NOMA simulation based on OAI

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1.Functions in Downlink Simulation

2.Data in Downlink Simulation

3.Process of NOMA Simulation

4.Result of Simulation

5.Shortcomings and Expectation

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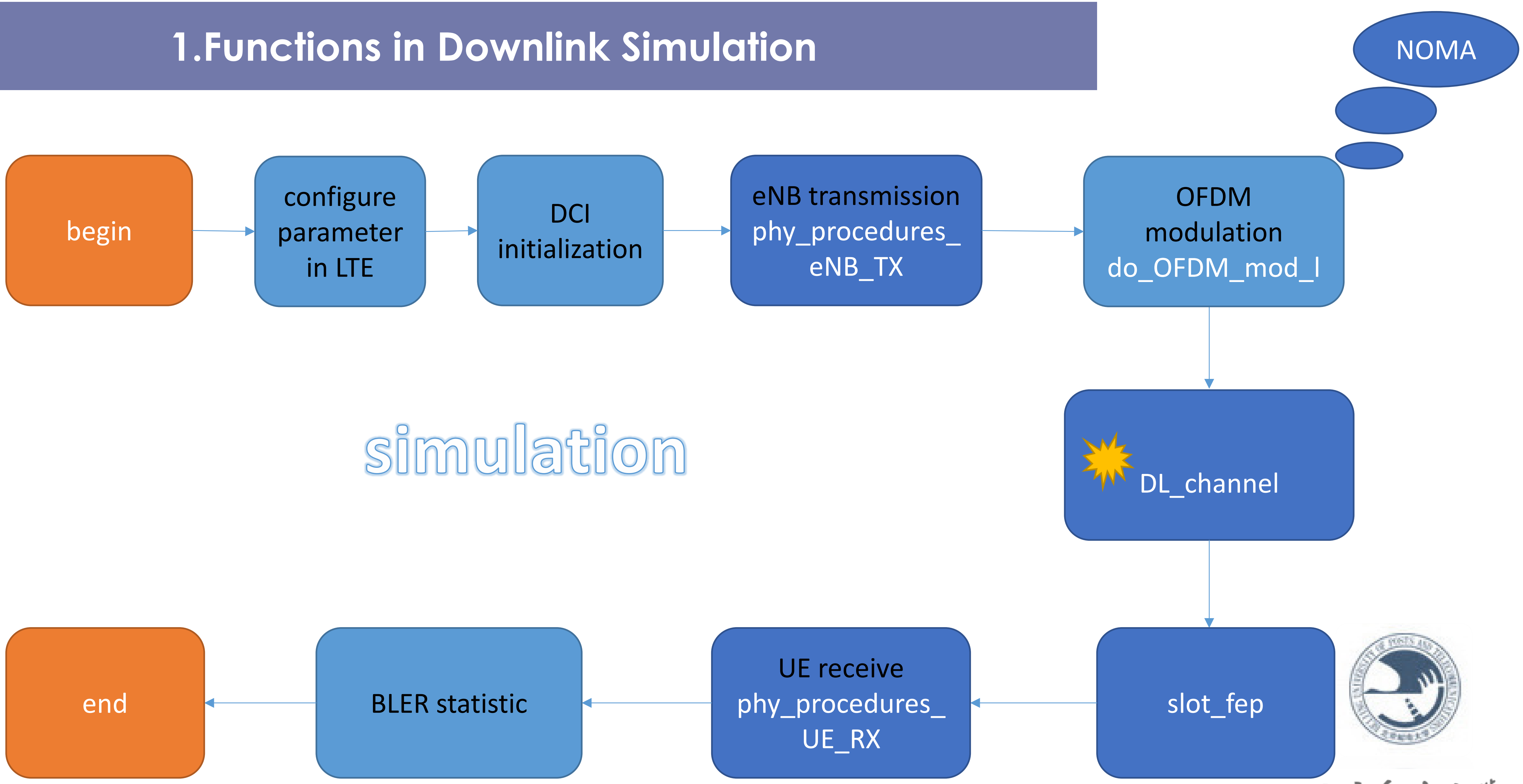
1.Functions in Downlink Simulation



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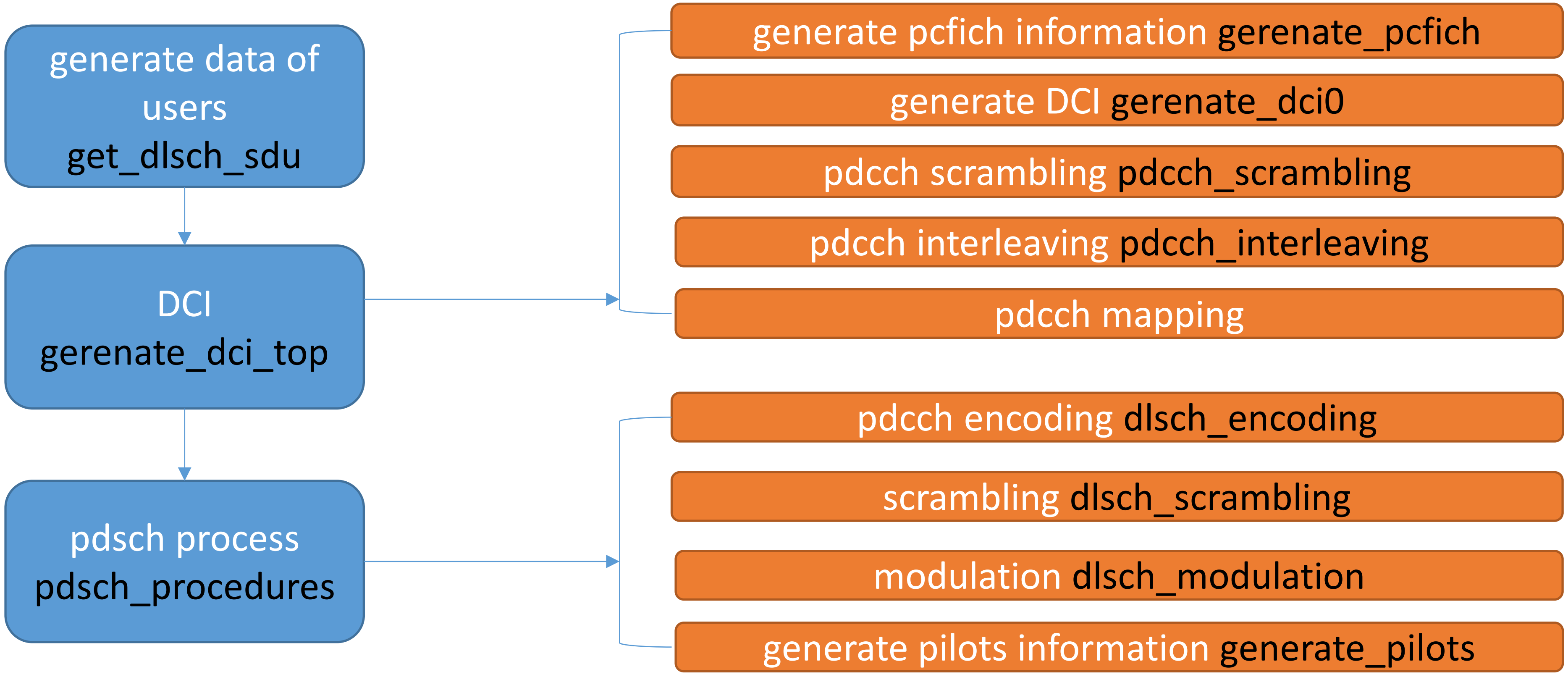
eNB transmission-> phy_procedures_eNB_

back

- The details of the function:



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generate data of users

back

- The data of users are random numbers,which is saved in input_buffer0 or input_buffer1.
- The random numbers are generated by the function unsigned int taus(void) and the operator and(&).
- And the function get_dlsch_sdu will return the array input_buffer0 or input_buffer1 based on the parameter Tbindex is 0 or 1(when Tbindex is 0, input_buffer0 will be returned, or input_buffer1 will be returned).

CHANNEL -> DL_channel

back

- The file dlsim.c can simulate many kinds of channels, including SCM_C channel, SCM_D channel, EPA channel, EVA channel, ETU channel, MBSFN channel, Rayleigh channel, Rice channel and AWGN channel.
- And the model of the sumulation is just like $y = x \otimes h + n$.
- In the model, x is the data to be transmitted, h is channel impulse response, n is white Gaussian noise and y is the receiving data.
- In the simulation of NOMA, I set the channel as AWGN channel, so the channel impulse response h_{awgn} is 1, and the model is $y = x + n$.

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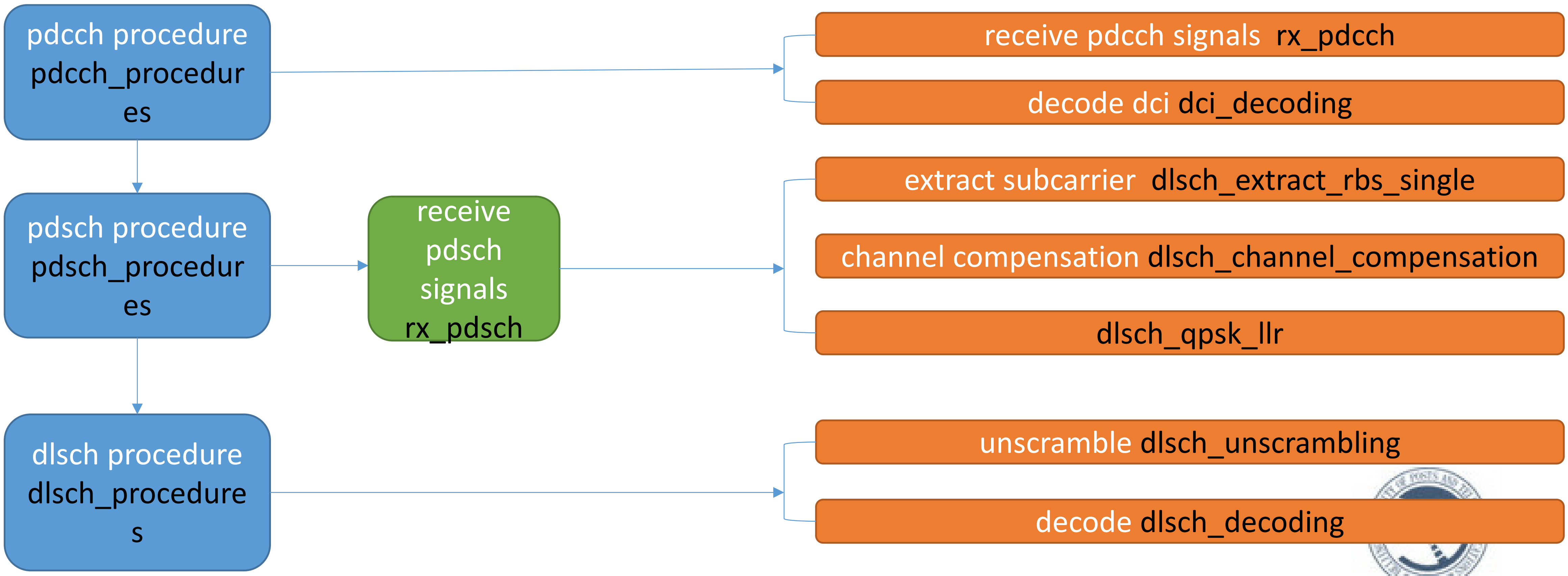
UE receive -> phy_procedures_UE_RX

back

- The details of the function:



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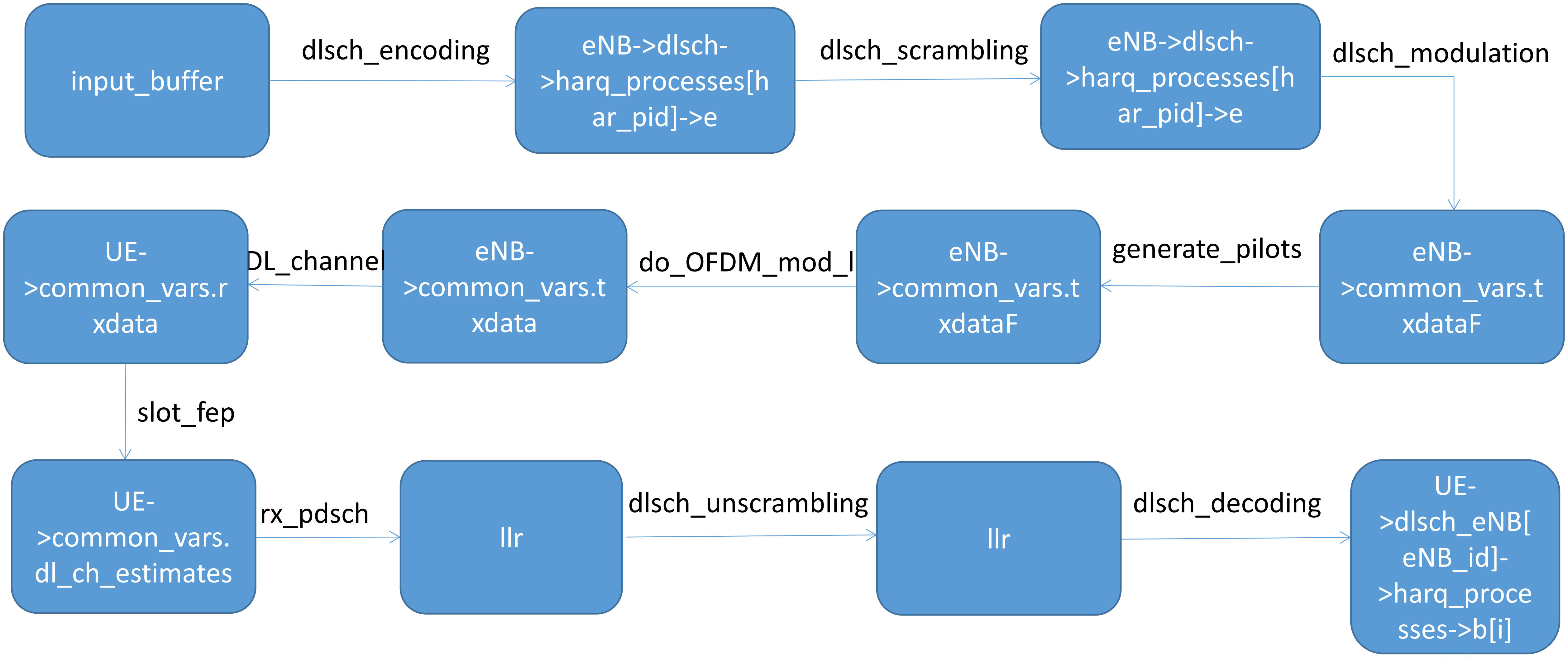
2.Data in Downlink Simulation



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3.Process of NOMA Simulation

- Step 1:There are 2 UEs in my simulation, the channel of one is good, and the other is bad.
- Step 2:After encoding, scrambling,modulating and IDFT of the data from different users,we can reach two txdata array. Txdata1 is the data from UE1 with good channel, and txdata2 is the data from UE2 with bad channel.
- Step 3:So the new array txdata = (alpha*txdata1 + beta*txdata2)/(alpha+beta), alpha<beta.
- Step 4:Send txdata to DLchannel, we can reach rxdata.

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- Step 5:For UE2, we can directly use the array rxdata and send it to the function phy_procedures_UE_RX to get the result.
- Step 6:For UE1, firstly, we need send rxdata to phy_procedures_UE_RX to get the data of UE2. And then we send the data we got to phy_procedures_eNB_TX. So we can reach a new txdata array, we call it txdata'. Then we can reach a new rxdata called rxdata' by the formula.

  rxdata' = [rxdata * (alpha+beta) - txdata' * beta]/alpha

  At last, we send the array rxdata' to phy_procedures_UE_RX, and we can get the data of UE1.

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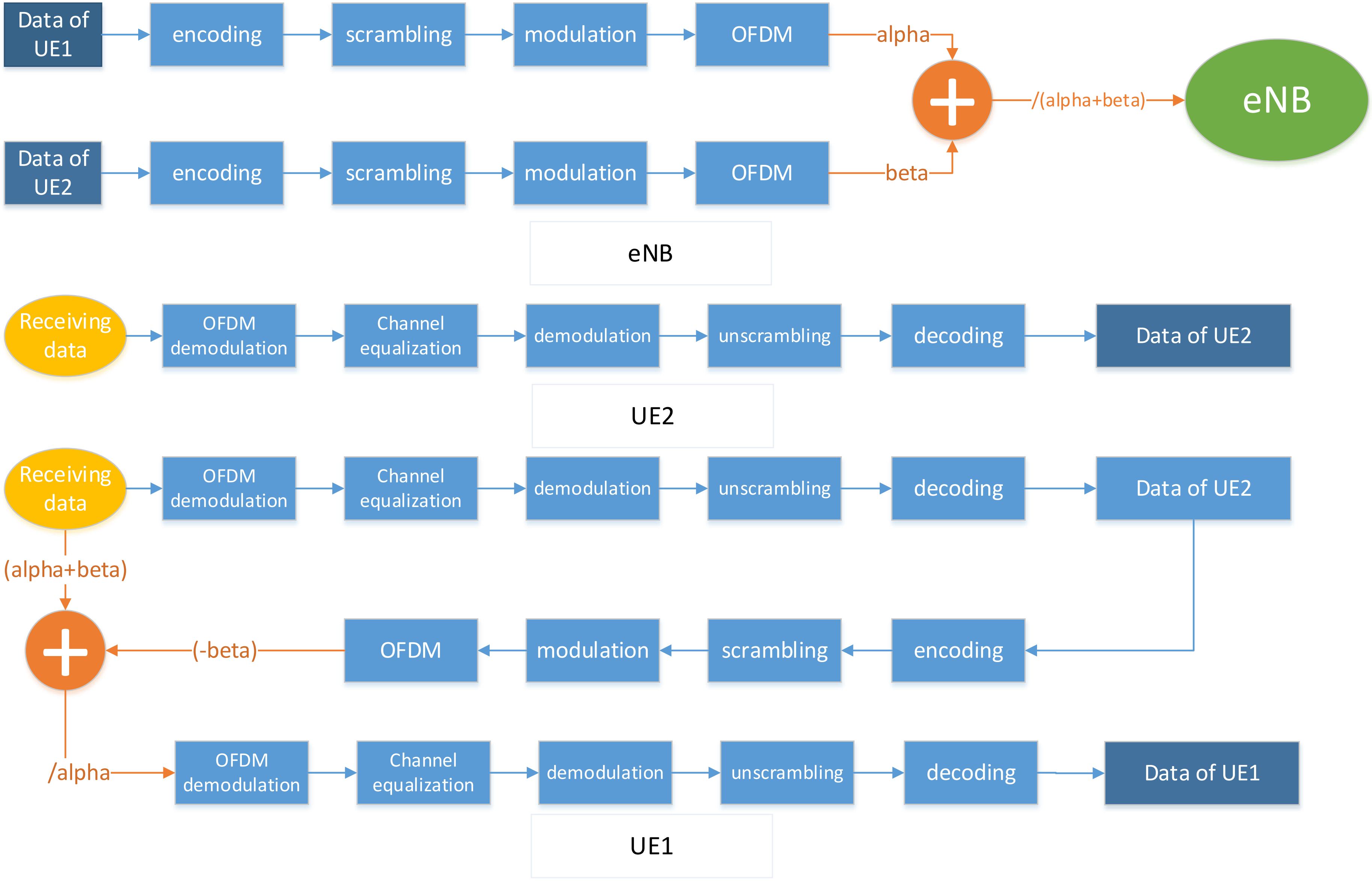
NOMA


Data of UE1
encoding
scrambling
modulation
OFDM
alpha
Data of UE2
encoding
scrambling
modulation
OFDM
beta
/(alpha+beta)
eNB
eNB
Receiving data
OFDM demodulation
Channel equalization
demodulation
unscrambling
decoding
Data of UE2
UE2
Receiving data
OFDM demodulation
Channel equalization
demodulation
unscrambling
decoding
Data of UE2
(alpha+beta)
encoding
scrambling
modulation
OFDM
(-beta)
/alpha
OFDM demodulation
Channel equalization
demodulation
unscrambling
decoding
Data of UE1
UE1

4.Result of Simulation

In my simulation, the parameters are set as follows:

parameter	value
duplex mode	FDD
transmission mode	TM1(SISO)
DL carrier frequency	2.59GHz
system bandwidth	5MHz
channel	AWGN

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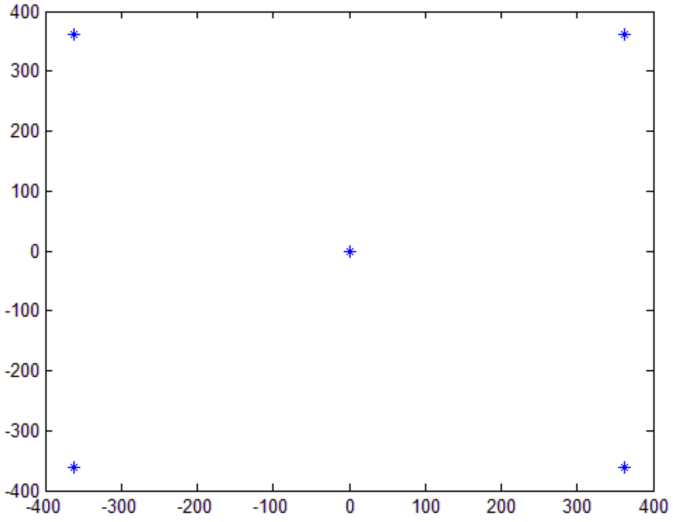
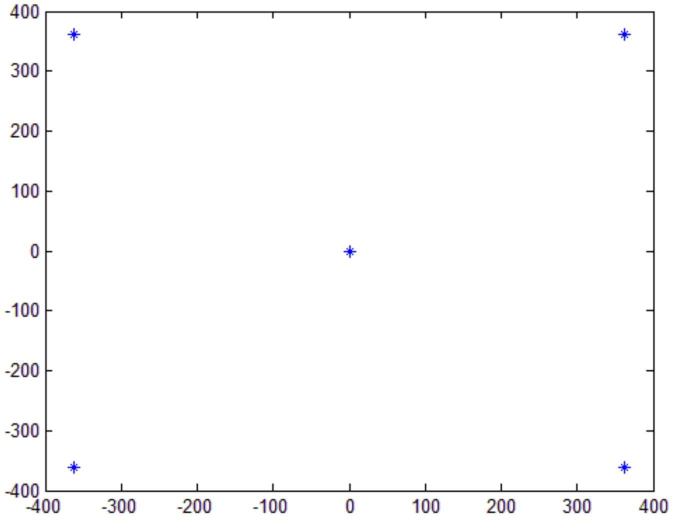
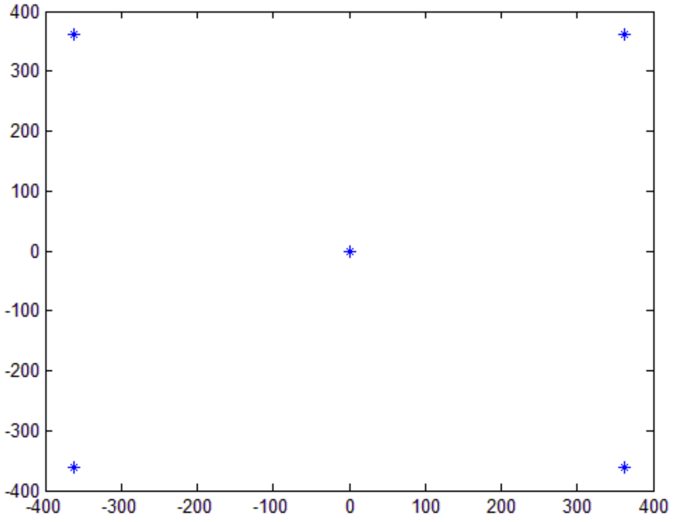
constellation



picture1



picture2



picture3

- picture1 and picture2 are the constellations of UE1 and UE2(the array txdataF after dlsch_modulation)
- picture3 is the constellation of UE1 again(in step 6, we need to use the data of UE1 to reach txdata', and this is the constellation of txdataF after dlsch_modulation).

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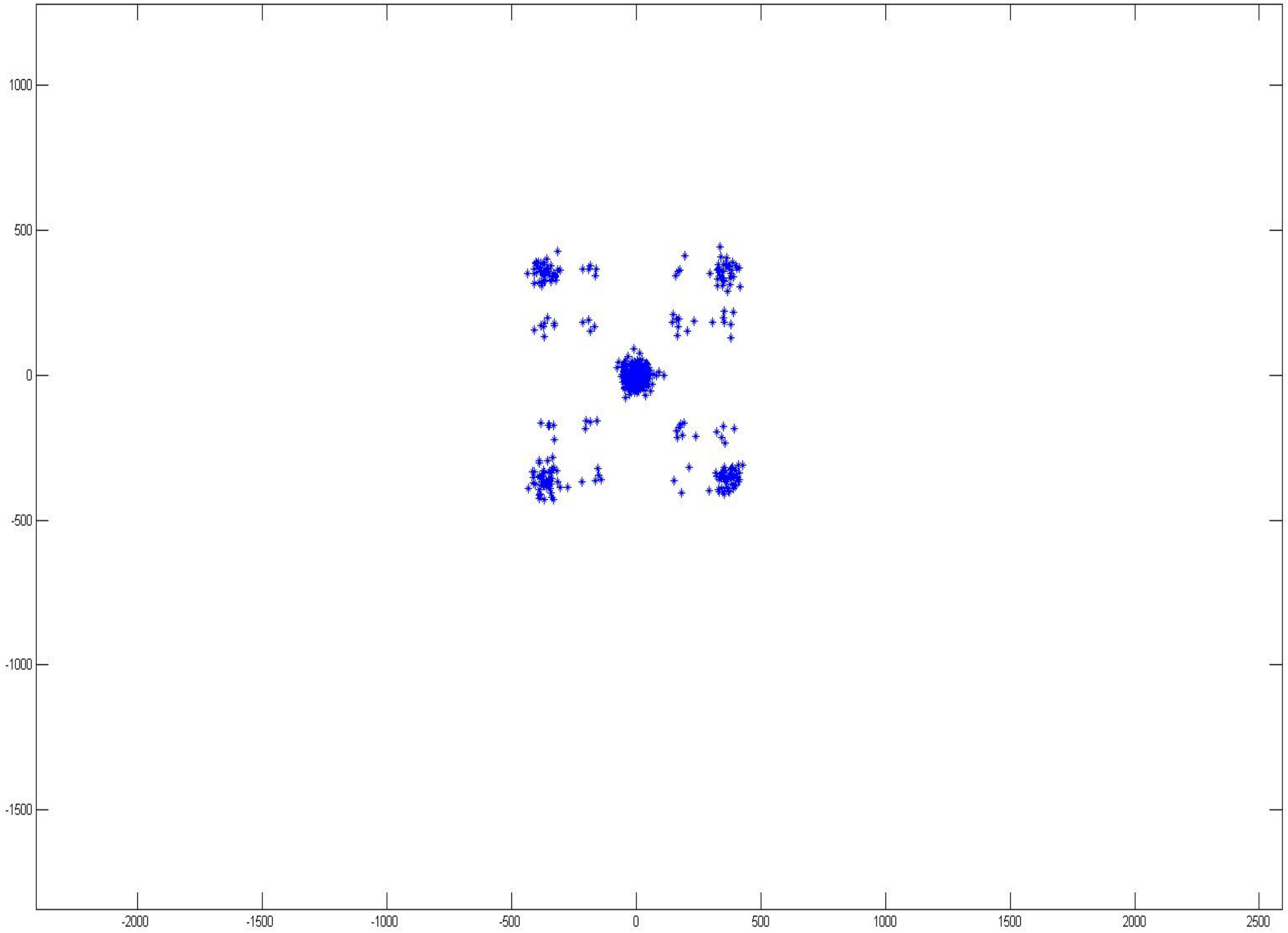
constellation



- ✓ This is the constellation of rxdataF just after going through AWGN Channel.

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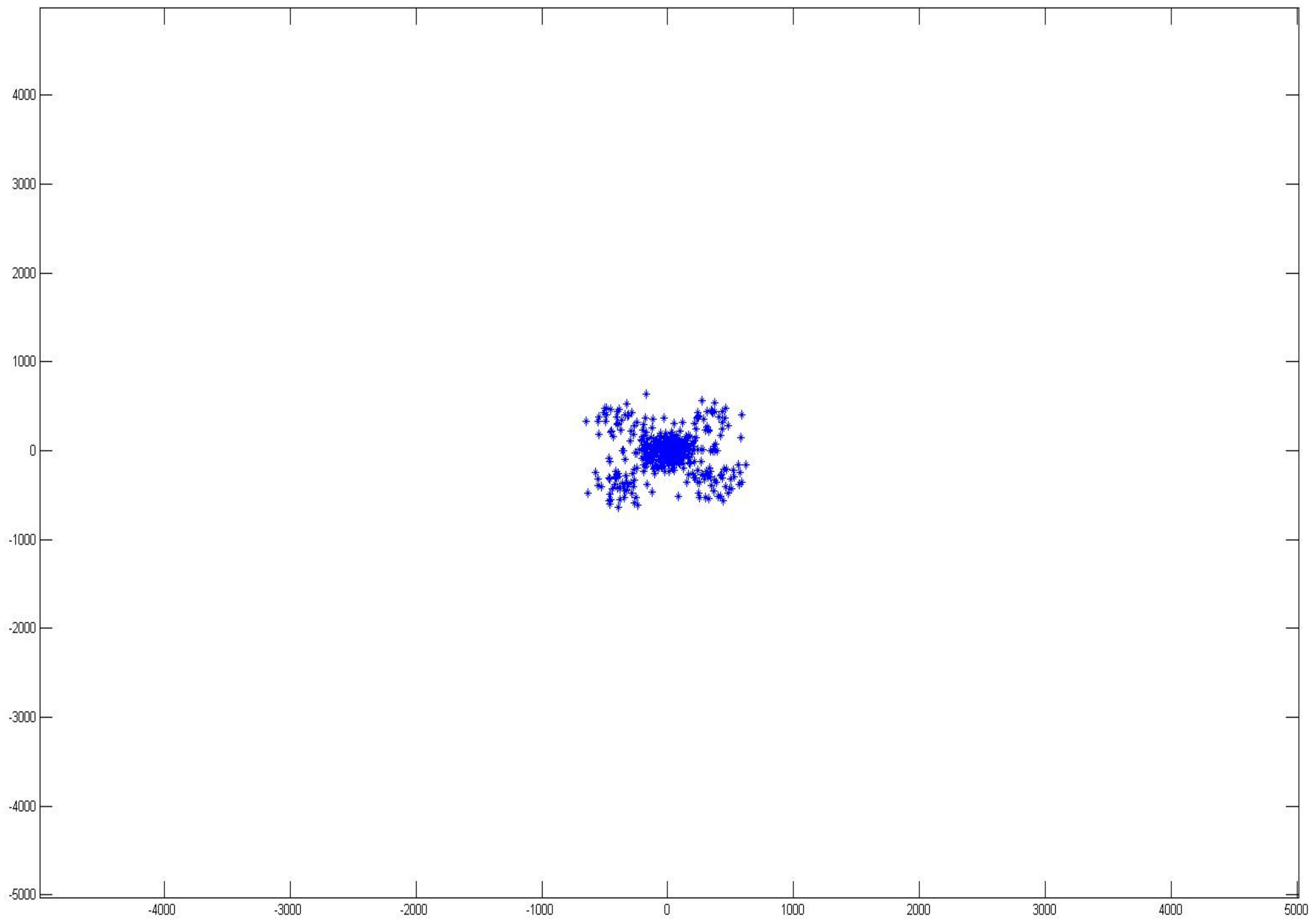
constellation



- ✓ This is the constellation of rxdataF'.

power allocaion

- In this simulation, we don't have the picture of error rate because when the result is wrong, the result is 0 all the time and when the sinulation system can reach the result, the result is always totally the same as the user's data(input_buffer). So when the simulation system cannot reach the result, the error rate is always around 50% and 0 otherwise.

- But I did another work---the relation between power allocation and SNR.We can see, when the power allocation is settled, we can always find a minimun SNR of UE1 with good channel that makes the result right. So this SNR is called mSNR.

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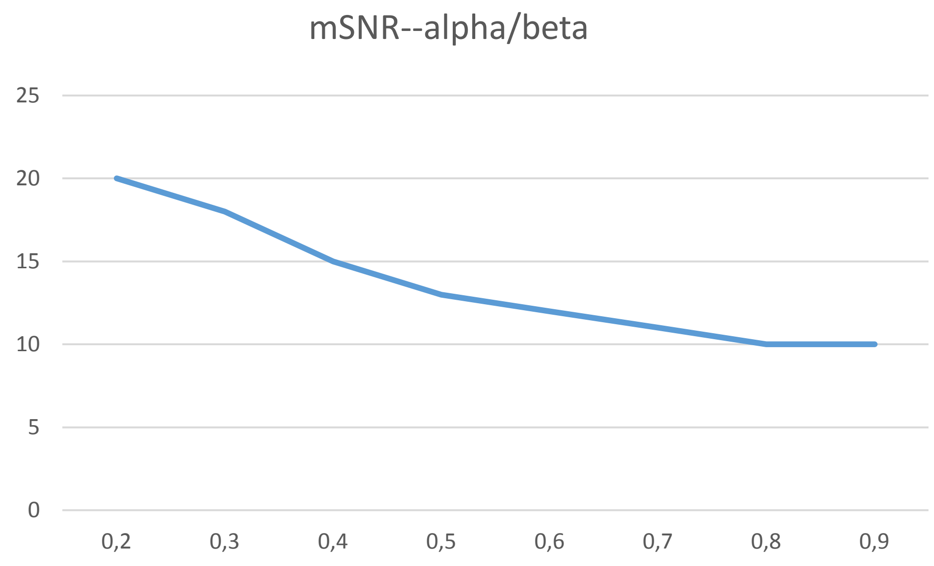

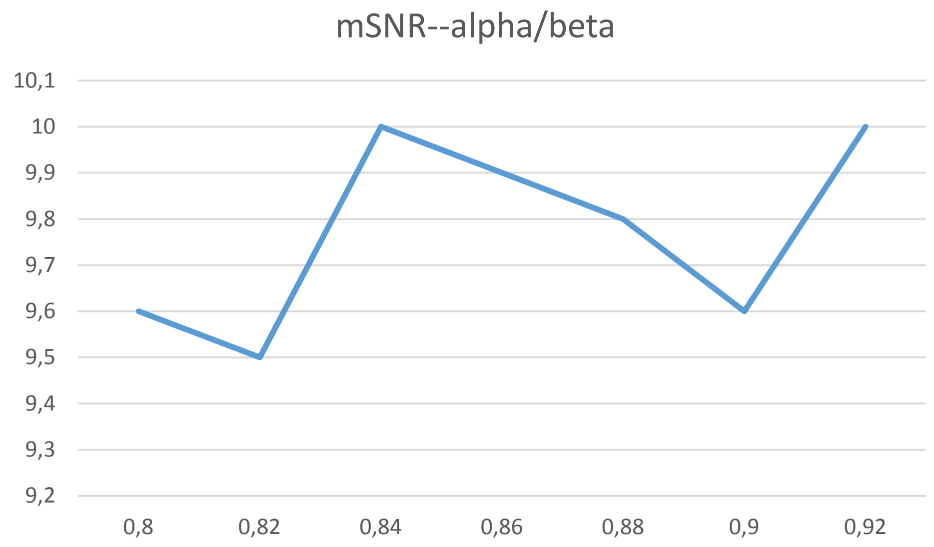

- The x axis is the rate of alpha/beta, and y axis is mSNR(dB).
- We can see from the first picture, as the inscreasing of alpha/beta, the mSNR decreases. But it stops at 0.8--0.9.
- So I increase the precision of alpha/beta just like picture2.And we can see it goes irregular in this range.
- And after 0.92, the result goes wrong.
- So we can make the conclusion that in that simulation, the best power allocation rate is from 0.8 to 0.9, which allows channels with SNR around 10dB.

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5.Shortcomings and Expectation

- **Shortcomings:**

  This simulation can only simulate the most ideal scene in noma system, just like AWGN channel, SISOand so on. So it can only adapt to the ideal scene and some of the result may not be realistic in practice.

- **Expectation:**

  On the one hand, I will do more work on the simulation, so I will conclude more useful things, on the other hand, I will try to build NOMA system in real world.

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THANK YOU

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