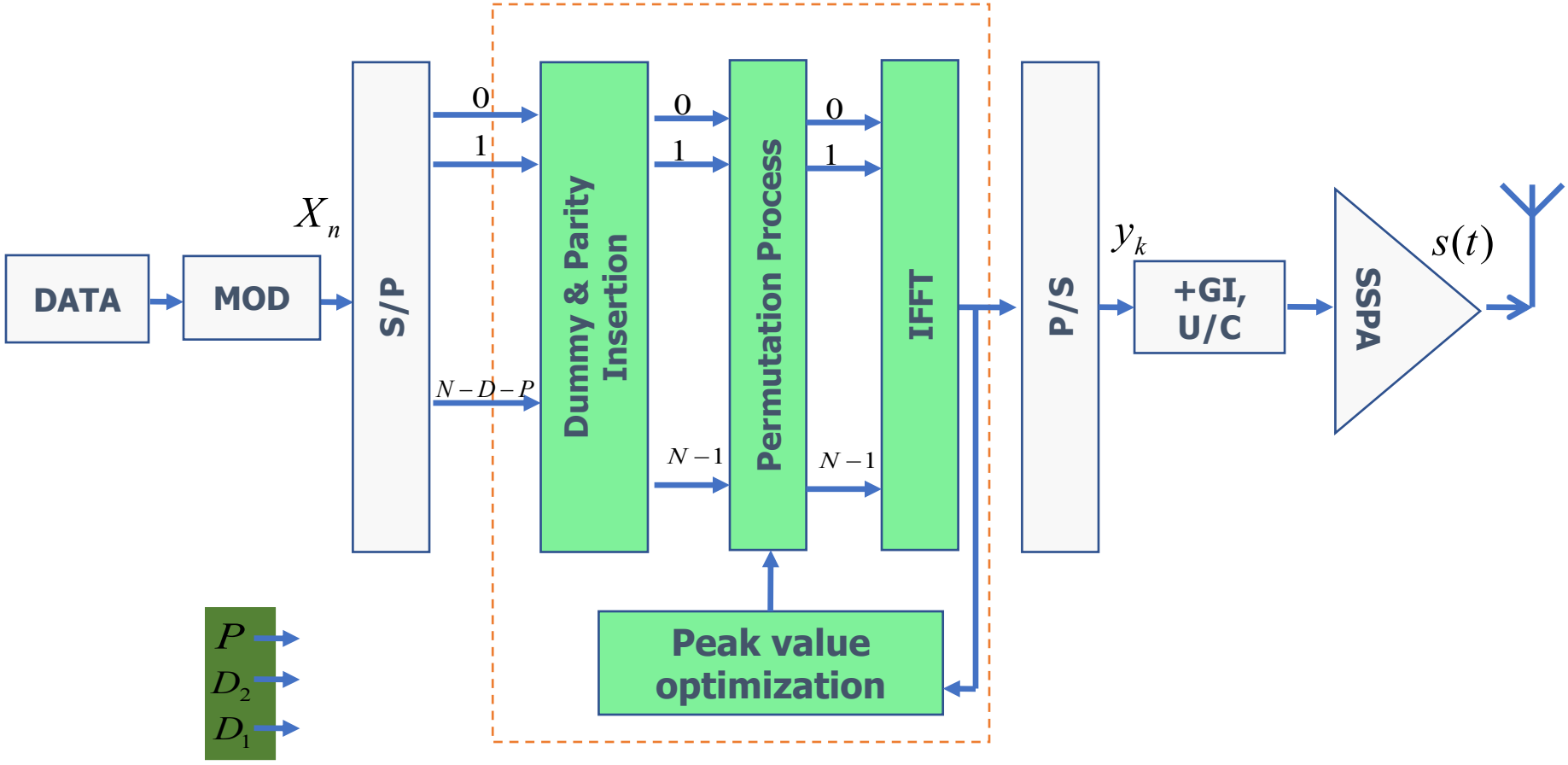
$$F[\rho] = \frac{\rho}{[1+(\rho/A)^{2r}]^{1/2r}}$$

ρ : the amplitude of input signal

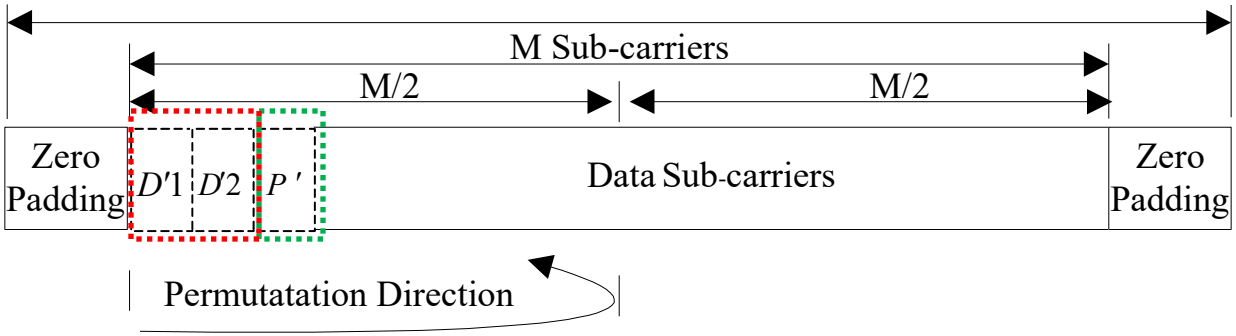
A : the saturated output level

r : the parameter to decide the non-linear level

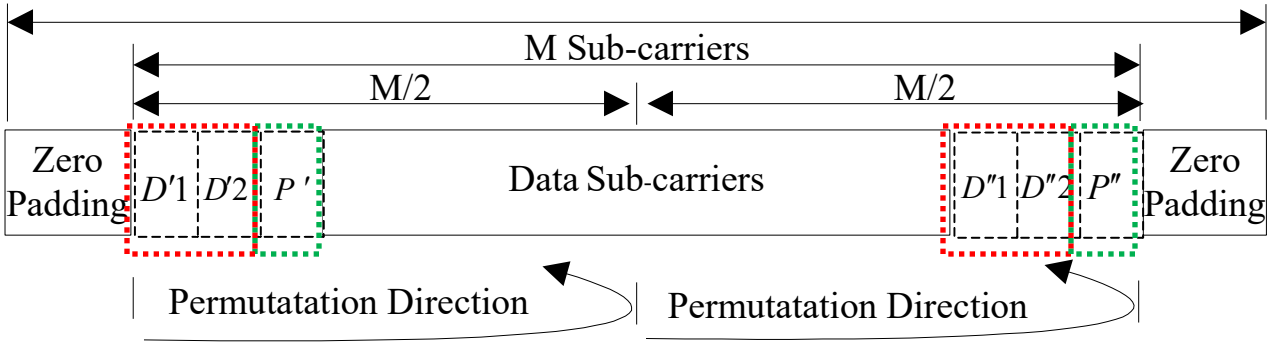
Structure of transmitter for the proposed method



Frequency domain OFDM symbol for proposed PS method

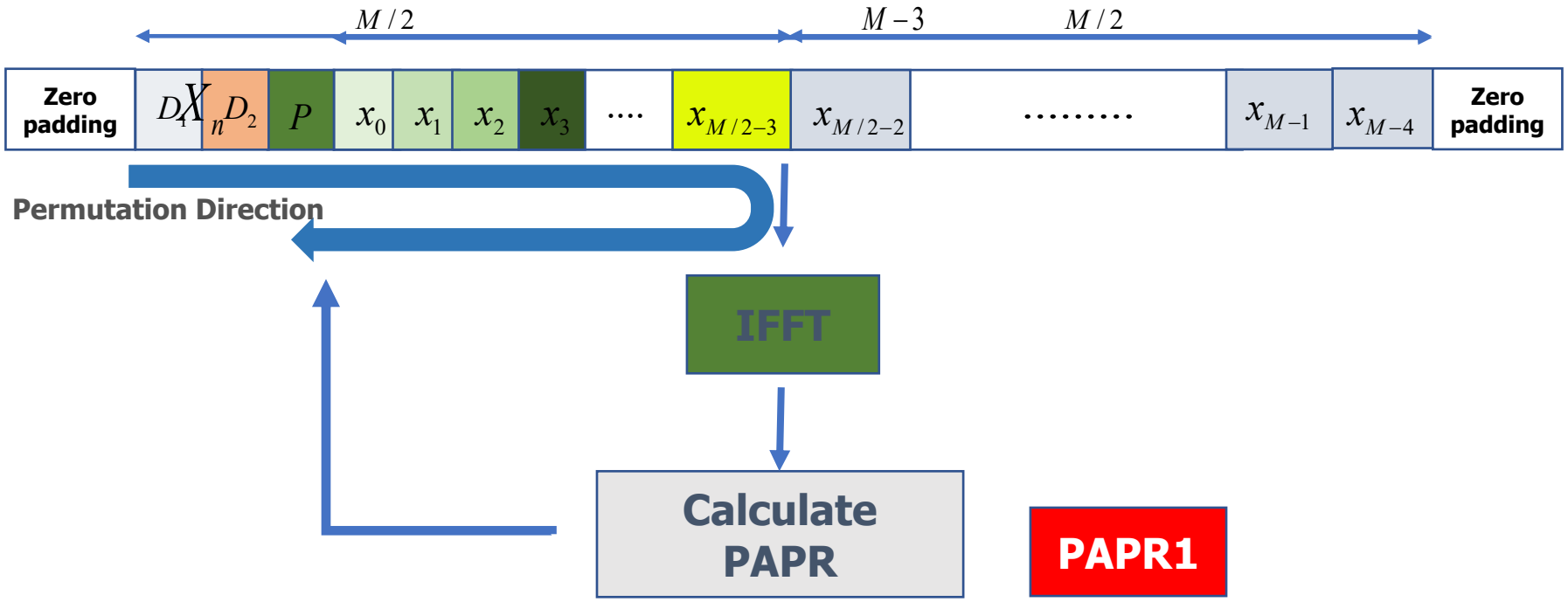


(a) Type I



(a) Type II

Permutation method



$$L = 1$$

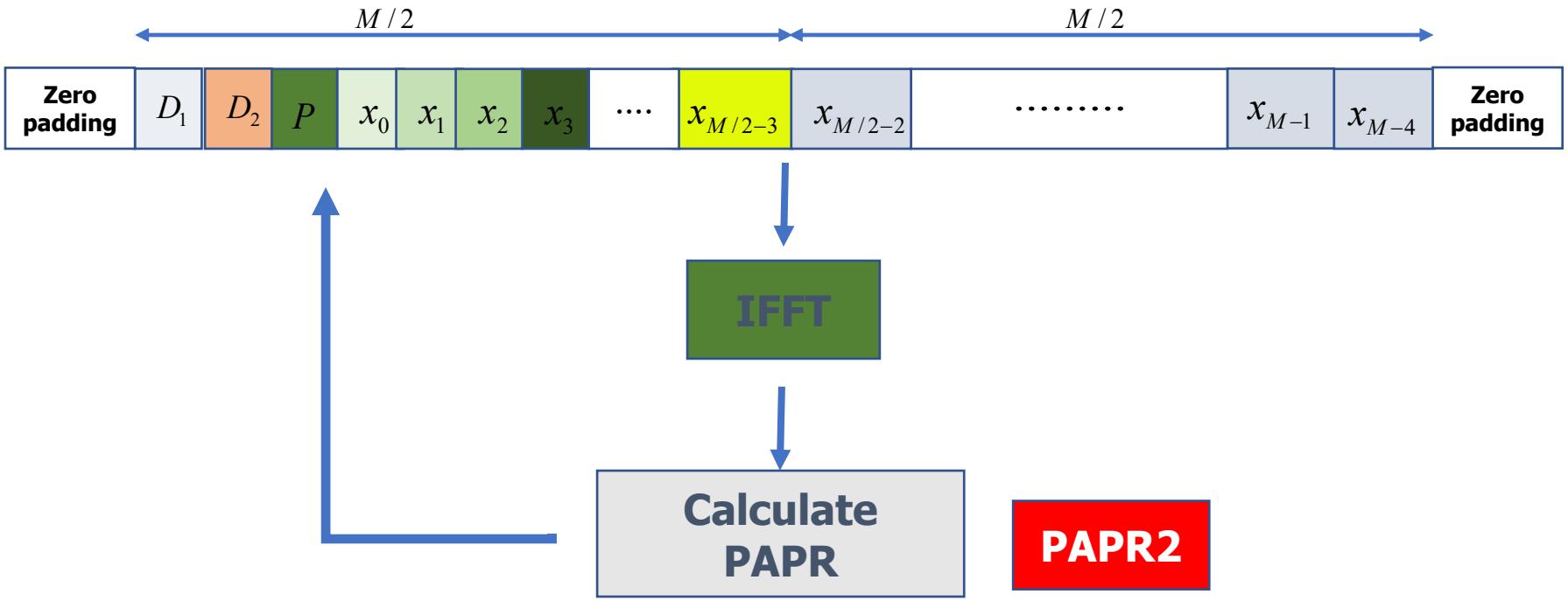
D = ***Dummy subcarrier with power of 0***

P = ***Parity check subcarrier***

$$P = (-1)^{(M/2-L+5)}.\alpha$$

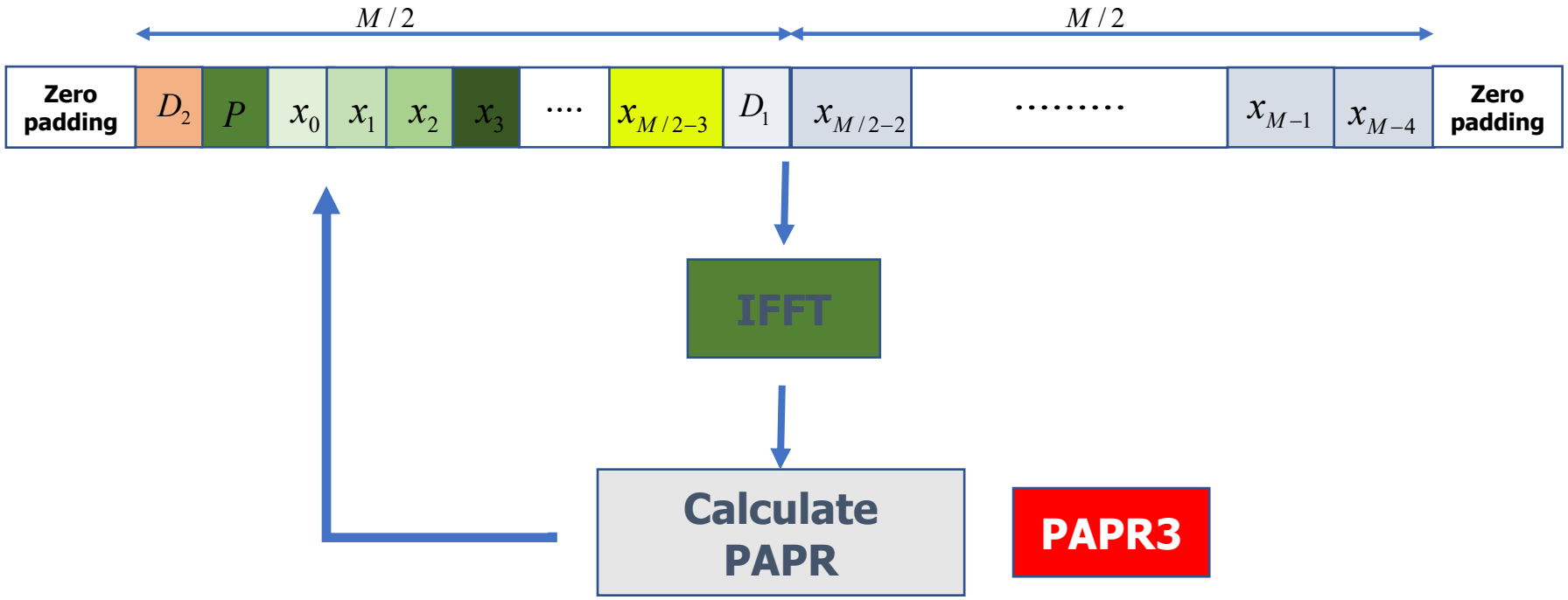
α = **Power as the same as the averaged power of data transmitter**

Permutation method (2)



$$L = 2$$

Permutation method (3)



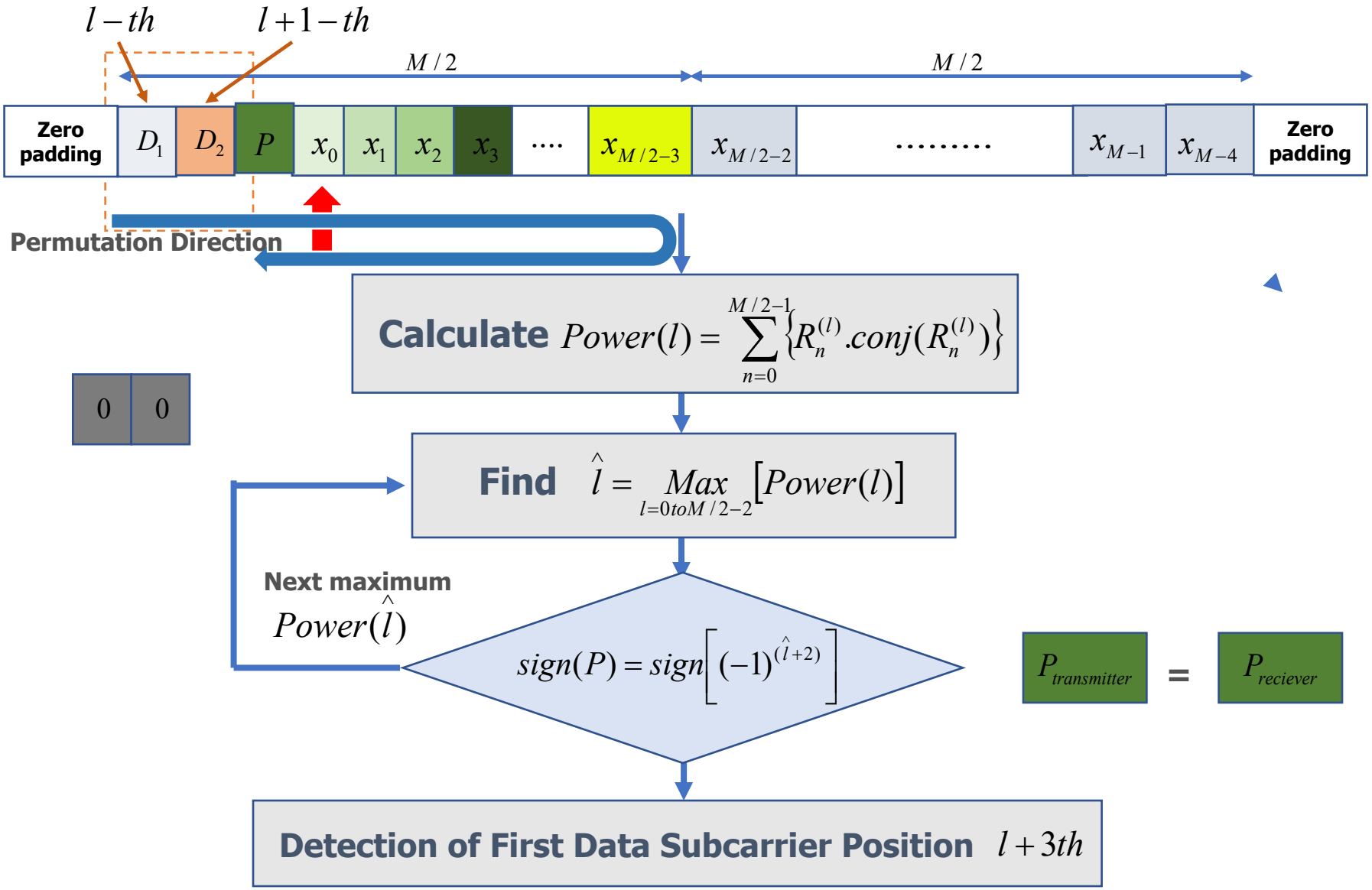
$$L = 3$$

Detection algorithm for PS method

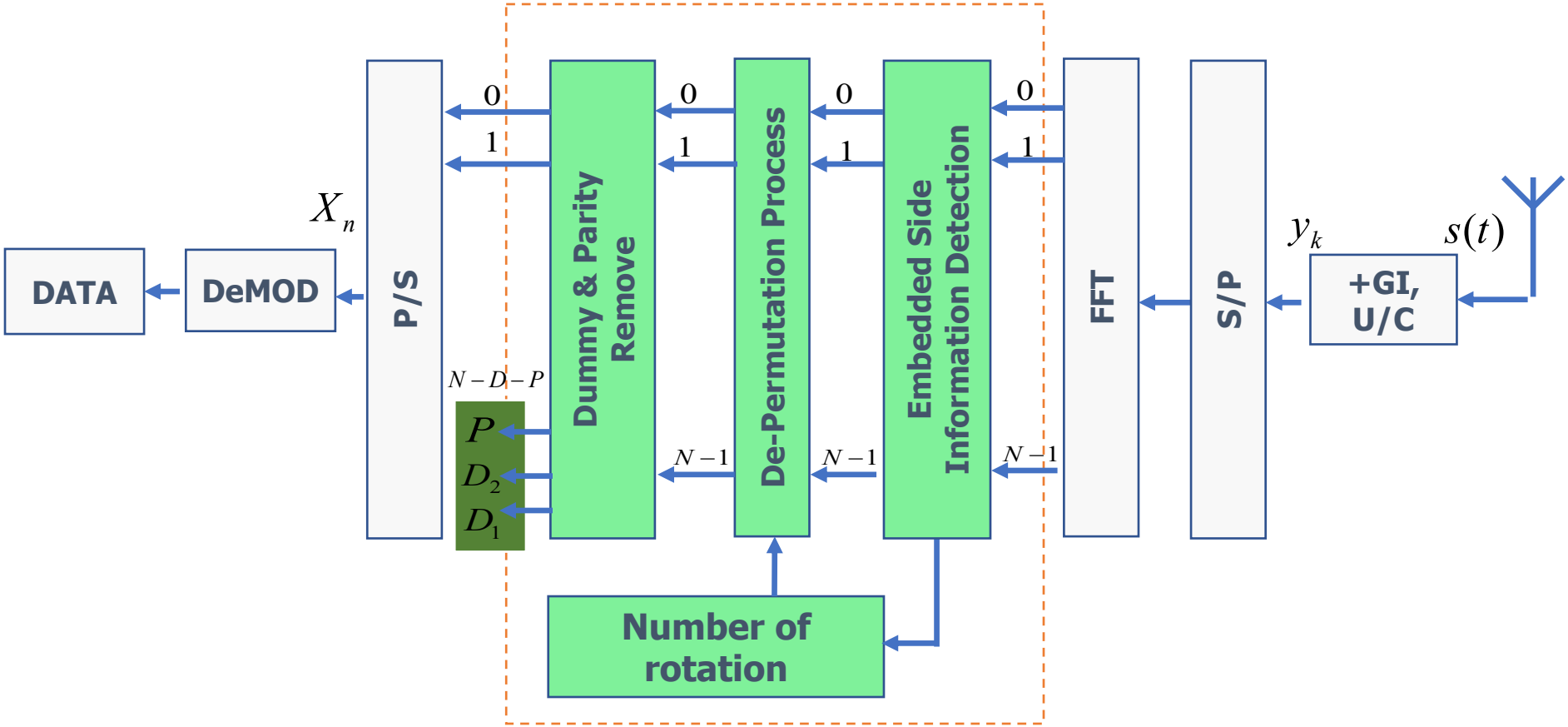
To detect the correct demodulation of data information

- **The position of first data subcarrier can be detected by finding the position of dummy and the sign of parity check sub-carriers**
- **Firstly, replace the consecutive two subcarriers to zero from the start of received signal in F-domain and calculate the power of received signal**
- **The first position of subcarrier can be detected by parity check subcarrier and the dummy subcarrier with the maximum power**
- **The original data sequence can be recovered and data information can be demodulated correctly**

Detection algorithm for PS method



Structure of receiver for the propose method



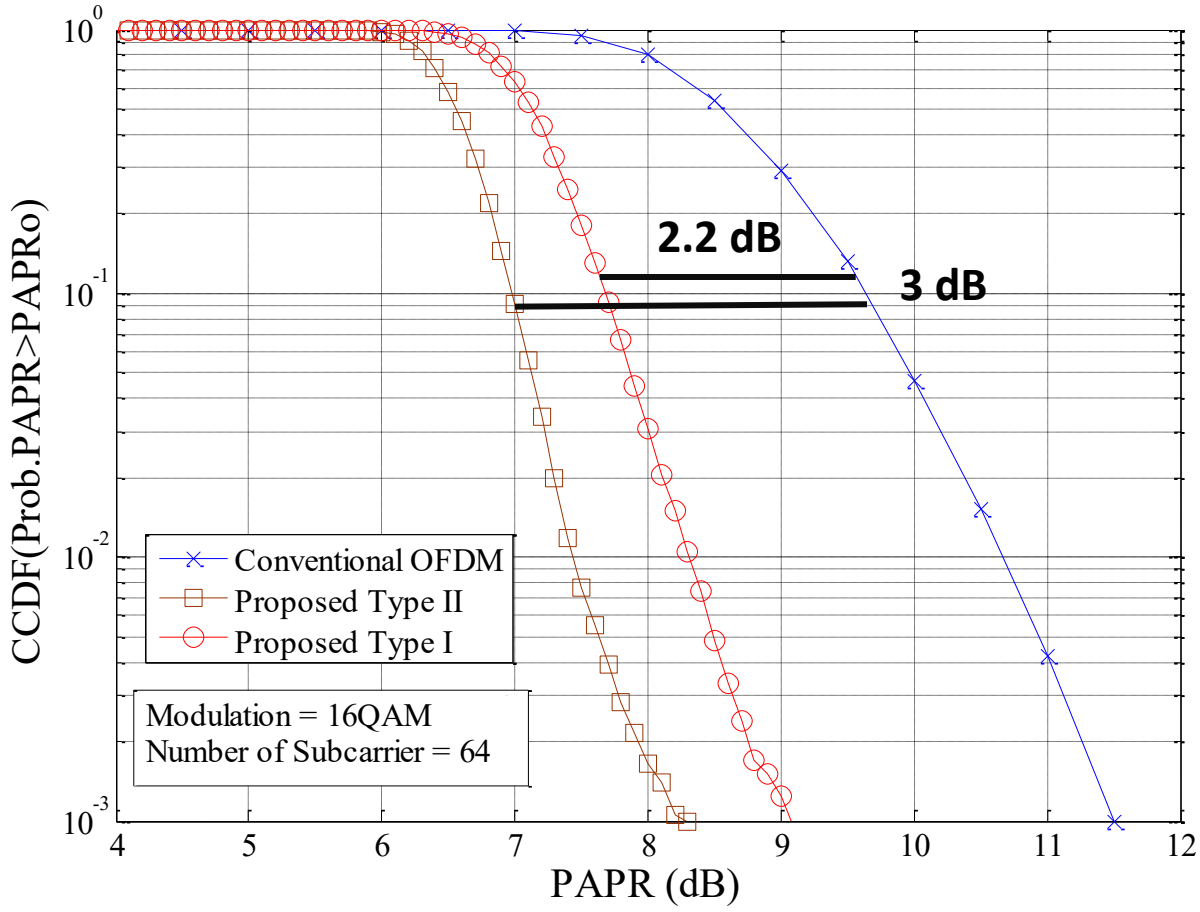
Simulation parameters

Modulation method	**64QAM**
Demodulation method	**Coherent**
OFDM bandwidth	**5 MHz**
Number of FFT points (N=Z+M)	**256**
Number of sub-carriers (M=D+P+K)	**64**
Number of dummy sub-carriers (D)	**2**
Number of parity sub-carriers (P)	**1**
Number of data sub-carriers (K)	**61**
Number of zero padding (Z)	**192**
Symbol duration	**12.8 us**
Guard interval	**1.2 us**
Model of non-linear amplifier	**SSPA**
Non-linear parameter of Eq. (2)	**r=2**
Channel model	**AWGN**

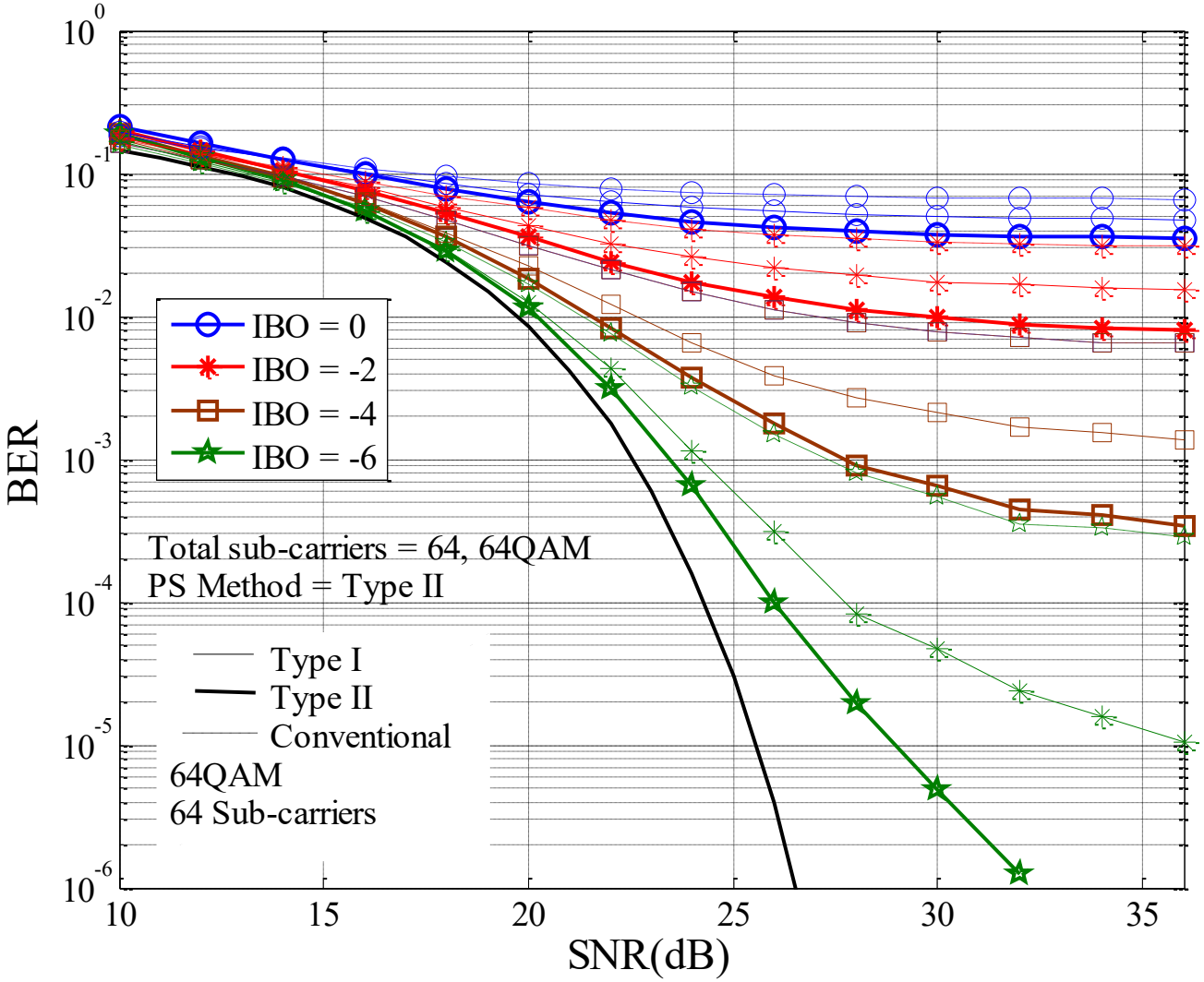
Transmission efficiency for proposed method

Number of Sub-carriers	Transmission efficiency Type I	Type II
64	Type I	Type II
256	61/64 (95.3%)	58/64 (90.6%)
1024	253/256 (98.8%)	250/256 (97.7%)

PAPR performance of proposed method



BER performance of proposed method in non-linear channel



Conclusions

- This paper proposed the PAPR reduction method for OFDM signal by using permutation sequences with embedded side information
- The salient future of proposed method is to rotate the subcarriers in the frequency domain so as to reduce the PAPR
- The rotation number selected at transmitter can be detect at the receiver by using the very few dummy subcarriers
- The proposed method can achieve higher transmission efficiency and better BER performance in the non-linear channel