Bit Error Rate (BER) Performance of Various Digital Modulation Schemes in Three User NOMA Using SIC Under Rayleigh Fading Channel

B Cyrus[1] U Pradeep Kumar[2]

[1]P.G. Scholar, Department of ECE, Sanketika Vidya Parishad Engineering College, Visakhapatnam, India

[2]Assistant Professor, Department of ECE, Sanketika Vidya Parishad Engineering College, Visakhapatnam, India

ABSTRACT

This paper analyzes the bit error rate (BER) execution of downlink non-symmetrical various access networks for binary phase shift keying adjustment and quadrature phase shift keying regulation. BER is determined for every client under added substance white Gaussian noise and Rayleigh fading diverts in amazing successive interference cancellation (SIC) case. Then, in SIC case, the asymptotic BER articulation in a high signal to noise ratio (SNR) district in proportionate with sent power is acquired.. Then, at that point, a plausible scope of force portion coefficients is observed to such an extent that a decent BER execution can be given for every client regard to QPSK and BPSK. It has been tried for close to client and Far client BER execution regarding sent power. At last, through Recreations it are approved to utilize MATLAB insightful outcomes.

Key Terms : Bit Error Rate(BER),NOMA,QPSK,BPSK

I. INTRODUCTION

Non-orthogonal multiple access (NOMA) is one of the primary radio access techniques in next-generation radio communications. Compared to orthogonal frequency division multiple access(OFDMA) NOMA offers a set of desired benefits, such as enhanced spectrum efficiency, reduced latency with high reliability , and better connectivity . The baseline idea of NOMA is to serve multiple users using the same resource in terms of time, frequency, and space. NOMA has the potential to be applied in various fifth generation (5G) communication scenarios.

Power distribution is vital in non orthogonal multiple access (NOMA). We utilize dynamic power portion plan to accomplish explicit objective. The objective could be boosting the aggregate rate, expanding the energy proficiency. The power assignment conspire we will find in this post is a straightforward one whose objective is to give client decency. we call this fair power distribution conspire .

Fair Power Distribution gives need to the frail/far client. That is, the power distribution coefficients are determined with the end goal that the far client's objective rate is met. Solely after gathering the objective pace of far client, everything the leftover accessible power is apportioned to the close to client. To do that we really want to determine the power assignment coefficients to meet this detail.

BER execution of a Three client NOMA network by following a more reasonable model to be specific Rayleigh fading model. Rayleigh fading model can be utilized when there is no view (way between the transmitter and the collector. As such, all multipath parts have gone through limited scope blurring impacts like reflection, dispersing, diffraction, shadowing. We will consider an outrageous instance of Rayleigh fading where each communicated piece goes through an alternate constriction and stage shift due to multipath transmission. As such, the channel changes for each piece. We will initially take a gander at the framework model and sign model of NOMA. The way that NOMA permits different clients to send and get all the while utilizing a similar recurrence might seem fascinating. The two key tasks that make NOMA conceivable are superposition coding which should be done at the transmitter side and progressive obstruction scratch-off (otherwise called SIC) at the recipient side. In this post we will see about superposition coding. NOMA requires superposition coding at the transmitter side.

NOMA utilizes power area multiplexing of clients sharing same time and recurrence assets. It can be achieved by conducting superposition coding at the transmitter and successive interference cancellation (SIC) at the collector.

II. PROPOSED MODEL

In this proposed model we are going to MUX three clients, each with QPSK adjustment, in a solitary recurrence transporter. Here we consider a remote organization comprising of three NOMA clients, numbered U1, U2 and U3. Let d1d1, d2d2 and d3d3 indicate their particular good ways from the base station (BS) to such an extent that, d1>d2>d3d1>d2>d3. In view of their distances, U1 is the most fragile/farthest client and U3 is the most grounded/closest client to the BS.

A super position coding is utilized to make NOMA communicate signal, which is

x = √a1x1 + √a2x2 + √a3x3 (1)

The sign got at the ith client is given by,

yi=hix+ni (2)

Let h1h1, h2h2, and h3h3 mean their comparing Rayleigh blurring coefficients with the end goal that, |h1|2<|h2|2<|h3|2|h1|2<|h2|2<|h3|2 .(The channels are requested this way in light of the fact that hi∝1dihi∝1di)

Let α1α1, α2α2 and α3α3 mean their separate power distribution coefficients. As indicated by the standards of NOMA, the most fragile client should be dispensed the most power and the most grounded client should be assigned the least power. Accordingly, the power assignment coefficients should be requested as α1>α2>α3α1>α2>α3. The decision of force assignment coefficients has an extraordinary importance on the exhibition of a NOMA organization. Here, for straightforwardness, we are utilizing fixed power assignment. There are a few unique power allotment plans accessible, that would give better execution. Let x1x1, x2x2 and x3x3 signify the QPSK balanced messages that the BS needs to individually ship off U1, U2 and U3. Then, at that point, the superposition coded signal communicated by the BS is given by,

x=P—√(α1—√x1+α2—√x2+α3—√x3)x=P(α1x1+α2x2+α3x3) (3)

The sign got at the ith client is given by

yi=hix+niyi=hix+ni (4)

where ni means AWGN at recipient of Ui.

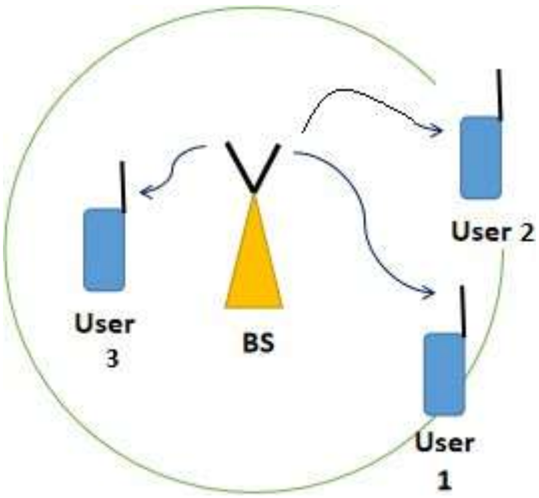


Fig 1: **NOMA** ***3 user network Model***

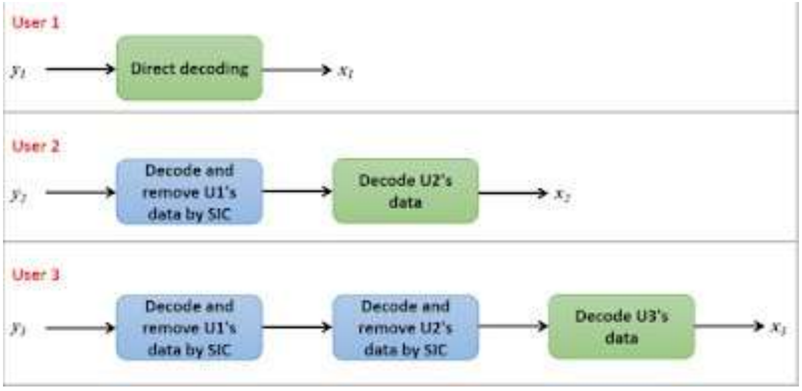


Fig2: SIC decoding procedure

Above figure shows how SIC method is completed and it is made sense of at every client level as underneath. At Client 1

Since U1 is dispensed the most powerful, will perform direct translating from y1y1, treating the signs of U2 and U3 as impedance. Accordingly, the attainable pace of U1 is

R1=log2(1+α1P|h1|2α2P|h1|2+α3P|h1|2+σ2)R1=log2(1+α1P|h1|2α2P|h1|2+α3P|h1|2+σ2) (5) which can additionally be streamlined as

R1=log2(1+α1P|h1|2(α2+α3)P|h1|2+σ2)R1=log2(1+α1P|h1|2(α2+α3)P|h1|2+σ2) (6)

From the above condition, we mention one significant objective fact. Since α2+α3α2+α3 is available at the denominator, presently we need α1α1 to fulfill α1>α2+α3α1>α2+α3. Really at that time, U1's power will overwhelm in the send sign, xx and in the got signal, y1y1. At Client 2 Next how about we compose the rate condition for U2. Since α2<α1α2<α1 and, α2>α3α2>α3, U2 should perform progressive obstruction crossing out to eliminate U1's information and treat U3 as impedance. In the wake of eliminating U1's information by SIC, the attainable rate for U2 is,

R2=log2(1+α2P|h2|2α3P|h2|2+σ2)R2=log2(1+α2P|h2|2α3P|h2|2+σ2) (7)

Since α3α3 is available in the impedance term at the divisor, we need α2α2 to fulfill α2>α3α2>α3. At Client 3 At last, U3 (α3<α1α3<α1, α3<α2α3<α2,) needs to conduct SIC twice to eliminate both U1 and U2 information from y3y3. Since the α1α1 term rules in y3y3, it should be taken out first. From that point forward, the α2α2 term should be eliminated. The reachable rate is,

R3=log2(1+α3P|h3|2σ2) (8)

In the situations (1),(2)and (4),(5) h1,h2,h3 are Rayleigh coefficients . The (randn(N/2,1)+1i*randn(N/2,1)) creates N/2 Rayleigh coefficients, one for every image that is sent. Then, we need to set the mean and difference of our Rayleigh coefficients as needed. We believe that the mean should be nil. randn() consequently creates zero mean arbitrary factors so we don't have an issue there, Presently, the change. The fluctuation should be [distance^-(way misfortune exponent)]. randn() produces arbitrary factors with difference 1. Subsequently, [randn()+1i*randn()] will have difference 2. In this way, first are separating by sqrt(2) to cause it to have unit difference. Then, we are duplicating by [sqrt{distance^-(way misfortune exponent)}] to get the ideal fluctuation.Lets characterize an arbitrary capacity to create client information , the capacity is characterized as While producing irregular genuine numbers, the randn work creates information that keeps the guideline ordinary dispersion, for an arbitrary genuine variable x with mean 0 and difference 1

$f(x)=1/\sqrt{2\pi} * e^{-x2/2}$ (9)

While producing irregular complex numbers, like while utilizing the order randn(...,"like",1i), the randn work creates information that adheres to the guideline complex typical appropriation:

$f(z)= 1/\sqrt{2\pi} * e^{-|z|2}$ (10)

for an irregular complex variable z whose genuine and nonexistent parts are autonomous ordinarily conveyed arbitrary factors with mean 0 and difference 1/2.Characterize how much clamor power. For that, we should think about a data transfer capacity of 1 MHz. As we probably are aware, the warm commotion power is , kTB. For data transmission of 1 Hz, the clamor power is

$\log_{10}(kT)=-174\log_{10}(kT)=-174$ dBm (11)

In this way, for 1 MHz transfer speed, the commotion power will be

$-174+\log_{10}(1MHz)-174+\log_{10}(1MHz)$ (12)

Utilizing the clamor power determined commotion tests for every one of the three clients are created. Irregular message bits for clients are Created BPSK and QPSK balance for every client's message is finished. Utilizing BPSK and QPSK modulator and demodulator adjustment and demodulation is done on the sent and got bits appropriately. We have set the contention 'Touch Contribution' as evident in light of the fact that we will take care of crude double information. Utilizing our QPSK mod item to perform regulation is extremely basic. We utilize the progression work and, in its contention, pass our QPSK mod article and the twofold piece stream to be adjusted.We have set the contention 'Spot Contribution' as obvious in light of the fact that we will take care of crude paired information. Utilizing our BPSKmod object to perform tweak is exceptionally basic. We utilize the progression work and, in its contention, pass our BPSKmod object and the paired piece stream to be regulated.
Compose got signal condition for every one of the three clients

$$y1 = \sqrt{(pt(u))}*x(h1 + n1)$$
$$y2 = \sqrt{(pt(u))}*x(h2 + n2) \quad (13)$$
$$y3 = \sqrt{(pt(u))}*x(h3 + n3)$$

Perform balance by isolating each gotten signal with the individual client's blurring coefficient

$$eq1 = y1/h1;$$
$$eq2 = y2/h2; \quad (14)$$
$$eq3 = y3/h3;$$

dec12_remod = step(QPSKmod, dec12) dec12_remod = step(BPSKmod, dec12)

$$rem2 = eq2 - \sqrt{(a1*pt(u))}*dec12\_remod \quad (15)$$

The recipient handling side of U1. Straightforwardly demodulate eq1 to get x1. Continuing on toward U2. In the first place, straightforwardly translate x1 . dec12 is in 0's and 1's. Prior to taking away dec12 from eq2, we should first re adjust it to change it over completely to a similar structure as in eq2. Presently, we can perform SIC to eliminate our gauge of U1's information (i.e., dec12_remod) from eq2. rem2 contains U2 and U3's information. Do coordinate QPSK demodulation on rem2 as in the past, to get U2's information. Continuing on toward U3. First immediate disentangle x1 from eq3. Re tweak the gauge of x1 that is acquired and deduct it from eq3.Continuing on toward U3. First immediate translate x1 from eq3. Re adjust the gauge of x1 that is acquired and take away it from eq3.dec13 is unraveling utilizing step reaction of QPSKdemod and eq3 which is characterized previously. dec13_remod is re modulation utilizing step reaction utilizing QPSKmod and dec13,similarly a similar technique is finished BPSK as far as above equations(re modulation and adjustment)

$$rem31 = eq3 - \sqrt{(a1*pt(u))}*dec12\_remod \quad (16)$$

Once more, demodulate rem31 to get x2. Re modulate the gauge of x2 and take away it from rem31.dec23 is translating utilizing step reaction among QPSKdemod and rem31. dec23_remod is re modulation usnig step reaction for QPSKmod and dec23 rem3 = rem31 - √ (a2*pt(u))*dec23_remod (17)

dec3 is step reaction of QPSKdemod and rem3 and rehash same strides by supplanting BPSK with QPSK.BER is determined for three clients utilizing BPSK and QPSK. For this, we use biterr() work.

ber1(u) = biterr(dec1,x1)/N;
ber2(u) = biterr(dec2, x2)/N; (18)
ber3(u) = biterr(dec3, x3)/N;

III. SIMULATION AND RESULTS

As per the assumptions in Section II, the two modulation schemes are performed for the three distinct users and the results are analyzed. The performance results of BPSK and QPSK downlink NOMA system with three users is shown in Fig. 3.Individual modulation scheme BER performance of three user SIC based NOMA are discussed here. BPSK modulation is applied to NU(near user), second user and FU(far user) and PLOT between BER and Transmission Power is done and can be seen in below figure and comparative table is drawn to analyze BER performance for each user.

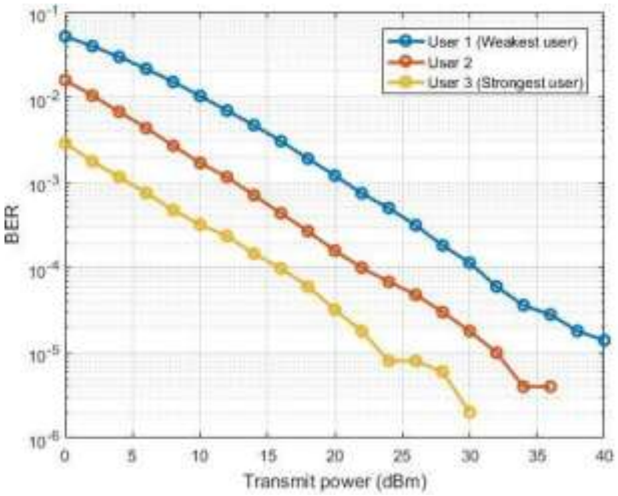
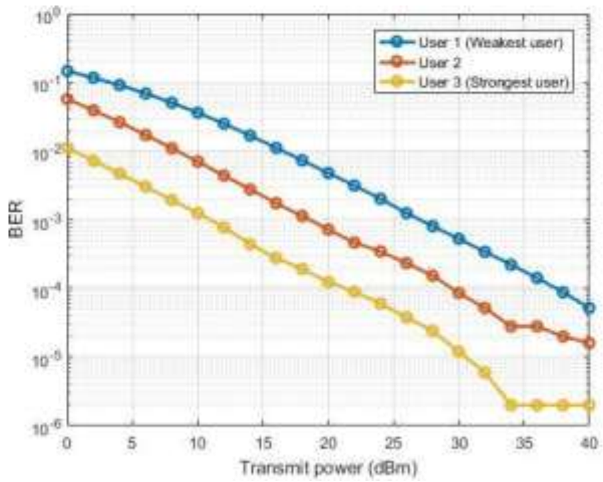


Fig3: plot between BER vs Pt with 3 users

BPSK			
Pt	BER USER1	BER USER2	BER USER3
2	0.038988	0.010562	0.001848
6	0.021072	0.004322	0.000754
10	0.010294	0.0018	0.000252
14	0.004476	0.000784	9.80E-05
18	0.001968	0.000328	4.80E-05
22	0.000806	0.000138	2.20E-05
26	0.000326	5.20E-05	1.00E-05
30	0.000138	1.20E-05	4.00E-06
34	5.20E-05	1.00E-05	4.00E-06
38	1.60E-05	4.00E-06	0

Table1: BER evaluation for multiple using BPSK users using BPSK

As per the plot and table it is observed at low transmission power i.e Pt=2db BER for user1(weakest user)=0.038988 ,user3(strongest user)=0.001848 and at high transmission power i.e Pt=38 BER for user1(weakest user)=1.6*10^-5, user3(strongest user)=0. Now QPSK modulation is applied to NU(near user), middle user and FU(far user) and PLOT between BER and Transmission Power is done and can be seen in below figure and comparative table is drawn to analyze BER performance for each user



QPSK			
Pt	BER USER1	BER USER2	BER USER3
2	0.116082	0.038872	0.007438
6	0.068956	0.017218	0.003118
10	0.03649	0.007258	0.001308
14	0.017018	0.002892	0.000494
18	0.007462	0.001082	0.00019
22	0.003018	0.000392	6.60E-05
26	0.001188	0.000132	2.40E-05
30	0.000518	5.60E-05	6.00E-06
34	0.00023	2.40E-05	0
38	9.00E-05	1.20E-05	0

Fig4: plot between BER vs Pt using QPSK with 3 users

Table2:BER evaluation for multiple users using QPSK

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As per the plot and table it is observed at low transmission power i.e Pt=2db BER for user1(weakest user)=0.116082 ,user3(strongest user)=0.007438 and high transmission power i.e Pt=38 BER for user1(weakest user)=9*10^-5, user3(strongest user)=0. In BPSK and QPSK it was observed that as transmission power increases BER decreases and it may attain ideal condition. Here combined Results of QPSK and BPSK are plotted and corresponding BER performance is tabulated for comparison.

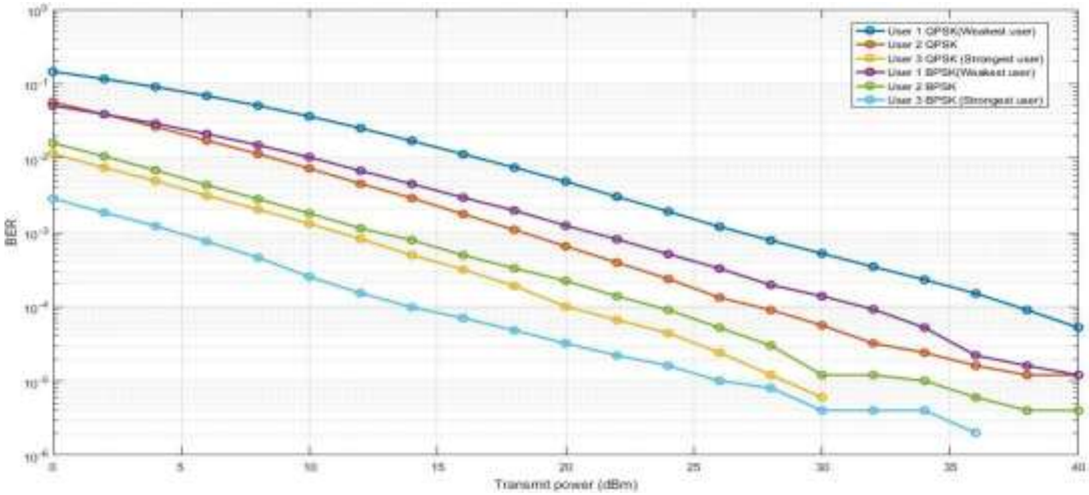

Fig4: plot between BER vs Pt, comparing QPSK and BPSK for three user

Pt	BPSK			QPSK		
	BER USER1	BER USER2	BER USER3	BER USER1	BER USER2	BER USER3
2	0.038988	0.010562	0.001848	0.116082	0.038872	0.007438
6	0.021072	0.004322	0.000754	0.068956	0.017218	0.003118
10	0.010294	0.0018	0.000252	0.03649	0.007258	0.001308
14	0.004476	0.000784	9.80E-05	0.017018	0.002892	0.000494
18	0.001968	0.000328	4.80E-05	0.007462	0.001082	0.00019
22	0.000806	0.000138	2.20E-05	0.003018	0.000392	6.60E-05
26	0.000326	5.20E-05	1.00E-05	0.001188	0.000132	2.40E-05
30	0.000138	1.20E-05	4.00E-06	0.000518	5.60E-05	6.00E-06
34	5.20E-05	1.00E-05	4.00E-06	0.00023	2.40E-05	0
38	1.60E-05	4.00E-06	0	9.00E-05	1.20E-05	0

Table III: BER evaluation and comparison between BPSK and QPSK for three users

The overall results shows as transmission power increases BER is decreasing and near user is having better BER compared with other two users and finally based on comparison it can be finalized as BER of user1 > BER of user2 > BER of user3.

IV. CONCLUSION AND FUTURE SCOPE

In this paper, performance study on BER performance of three-user Downlink NOMA system for BPSK and QPSK using SIC detector has been confer . For all used modulations three users are considered and performed simulation to obtain results to compare BER performance in two scenarios. One is BER performance along with transmission power. In this scenario it was observed that transmission power increment leads to low bit error rate (BER) but at certain transmitted power ideal condition is obtained with BER which is not suggested. Second Scenario is Near User and Far User consideration, near user will be considered as strongest user and Far user is considered as weakest user. It was observed that in both QPSK and BPSK Near User is performing better than Far user with transmission power. Based on above results it was concluded that BPSK Modulation technique is more suitable for SIC based NOMA compared to

QPSK.

All the above work was carried out considering static SIC NOMA, means stable interference and as a future scope the work will be carried out considering dynamic SIC may lead to optimal downlink NOMA performance.

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