ON PERFORMANCE OF JUDGING REGION AND POWER ALLOCATION FOR WIRELESS NETWORK CODING WITH ASYMMETRIC MODULATION

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- TWO time-slots DNF(denoise-and-forward)network coding;
- corresponding power matching ratio according to modulation types;
- simulations

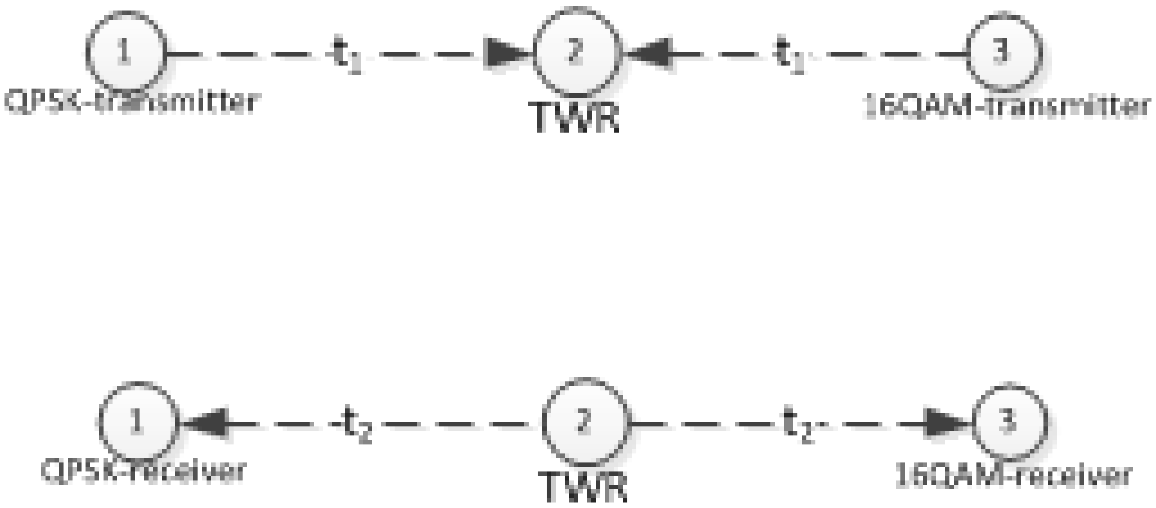
1 power matching with different modulation types

BACKGROUND:

As for DNF mode of two time-slots NC aided by TWR , the problem will be met:

1. How to allocate two transmitters' powers
2.Their influence with the performance at TWR
3.How to the improve the performance most efficiently when we get the throughput improvement by NC

Two-time slots NC scenario



1.1 Investigation of power matching

For traditional communication system, the better performance will be got at the destination when the transmission power is bigger. Or we can say the communication reliability will be higher.

1) but we find that, increasing the transmission power of one transmitter or the other separately or simultaneously without coherence will not optimum the performance.

2) the schemes of power matching are different for different modulation types;

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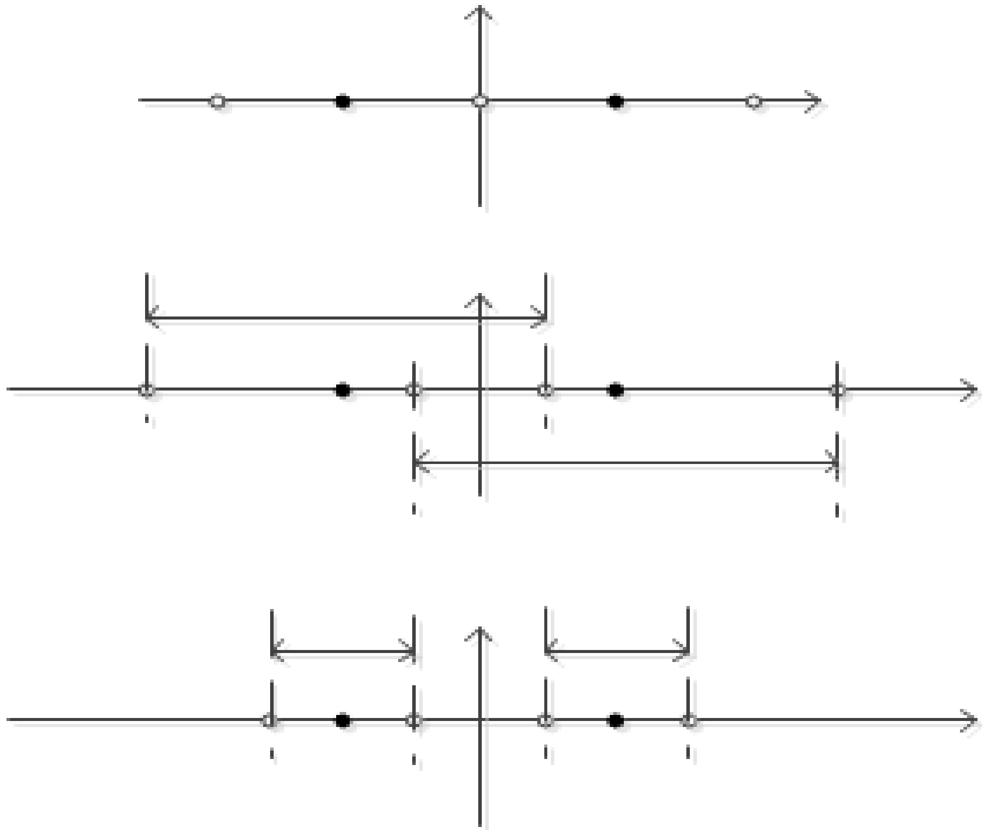
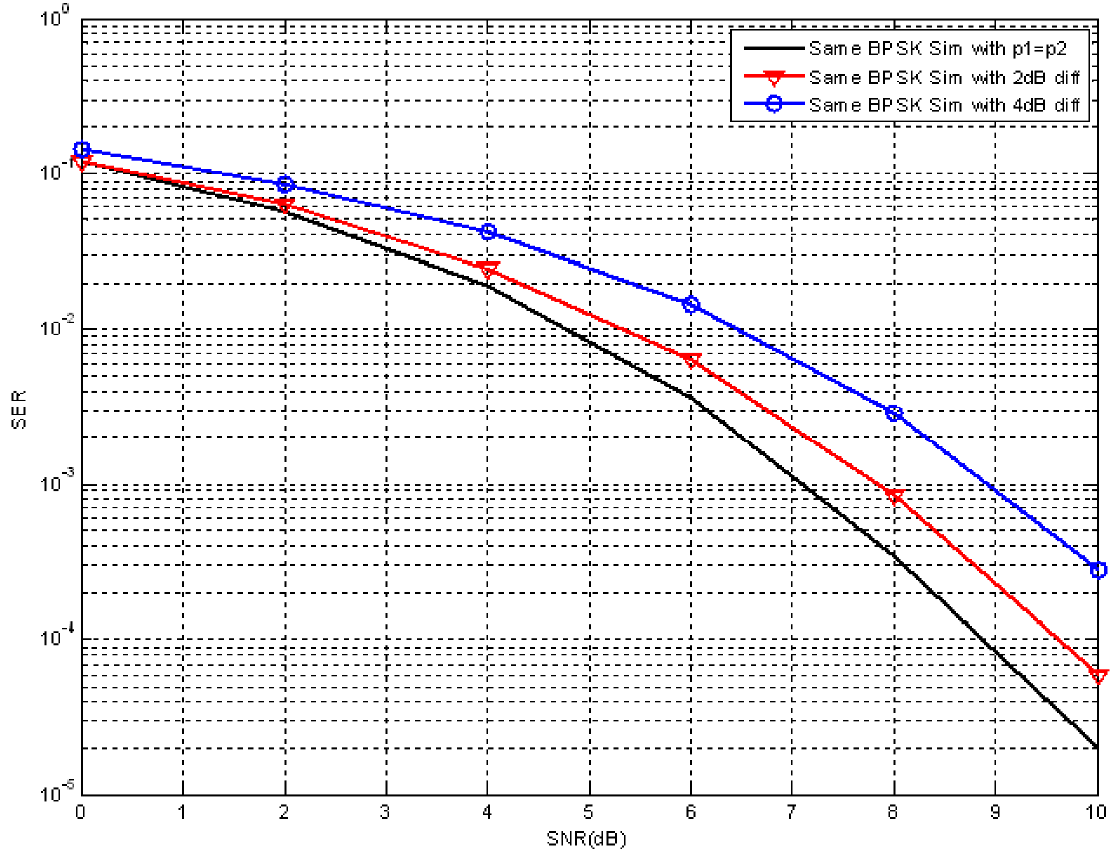
We start our discussion from the simplest situation : BPSK with BPSK



BPSK-BPSK network coding

(1)$P_1=P_2$;(2)$P_1>P_2$;(3)$P_1<P_2$

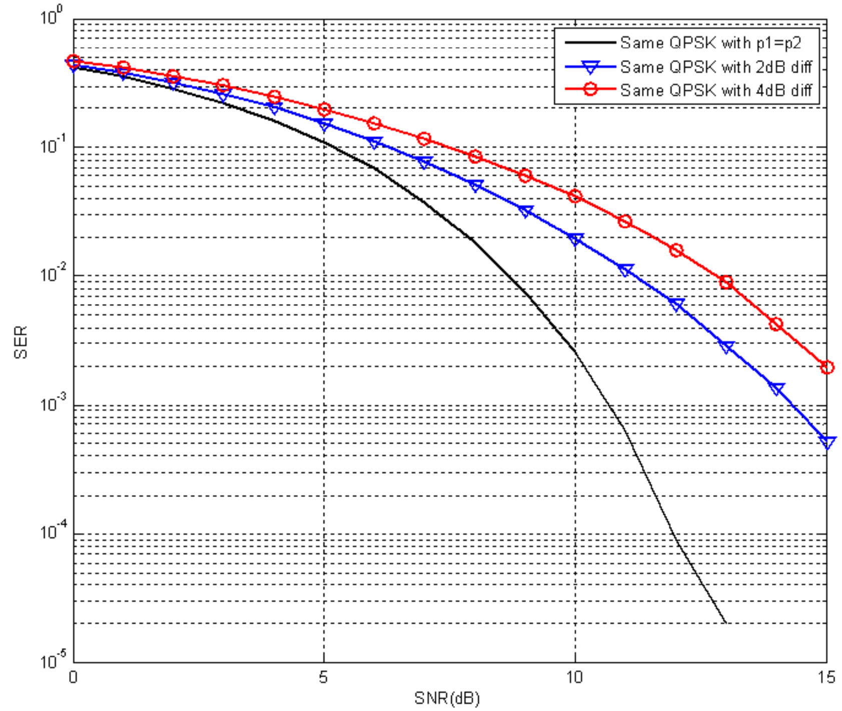
BPSK-BPSK network coding



SER performance with SNR

conclusion： the most efficient performance improvement at TWR is with the situation the two transmission powers are the same

QPSK-QPSK

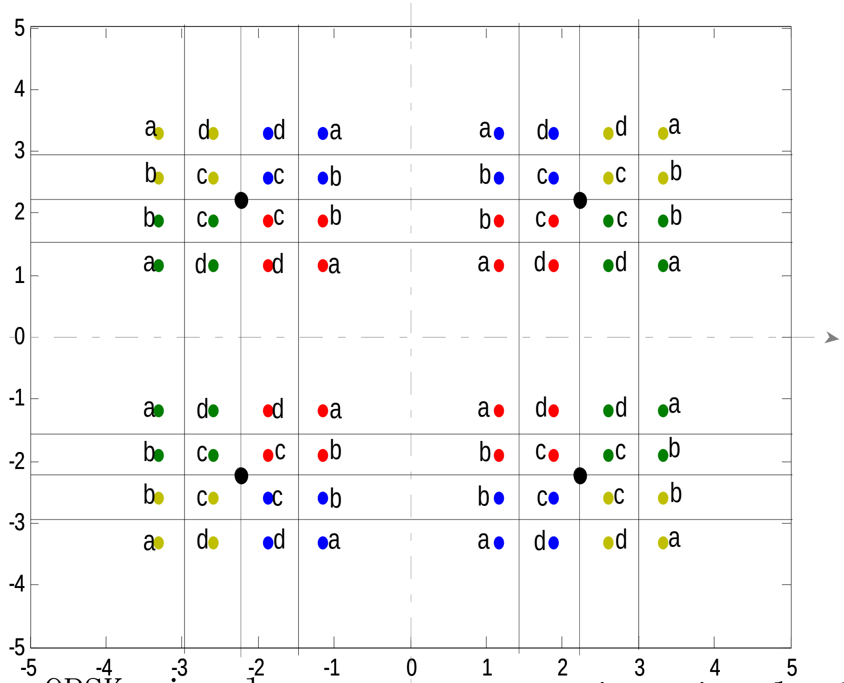


SER performance with SNR for QPSK-QPSKsituation

We have the same conclusion.

QPSK-16QAM

Superposing constellations of QPSK-16QAM



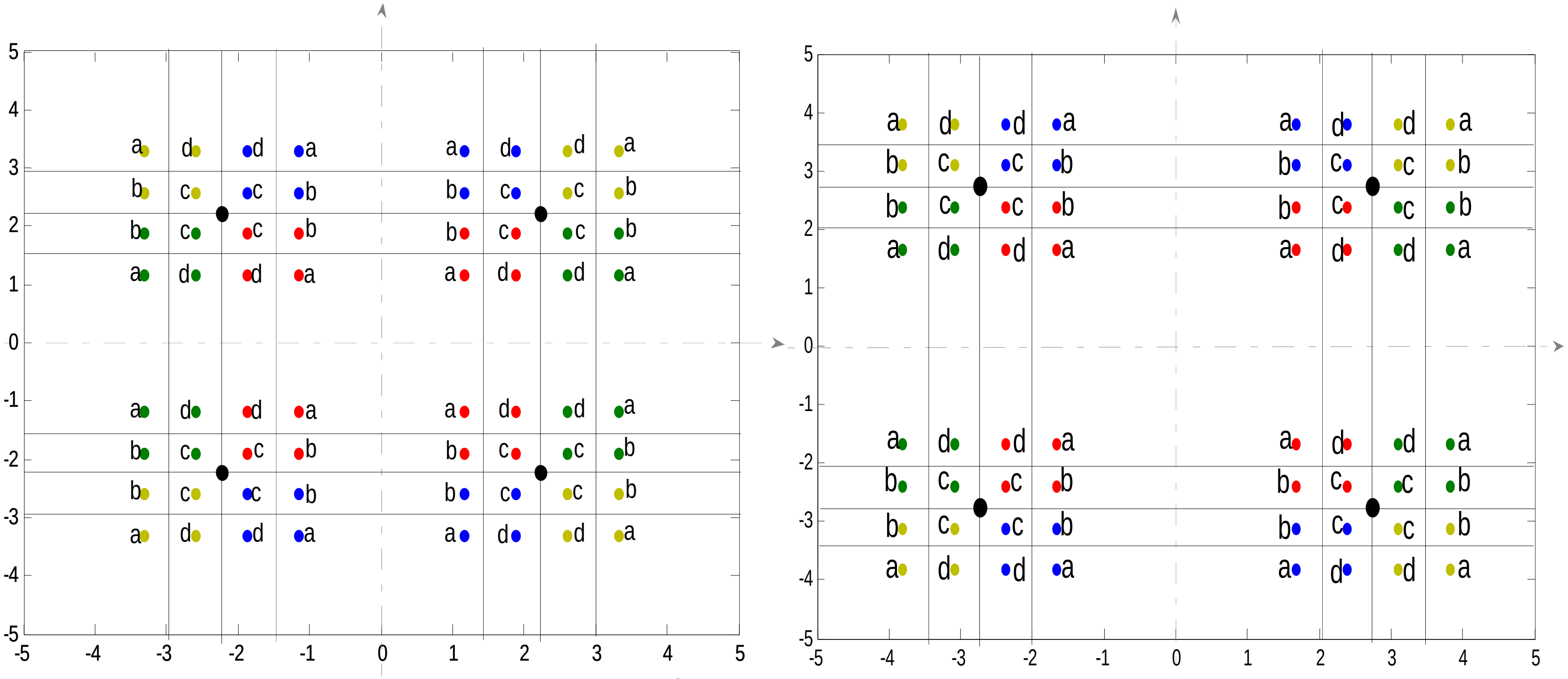
● –QPSK signal ● ● ● ● –superposing signal of QPSK by 16QAM

The mapping scheme for downlink

Region occupied by	I-component	Q-component
Red dots	-（opposite）	-（opposite）
Yellow dots	+（same）	+（same）
Green dots	+（same）	-（opposite）
Blue dots	-（opposite）	+（same）

Region occupied by	I-component of 16QAM	Q-component of 16QAM
a	3	3
b	3	1
c	1	1
d	1	3

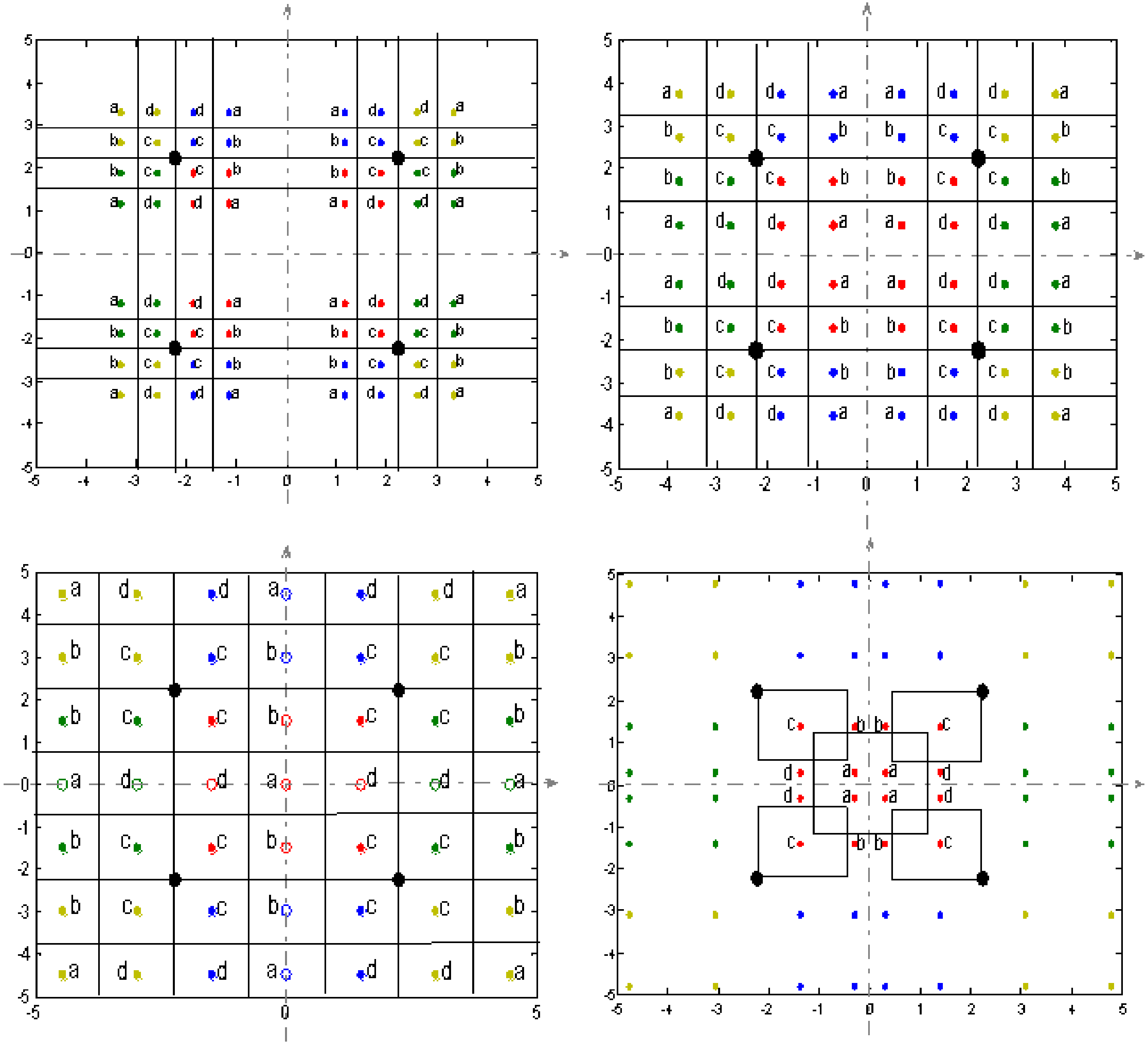
QPSK-16QAM功率匹配图形解释



QPSK-16QAM with fixed P16qam and increasing Pqpsk

Appearance： for fixed P_{16qam}， P_{qpsk} increasing， the superposing constellations around the axes will leave away from them, so the decision regions will be larger， but those for others will not change

Conclusion ： SER performance for part constellations will be improved， and that is not optimization.



QPSK-16QAM network coding with fixed Pqpsk and increasing P16qam

Appearance： for fixed P_{qpsk}， P_{16qam} increasing,
1)The decision regions for the constellations around the axes are decreasing， but from the view of Gaussian distribution, the distribution centers are closer to the decision region center， their SER performance gets improved；
2） for the constellations not around the axes， their SER performance also gets improved because of the decision region increasing ；
3） P_{16qam} increasing continuously , the constellations fall on the axes, then the decision regions for different decision results will superpose, and the performance will be worse;
Conclusion： to improve the performance, we should keep the transmission power matching to avoid the situation in 3) to become true. And the most efficient matching ratio will be the marginal value.

Derivation of marginal value for QPSK-16QAM

Normalization factors for QPSK and 16QAM transmission powers

$$\gamma_{qpsk} = E\left(\left|\alpha_{qpsk}\right|^2\right) + E\left(\left|\beta_{qpsk}\right|^2\right) = 2$$

$$\gamma_{16qam} = E\left(\left|\alpha_{16qam}\right|^2\right) + E\left(\left|\beta_{16qam}\right|^2\right) = \frac{2\times(1^2+3^2)+(1^2+1^2)+(3^2+3^2)}{4} = 10$$

From previous discussion we know the marginal value corresponds to the third diagram where 16QAM constellations fall on the axes and those have the same decision results superpose with each other. and the power relation is:

$$\sqrt{P_{qpsk}/\gamma_{qpsk}} = 3\sqrt{P_{16qam}/\gamma_{16qam}}$$

$$p_{qpsk} / p_{16qam} = 1.8$$

SER performance at TWR

After derivation we get the SER at TWR :

$$P_{up}=\left[-\frac{1}{2}Q(2a'+5b')-\frac{5}{8}Q(2a'+b')\right]$$

$$+[-\frac{9}{4}Q(b')-\frac{1}{16}(Q(2a'-5b')^2+Q(2a'-3b')^2+Q(2a'-b')^2+Q(2a'+5b')^2+Q(2a'+3b')^2+Q(2a'+b')^2)]$$

$$+[3-\frac{3}{4}(Q(2a'-5b')^2-Q(2a'-3b')^2+Q(2a'-b')^2-Q(2a'+5b')^2)+\frac{7}{8}(Q(2a'+b')^2-Q(2a'+3b')^2)]Q(b')$$

$$+[\frac{1}{2}+\frac{1}{8}(Q(2a'+5b')^2+Q(2a'-3b')^2-Q(2a'-b')^2+Q(2a'+b')^2-Q(2a'+3b')^2)]Q(2a'-5b')$$

$$+[\frac{1}{8}(Q(2a'-b')^2+Q(2a'+5b')^2-Q(2a'+b')^2+Q(2a'+3b')^2)-\frac{1}{2}]Q(2a'-3b')$$

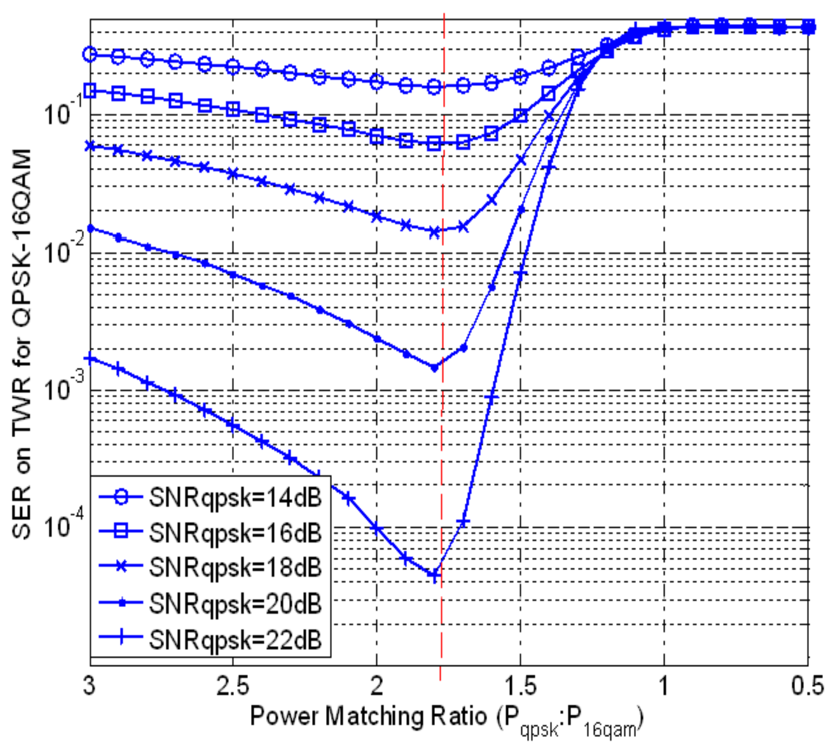
$$[\frac{1}{2}+\frac{1}{8}(Q(2a'+5b')^2+Q(2a'+b')^2-Q(2a'+3b')^2)]Q(2a'-b')$$

And pervious problem can be expressed as :

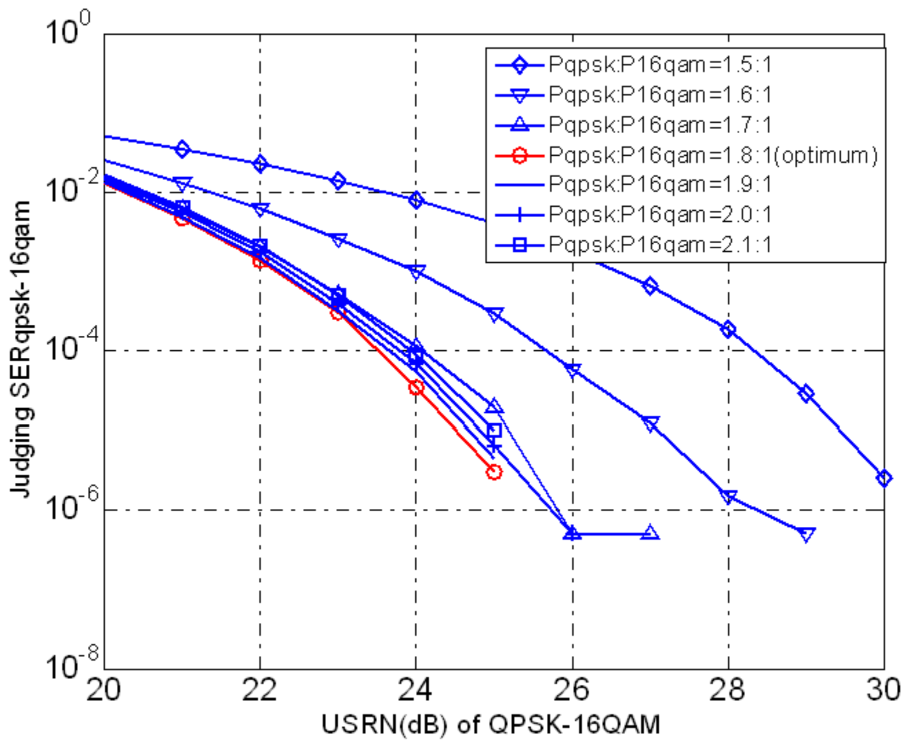
$$\begin{aligned} \min \quad & \mathrm{SER}_{TWR} \\ s.t. \quad & \mathrm{P}_{qpsk} + P_{16qam} = P_{\lim} \\ & \mathrm{P}_{qpsk} > 0 \\ & \mathrm{P}_{16qam} > 0 \\ & \sqrt{P_{qpsk} / 2} \geq 3\sqrt{P_{16qam} / 10} \end{aligned}$$

The optimum value is also :

$$\mathrm{p}_{\mathrm{qpsk}} / \mathrm{p}_{\mathrm{16qam}} = 1.8$$

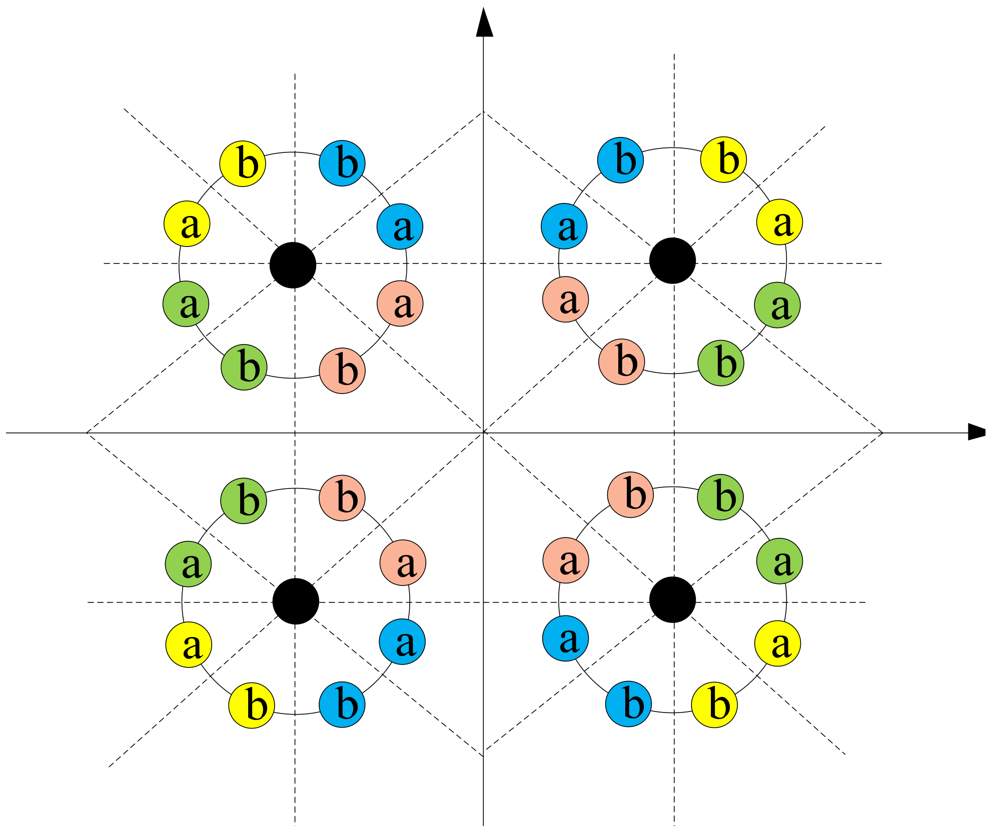


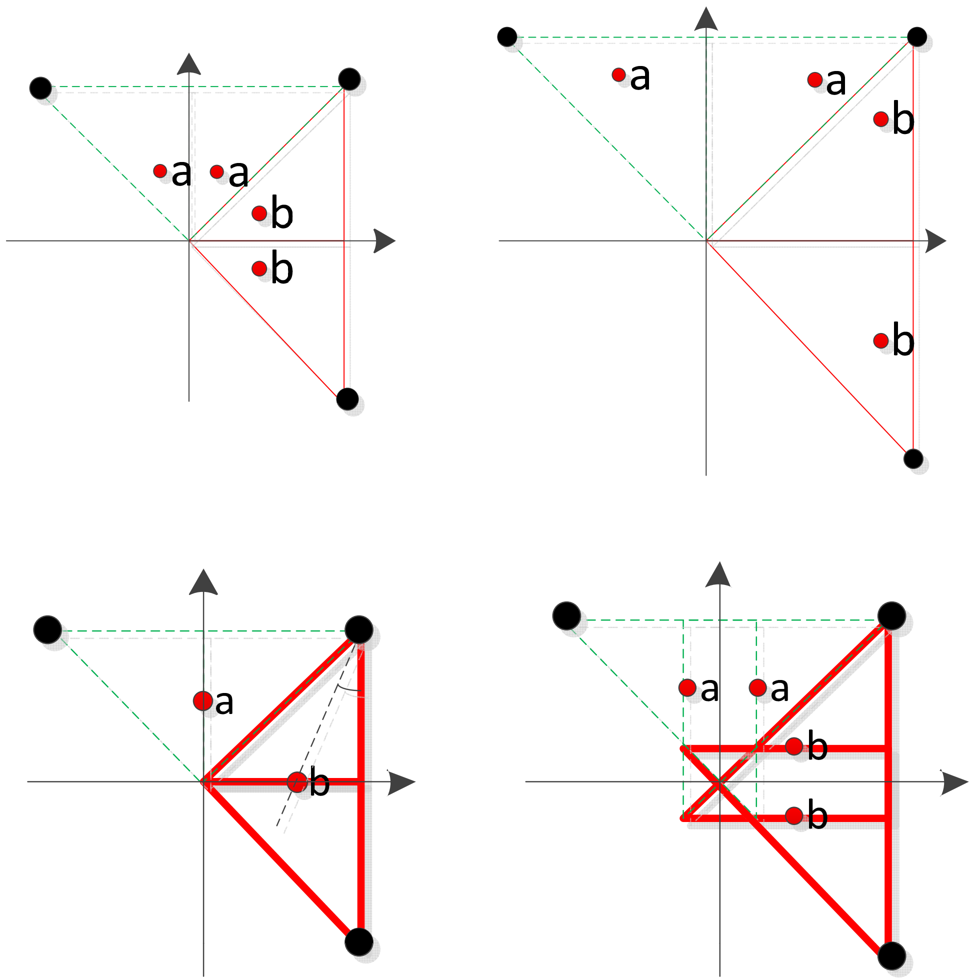
Fixed P_{qpsk}, SER performance with P_{16qam} changing



SER with the total transmission power (for different fixed power matching ratio)

QPSK-8PSK

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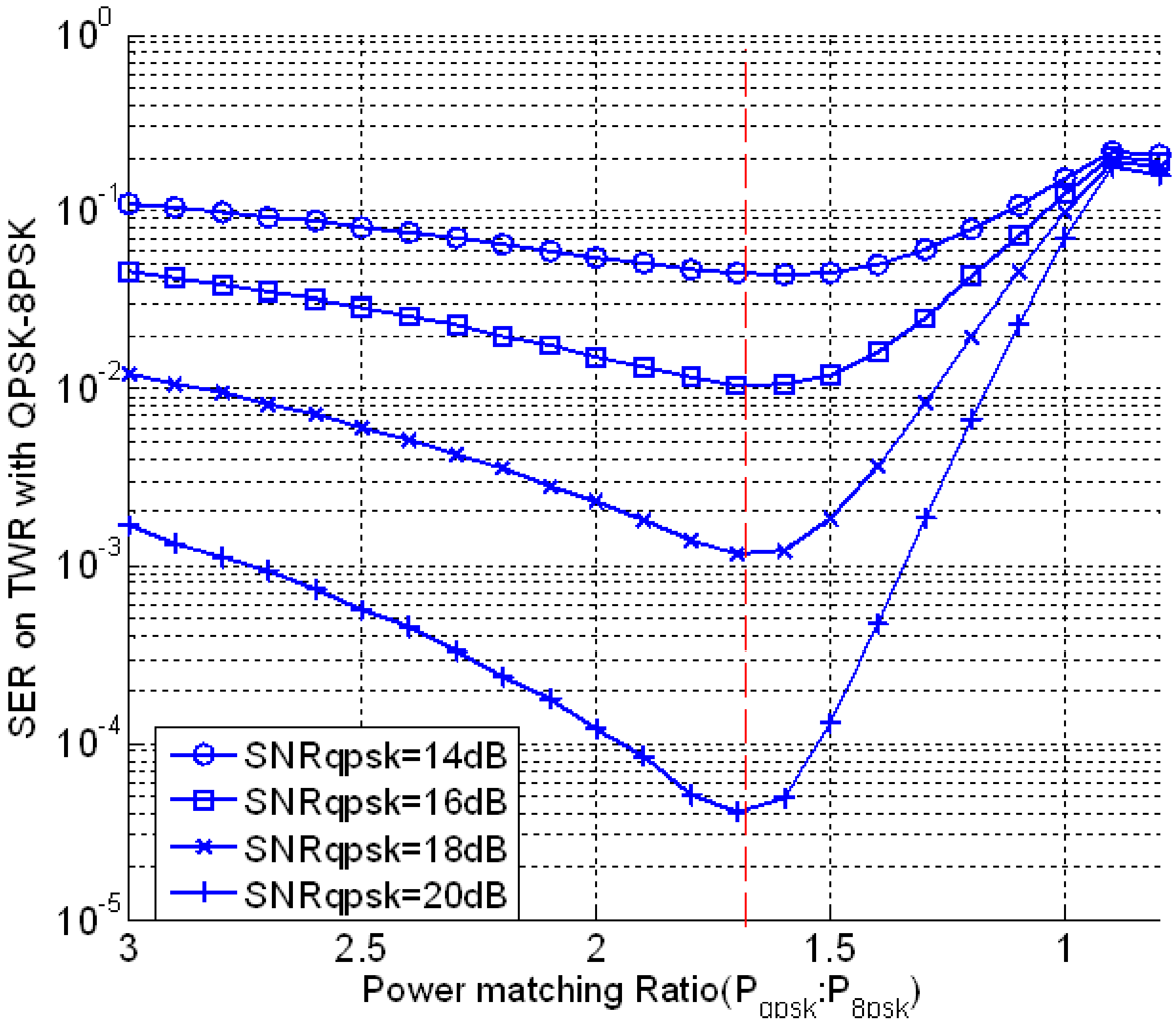
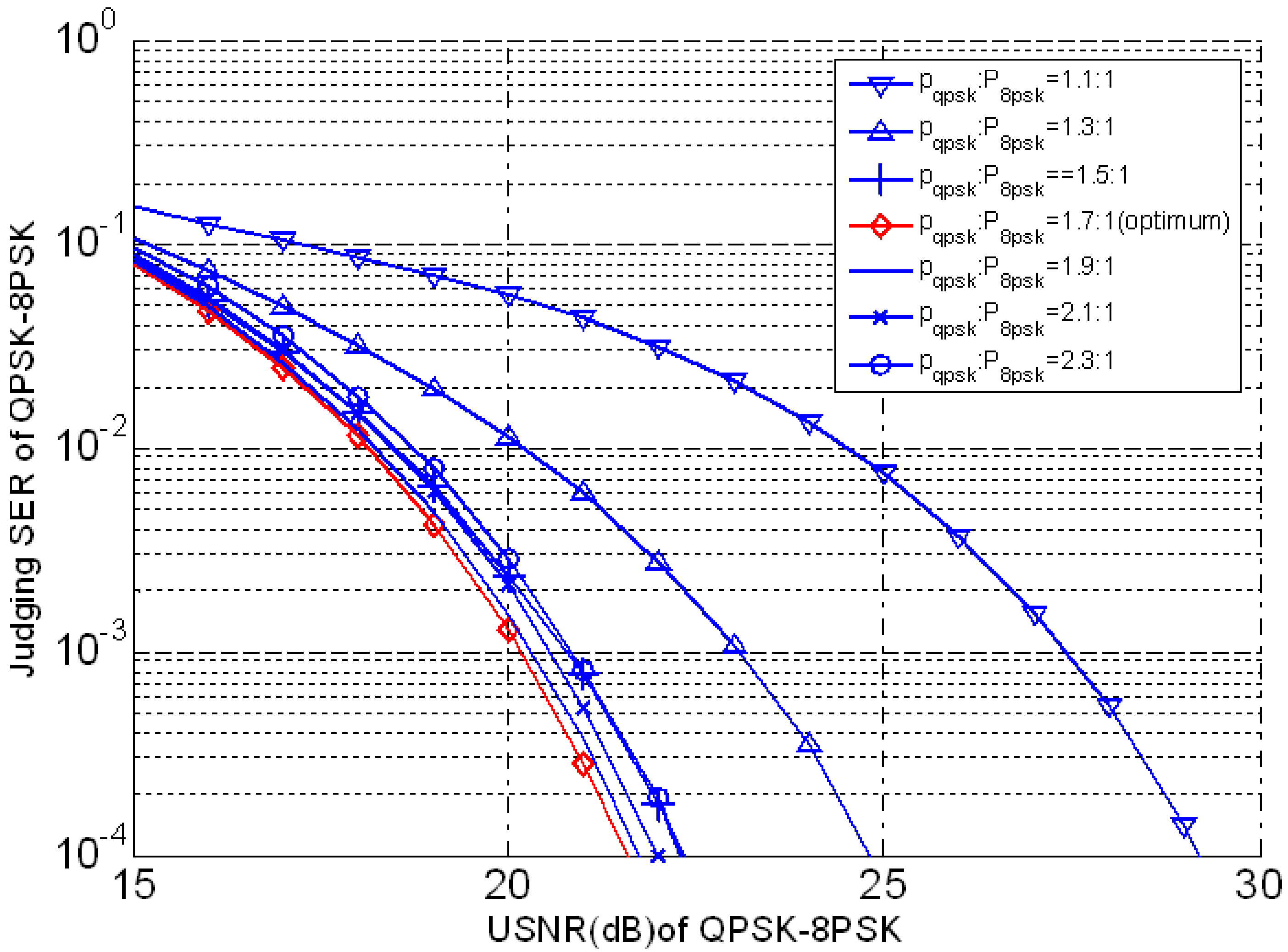


Fixed P_{qpsk}, SER performance withP_{8psk} increasing



SER performance with total power increasing (for different power matching ratios)

Conclusion

for the network coding of two-time slots, we need to consider the two transmitters power ratio according to their modulation types. And different ratios influence the decoding performance at TWR significantly though the total power has no changes.

Thank you