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Research Article

NOMA and OMA-Based Massive MIMO and Clustering Algorithms for Beyond 5G IoT Networks

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The Internet of Things (IoT) has brought about various global changes, as all devices will be connected. This article examines the latest 5G solutions for enabling a massive cellular network. It further explored the gaps in previously published articles, demonstrating that to deal with the new challenges. The mobile network must use massive multiple input and output (MIMO), nonorthogonal multiple access (NOMA), orthogonal multiple access (OMA), signal interference cancellation (SIC), channel state information (CSI), and clustering. Furthermore, this article has two objectives such as (1) to introduce the cluster base NOMA to reduce the computational complexity by applying SIC on a cluster, which ultimately results in faster communication and (2) to achieve massive connectivity by proposing massive MIMO with NOMA and OMA. The proposed NOMA clustering technique working principle pairs the close user with the far user; thus, it will reduce computational complexity, which was one such big dilemma in the existing articles. This will specifically help those users that are far away from the base station by maintaining the connectivity. Despite NOMA's extraordinary benefits, one cannot deny the significance of the OMA; hence, the other objective of the proposed work is to introduce OMA with MIMO in small areas where the user is low in number, it is already in use, and quite cheap. The next important aspect of the proposed work is SIC, which helps remove interference and leads to enhancement in network performance. The simulation result has clearly stated that NOMA has gained a higher rate than OMA: current NOMA users' power requirement (weak signal user 0.06, strong signal user 0.07), spectral efficiency ratio for P-NOMA and C-NOMA (21%, 5%), signal-to-noise ratio OMA, P-NOMA, C-NOMA (28, 40, 55%), and user rate pairs NOMA, OMA (7, 3), C-NOMA, and massive MIMO NOMA SINR (4.0, 2.5).

1. Introduction

The Internet was considered as a network for connecting devices, such as desktop computers, laptops, routers, sensor nodes, smartphones, and home appliances [1]. The interaction between these devices via the Internet is described as the Internet of Things (IoT). The internet users are growing rapidly as approximately 1000-fold data traffic has been increased by 2020 [2]. Consequently, spectral efficiency could become a key challenge to control such explosive data traffic [3]. Enhanced technologies have been the major need for satisfaction of these requirements [4]. Millimeter-wave communications, ultradense network, massive multiple-input and output (MIMO), and nonorthogonal multiple access (NOMA) have been proposed to address the 5th Generation challenges. At present, NOMA schemes have gotten more attention as compared to other multiple access techniques, which is further divided into 2 phases, that is, power domain multiplexing [5, 6] and code domain multiplexing, including multiple access with low-density spreading (LDS)

[7–9], sparse code multiple access (SCMA) [10], and multi-user shared access (MUSA) [11]. Some other multiple access schemes, such as pattern division multiple access (PDMA) and bit division multiplexing (BDM) [10], are also proposed. In [12], the author has put forward a low-complexity subsuboptimal grouping user method. However, the mentioned method works by exploiting the channel gain difference among users in the NOMA cluster and gang them either single cluster or multiple clusters to improve system throughput. In [13], the author has clearly mentioned that the orthogonal multiple access (OMA) cannot thoroughly vanish; NOMA is a futuristic term that could facilitate the users in terms of rendering massive connectivity and capacity improvement. Nonetheless, this never means that NOMA could thoroughly replace OMA scheme in the coming 5G networks. OMA could be better for the specimen for a small network where the near and far effect is insignificant. On the other hand, NOMA would be better if the network is big. Thus, the futuristic 5G will have a combo of NOMA and OMA to fully fill the demands of various applications and services.

More importantly, even though NOMA can render attractive merits, some hurdles should be sorted, such as advanced transmitter design and the trade-off between performance and receiver complexity [14–16]. This research focuses on both NOMA and OMA multiple access techniques that utilize power domain/code domain and time/frequency domain, respectively. The purpose of the proposed combination of OMA and NOMA is, firstly, one cannot neglect OMA since it is already implemented in 4G and working properly. Secondly, the study has shown that NOMA is superior to OMA as NOMA renders 1 msec throughput compare to OMA, but it is costly. Thirdly, when the users are near the base station, then the spectral efficiency is better than NOMA. Therefore, it is directed to present a combo to utilize their advantages.

The main contribution of this article is elaborated in the next sentences. Till now, none of the authors from [13, 17–19] have proposed a combination of NOMA and OMA. Thus, the objective of this paper is to propose a combination of NOMA and OMA in order to achieve high performance. Further, the proposed work also introduces cluster base NOMA to reduce the complexity. Several articles have discussed about user 1 and user 2 due to the increase in users. Decoding each user's signal using signal interference cancellation (SIC) requires additional implementation complexity. Therefore, it is recommended to use clustering, helping diminish the additional complexity [14, 20]. Next, with the aid of SIC, one can avoid interference and achieve a low complexity objective. After that, channel state information (CSI) works as a backbone to SIC as it senses the weak users signal and strong users and allocates the power accordingly. Without perfect CSI, SIC decoding cannot be decided by base station (BS) directly. Thus, an explicit SIC decoding order must be acquired 1st.

The rest of the paper is organized as follows: Section 2 describes the related work. Section 3 presents a research methodology. Section 4 illustrates the simulations results. Section 5 presents the discussion, and finally, Section 6 concludes.

2. Related Work

2.1. 5G Enabled IoT. IoT has been considered an imperative for the coming services and application environment which is indeed of massive capacity, high volume of nodes, dense traffic with adaptable and even wider bandwidth from narrowband to broadband, very low latency, and energy-efficient design [21, 22]. For this reason, 5G plays a major role in enabling IoT due to disruptive improvements in the radio and antenna systems, spectrum, and network architecture [23]. 5G is known as 5th generation wireless technology, an unutilized network with a high data rate, trustworthy, and low latency than the previous generations. 5th generation has followed the footprints of 4G; the fifth-generation encoding type is OFDM [24]. 5G networks can work as low frequencies and high as "millimeter wave," and that frequency can communicate a large amount of information/data, however, few blocks at a moment of time. 5G networks are further possibilities to be networks of minicells such as the size of a house router than to be a big tower; it is far from extending the network scope. The objective is to have extraordinary speed on hand and massive scope at low latency than 4G. The latency rate of 4G has been recorded near 50 milliseconds; however, 5G cut all the way down to almost one millisecond [25, 26], that is especially treasured for driverless vehicles and automatic programs. The motive of 5G is to attain transmission pace to 20-30 Gbps, which is 50 times faster than 4G networks [27]. And its speed has been being examined uninterrupted up to 1.5 Gbps while traveling 100 km/h and max up to 7.5 Gbps [28]. 5th generation network is determined to provide up to one million of connections per square kilometer. It also implies the entire wireless international interconnection with very high data rates [28, 29].

2.2. Generation towards 5G. After introducing the 5th generation wireless system in the previous section, this phase summarizes the comparison among mobile network generations. In [30], the authors have explained that 1G (Bell Labs) was introduced in the nineteen seventies and is based on analogue technology. The first generation (1G) communication medium used the frequency division multiplexing technique (FDMA), where the analogue signals were considered. The major fault in this analogy technology had a large size, poor voice, and battery. After this, the researchers [31] had invented the (2nd) generation in the late nineteen eighties having amazing features like the global system for mobile communication (GSM), and it was circuit switch, connection primly based technology, where the end system was dedicated for the whole call duration. As a result, it causes poor efficiency in the utilization of bandwidth and resources. This technology was also known as digital technology. Some of the negative points are digital technology that is lower data rate and inability. Another technology specifically developed for the marketing purpose and not officially described was 2.5 G [32]. With the increasing demands of users and technological development, the third generation (3G) was introduced by [25] that was based on extraordinary features such as dealing with the complex data, providing high data rate, supporting video, audio, message, and improving the overall mean of communication. This phenomenal technology used the code division multiplexing technique (CDMA). It guaranteed the globe with an increment in bandwidth up to 2 Mbps [33]. Finally, with the amazing feature, the 4th generation (4G) took place in 2011 by [34]. The requirement for the 4th generation is specified by International Military Tribunal (IMT-A) in 2009. 4th generation fulfill all the need of the users by providing the data rate up to 1G bps, HD Mobile TV, enhanced audio, and video calls, etc. 4G is so far the biggest achievement in the cellular sector because of having tight security mechanism and assuring the personal user communication from the security point of view such as gaming services, internet usage, and streamed media. 4G is thoroughly based on coded orthogonal frequency division multiplexing (COFDM) and MIMO. The distinction between OMA and NOMA is depicted in Table 1.

2.3. Multiple Access Techniques. The multiple access technique is categorized into two parts. The first part is called orthogonal, and the second part is called nonorthogonal [34] Both orthogonal and nonorthogonal use different access techniques. The orthogonal part uses frequency division multiple access (FDMA), time division multiple access (TDMA), and orthogonal FDMA (OFDMA) techniques, whereas the second part, nonorthogonal, uses code domain and power domain multiplexing. The main job of NOMA is serving multiple users at the same/time-frequency resources by assigning them various power levels. As per [35, 36], the orthogonal is better for the packet domain, having channel aware time and frequency schedule. As mentioned in the above comparison as shown in Table 1 of NOMA and OMA, one of the downsides of the NOMA is higher power requirement by a far user from the base station (BS) and (higher interference ratio) due to massive connectivity that ultimately leads to receiver complexity. NOMA's working principle is to serve multiple users at the same time/frequency by assigning different power levels; for the specimen, those users which are far away from the base station require more power to decode its information and maintain connectivity as compared to near user having strong connectivity. Thus, this causes complexity in the receiver and more power required. This can be avoided by using clustering and SIC with NOMA, which is discussed in detail in the methodology part in Sections 3.1, 3.2, 3.3, and 3.4 and detail view.

On the contrary, in OMA, every user can utilize orthogonal resources within a specific time slot, frequency band, or code to avoid multiple access interference, which definitely results in low power requirement and receiver complexity. Throughput of OMA is smaller due to rendering connectivity to the limited user and assigning resources for a specific time. As a result, many users have to wait until the first user is served, whereas NOMA serves multiple users at the same time by assigning them different power levels. To get clearer picture, the reader is suggested to go through the methodology part where each parameter has been discussed in detail.

OMA with NOMA as shown in Table 1 describes energy consumption, receiver complexity, user pairs, number of users in the cluster, and system throughput [37].

2.4. Advantages of NOMA for IoT. NOMA [38] has been found one of the most effective technologies in the telecommunication sector that will come up with certain benefits: To name a few of them such as high spectral efficiency, massive connectivity, low latency, quality of service, MIMO, NOMA with beam forming and MIMO, NOMA with radio and RA, and NOMA with clustering [39, 40].

NOMA is a vital enabling technology for 5G wireless networks because it allows them to meet heterogeneous criteria such as low latency, high dependability, huge connection, increased fairness, and high throughput [41]. NOMA is based on the idea of serving numerous users in the same resource block, such as a time slot, subcarrier, or spreading code. The NOMA principle is a broad framework, with numerous newly suggested 5G multiple access systems serving as examples [42]. The authors presented an overview of the latest NOMA and its various applications.

Extraordinary expectations for data speeds and capacity must be addressed beyond 5G networks [43]. The NOMA approach results in increased diversity gains, and huge interconnectedness could be a possibility to overcome these difficulties. One disadvantage of NOMA is the extra receiver complexity required to eliminate interuser interference (IUI) via SIC. In this way, the authors demonstrated how a cooperative relaying scheme could increase the NOMA system's total diversity gain and data rates. The cooperative NOMA system's user fairness and performance while implementing the irregular convolutional code are examined using extrinsic information transfer (EXIT) charts (IRCC). The suggested system's convergence analysis is evaluated utilizing the EXIT chart and IRCC [44, 45].

3. Research Methodology

The network is deployed based on the signal strength between the user and the base station. The nodes that occupy weaker signals describe that the nodes are far away from the BS, which requires additional power from the BS. Therefore, NOMA is considered here to connect nodes with the BS briefly described in Section 3.1. On the other hand, the nodes have a strong signal that requires less power for data communication. Thus, OMA is considered briefly described in Section 3.2. These considerations of NOMA and OMA ultimately provide massive connectivity without interruption and the least energy dissipation. Algorithms 1 and 2 are used for resource allocation and pairing users to reduce computational complexity, improve performance, and gain massive connectivity. Moreover, Section 3.2 describes OMA with MIMO that help render massive connectivity and reduce the chances of dropping connection. As a result, one can achieve higher spectral efficiency at a minimum cost. Furthermore, 3.3 and 3.6 illustrate NOMA with SIC works, helping avoid a collision often caused when two or more packets arrive simultaneously. 3.4 and 3.5 depict. Finally, Sections 3.7 and 3.8 highlight the latest

Table 1: Distinction between OMA and NOMA.

Specifications	OMA	NOMA
Full form	Orthogonal multiple access	Nonorthogonal multiple access
Energy consumption	Less	More
Receiver complexity	Low	High
Number of user pairs	More	Less
Number of users/clusters	Higher	Lower
System throughput (assumption: user fairness is guaranteed)	Smaller	Larger

```
# NOMA = Non-orthogonal Multiple Access
# SIC = Signal Interference Cancelation
# OMA=Orthogonal Multiple Access
Step 1: total 12 nodes randomly deploy
Step 2: User sends a request to BS for the allocation of resources
Step 3: Request processes to CSI
Step 4: CSI (Channel state information) calculates the distance
Step 4.1: if (distance >100 m)
                {
                        Users get NOMA;
                }
Step: After allocation of NOMA (all the strong users will be paired up with weak users) and SIC will be applied to avoid inter user
interference.
Step6:    else
                {
                        Users get OMA;
                }
Step7: end if.
```

Algorithm 1: Step by step working of user clustering.

parameters such as CSI and Massive MIMO, which helps in massive connectivity, allocating resources, and providing a free spectrum to carry out the transmission.

3.1. Use of NOMA with Massive MIMO. NOMA concept is based on power domain multiplexing assigns different power levels to the users based on higher and lower signals of the user, and users are distinguished based on their power levels while the prior technologies used to rely on code, frequency, and time-division multiplexing. The major problem with the OMA is low spectral efficiency, which normally causes when allocating resources like subcarrier channel to a user with poor CSI. However, in NOMA, users with poor channel state information CSI can also have access to all the resources like subcarrier by using the help of a strong CSI user, which ultimately results in high spectral efficiency. NOMA also uses superposition coding schemes at the transmitter side, such as the Success Interference Scheme (SIC), where the receiver can separate the users in downlink and uplink.

NOMA with massive MIMO has been proposed as one of the finest radio access technologies for the 5th generation mobile network. Massive MIMO is basically the upgraded version of MIMO, helping with NOMA in providing high spectral efficiency and throughput. MIMO has 2 to 4 antennas, whereas massive MIMO has more than 100 antennas that provide connectivity to massive users with high bandwidth. Deployment of NOMA in a mobile network demands high computational power to implement real-time power allocation and successive interference cancellation algorithms. The deployment time of 5G is expected to be 2020, and it means that the computational capacity for both handset devices and access points is anticipated to be high enough to run NOMA algorithms.

The following algorithm shows resources allocation using NOMA and OMA.

3.2. Detail View. This side of the article gives a detailed view of Algorithms 1 and 2, DFD, and Sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, and 3.8. Let us take a random basic 12 user's model [12] using SIC where all the users are clustered to reduce computational complexity. The pairing is based on the closeness of the users. The clustering mechanism is by pairing U1 with U2, U3 is with U4 ,and U5 is with U6, and so on. Signal interference cancellation is placed on the base station to avoid interuser interference and ensure guaranteed connectivity. As a result, larger throughput can be achieved. Further, the resources and power would be allotted to a particular user by calculating the maximum distance between the base station and using channel state information CSI. Moreover, it is vividly seen that users are multiplexed in the BS transmitter by power domain. The users are sorted in a cluster so that a user with poorer channel conditions will decode its information first than a cell edge

```
Step1: Total deployed 12
Step2: CSI calculate the distance of each user
Step3: if (distance >600 m)
        {.
        User 12 attached with user 1;
        }
Step4: else if (distance >500 m)
        {
        User 11 attached with user 2;
        }
Step5: else if (distance >400 m)
        {
        User 10 attached with user 3;
        }.
Step6: else if (distance >300 m)
        {.
        User 9 attached with user 4;
        }
Step7: else if (cluster distance >200 m)
        {
        User 8 attached with user 5;
        }
Step8: else
        {
        User 7 attached with user 6;
        }}
        End if
```

Algorithm 2: User clustering algorithm.

user with strong connectivity. Let us take an example of U1 and U2, U2 information will be decoded by the receiver using SIC with little loss after eliminating U1 interference, and then U1 information will be decoded by the receiver directly due to its high-power strength, which is quite easy to be captured. Furthermore, the steps of allocation resources and power are discussed following. First, the user requests the base station for the allocation of resources. The channel state information CSI will calculate the distance between the BS and the user [27]. After calculating the distance successfully, the power allocation and resources will be based on the far and close distance. For instance, U1 sent the request to the base station. As soon as the channel state information receives the request, it will calculate the distance. For example, the distance is 600 meters; so, the power and resources will be assigned accordingly.

In Algorithm 2, 12 users are randomly deployed [12], and the distance between the users and base station is 600 meters. Channel state information is used to calculate the distance between the base station and the user to pair it accordingly. For instance, user 12 is far from the BS; so, it will be paired with user 1 as user 1 is close to BS, and it has high power, which means that user 1 can easily decode the information of user 2 without any loss; hence, the high connectivity goal would be achieved. Moreover, if the distance is greater than 10, then user 11 will be paired with 2.

3.3. Use of OMA with MIMO. Here, the user deployment is based on the signal strength between the base station and user. All users with strong signals and fewer chances of dropping connections will get resources from OMA. The reason for assigning OMA is to achieve better spectral efficiency with minimum cost. The working principle of OFDMA is quite smooth and straightforward. Here, each user is allocated separate channel and orthogonal resources in time, frequency, or code domain; hence, no interference exists due to orthogonal allocation of the resources, which will lead to spectral efficiency improvement. Next, by employing massive MIMO, we can have massive connectivity features and a strong connectivity rate.

3.4. NOMA with SIC. The working principle of SIC is as follows. The receiver mostly uses this method in a wireless data transmission which permits two or more than two packets decoding that arrive simultaneously (collision can be commonly found in a regular system due to the arrival of more packets at the same time). SIC is used to decode the stronger signal first at the receiver side, subtract that from the combined signal, and then decode the difference as the weaker signal.

The major characteristic of NOMA is serving multiple users at the same time/frequency/code, however, with different power levels, which yields a significant spectral efficiency. For the specimen, below, we have considered user 1 and user 2. Both have different power levels; so, the BS serves them by allocating the same resource but differentiating them by assigning them different power levels. First, SIC detects the user 1 signals with low power and decodes Then, user 2 will directly decode its signals as it is close to the base station and has high power compared to user 1. This process continues until the last user is left in the queue.

3.5. User Clustering Scheme with Low-Complexity Suboptimal. A user clustering scheme with low-complexity suboptimal has been proposed for the downlink NOMA in this part. This scheme develops the channel gain distinctions in users and aims to enhance the throughput of the considered cell.

To pair the high channel gain, users will always benefit from the low channel gain user, which will cause the enhancement of the throughput. The main purpose of doing this is to high channel grow user can attain a higher rate even with the low power levels while making a large fraction of power available for the weak user, ensuring the guaranteed connectivity. The key feature of this clustering scheme is downlink NOMA which is achieved by the highest pair channel gain user and the least channel gain user into the similar NOMA cluster, while the second highest channel retains user and the second lowest channel retains user into another NOMA cluster, and so on. Second, to utilize the services of OMA, it is recommended to use OMA for an area where a user is less in number, and the near-far effect does not matter. Figure 1 expresses the clustering process of NOMA and OMA using data flow diagram.

3.6. Cluster Process Data Flow Diagram User Pairing Scheme. Within the underneath information stream graph Figure 2, first, user requests to the base station for allocation of

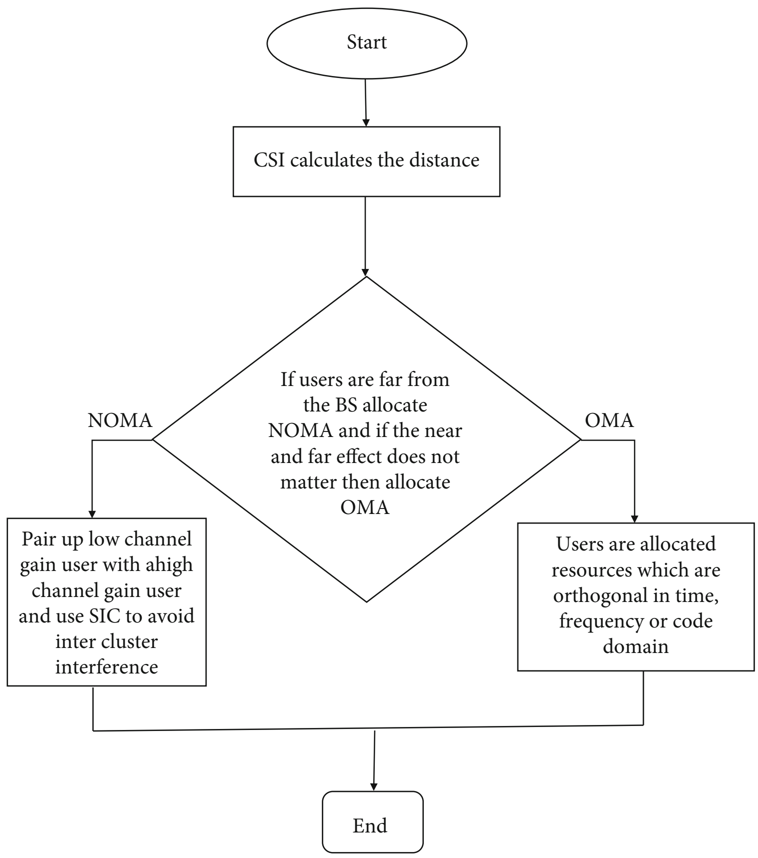

Figure 1: Clustering process of NOMA and OMA by using data flow diagram.

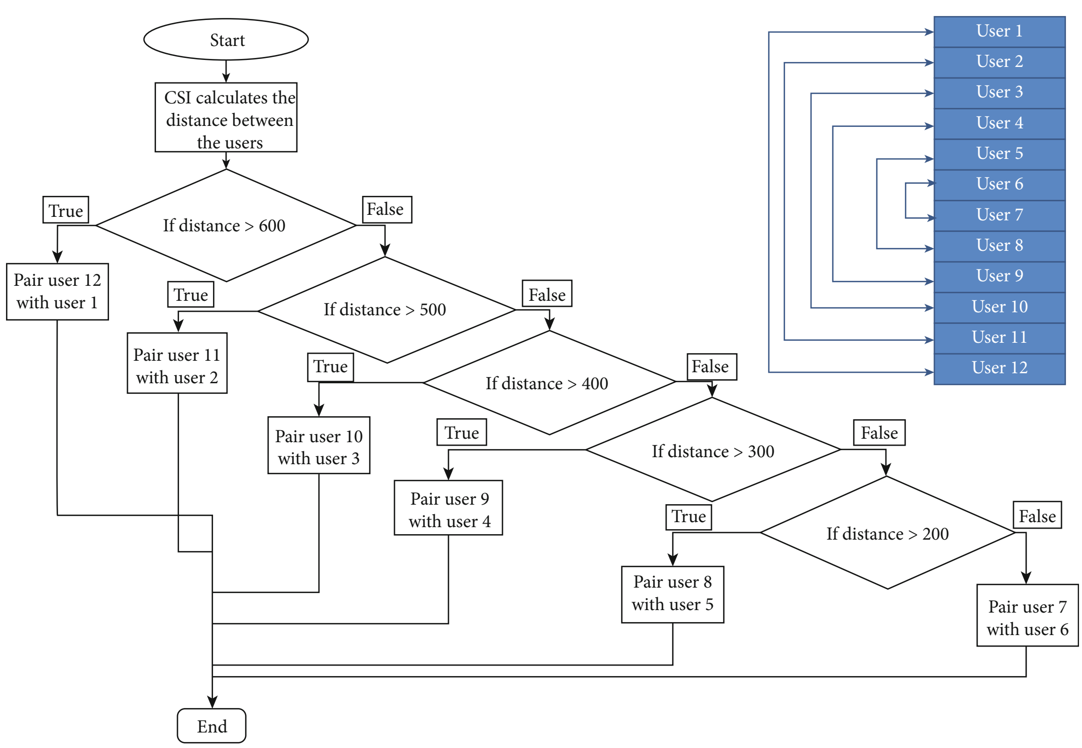

Figure 2: Cluster process flow chart.

resources. Once the BS receives the user request, the base station calculates the distance using CSI. If the user is far from the base station and has weak channel gain, BS will assign NOMA. The NOMA pairs the user having poor channel condition with a user having good channel condition. This way, both weak and robust users can utilize the channel simultaneously; however, if the near and far effect does not matter and the number of users is less, then BS will allocate OMA. The beauty of the OMA scheme is that radio resources can be allocated to multiple orthogonal users in frequency, time, or code domain. As a result, no interference occurs between users due to the orthogonally resources allocation.

3.7. Successive Interference Cancelation. Interference management is being considered the main cause of improvement in network capacity substantially. The SIC's main role is to enable users with the strongest signals to be sensed 1, hence, the least interference-contaminated signal. After this, signals are reencoded by a strongest user. As soon as reencoding is done, then these signals are subtracted from the composite signals. Now, this process is being followed by the 2nd strongest users' signals, which become strongest. When all these are done and the last user signal is sensed, the decoding of information by the weak user will not suffer from any kind of interference.

3.8. Channel State Information (CSI). CSI provides a communication link in the wireless communication world is used to propagate the signals from transmitter to receiver and represent the combined effects, such as power decay with distance, scattering, and fading. This whole process is known as channel estimation. High data rate and reliable communication in multiantenna systems can be gained by aiding CSI in adapting the transmission to current channel conditions.

CSI at the receiver and CSI at the transmitter are called channel state information receiver (CSIR) and channel state information transmitter (CSIT), respectively. The estimation of CSI is mandatory and often quantizes and feedback to the transmitter (though the reverse-link estimation is possible in the TDD system).

3.9. Massive Multiple-Input and Multiple-Output (MIMO). Massive MIMO includes multiple futuristic technologies, which provides the user with many antennas for smooth and interference-free communication, unlike prior technology, and the antennas were confined in numbers like 2 or 4, which causes delay and interference. Massive MIMO enables the concept of NOMA in providing interference-free and fast communications using these antennas. Therefore, the upcoming 5G will rely on NOMA along with the MIMO.

4. Simulation Results

This section is about simulation results of the current NOMA and proposed NOMA. The simulation experiment is conducted using MATLAB, one of the most prominent tools used for simulation results. In the simulation environment, users are randomly deployed in 200 to 600 m areas. Data rates are set as 300 kbps and 2.4 GHz band. This section compares the current NOMA with proposed NOMA in power allocation, spectral efficiency, sum rate, SNR (OMA, P-NOMA and C-NOMA), and SINR. The parameters used for simulation and results are shown in Table 2.

4.1. Current NOMA. The current NOMA result is depicted using Figure 3. To compare the current NOMA with the aforementioned, we propose NOMA. At first, we randomly took total 7 users, which are shown using "x-axis," and then on "y-axis," we use parameter power allocation to see the performance difference between C-NOMA and P-NOMA. By doing this, we analyze that in current NOMA, the power is almost equally assigned to both strong and weak users, causing performance degradation. In other words, the big dilemma in the current system is treating weak and strong user equally in terms of power allocation due to the imperfect channel state information CSI that not only effect on performance but also cause complexity. As per the below experiment, the minimum power used by strong and weak users is 0.01-0.02, and the maximum power by both users is 0.06–0.07.

4.2. Proposed NOMA. Figure 4 illustrates the power allocation mechanism of the proposed NOMA. On the "x-axis" number of users and "y-axis" power allocation, as per the simulation result below, one can easily understand the proposed NOMA advantage over the current NOMA. The working principle of the proposed NOMA is by allocating more power to the user having weak signal and possibly dropping connection. In Figure 4, the blue line denotes the strong user channel power requirement, and the red line denotes the weak user power requirement. The power allocation to each user is carried out based on the signal strength and distance of the user from the base station BS. If the user signals are weak, it will require more power to decode its information using SIC without losing the connection, which ultimately leads to helping in achieving high connectivity. The minimum power required by the strong user is 0.02, and the maximum is 0.07, whereas in a weak user, the minimum power is 0.03, and the maximum is 0.1.

4.3. P-NOMA vs. C-NOMA. Figure 5 compares current NOMA with proposed NOMA. Total 10 users have been clustered in P-NOMA to analyze the spectral efficiency. The result has clearly shown that as the number of clusters increases in P-NOMA, the spectral efficiency also increases, whereas in C-NOMA, spectral efficiency decreases with the increment of users. Moreover, the figure explains that the P-NOMA spectral efficiency is double C-NOMA, the most significant advantage. In contrast to C-NOMA, users without clusters have 5% spectral efficiency, whereas P-NOMA, a cluster user has a 21% spectral efficiency rate. This confirms that P-NOMA outperforms C-NOMA.

4.4. C-NOMA, P-NOMA, and OMA. Figure 6 analyzes C-NOMA, P-NOMA, and OMA. Signal-to-noise ratio parameter used to measure the interference ratio. By looking at the below figure, one can see the noise ratio of C-NOMA, which

Table 2: Parameters used for the simulation results.

Parameter	Value
Intersite distance	200 m, 600 m
Carrier frequency	2.4 GHz
Bandwidth per sub channel	180GHZ
Subchannel (N)	5, 10
Noise power	173 dBm
Number of transmitter antenna	64
Number of receiver antenna	64
Number of users per cluster	2
Algorithm	Low complexity suboptimal
Total transmission power	44 dBm (25w) for ISD = 200 m 49 dBm (80w) for ISD = 600 m
BS antenna height	10 m for ISD = 200, 32 m for ISD = 600 m
User equipment UE height	1.5 m
Minimum distance between UE and cell	35 m
Data rate	300 kbps

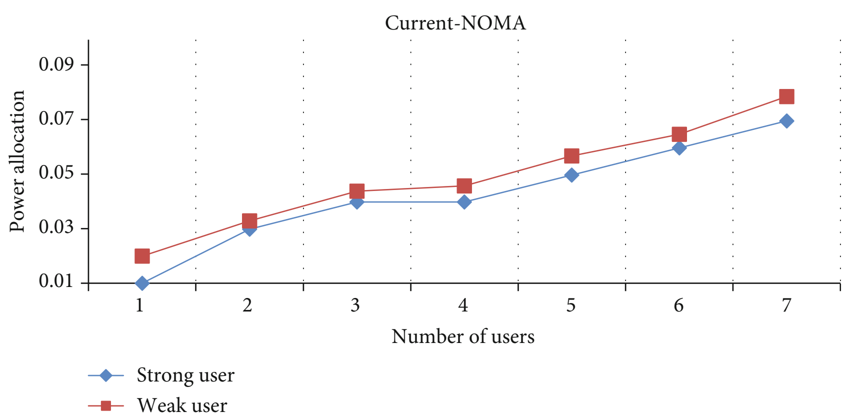

Figure 3: Current NOMA.

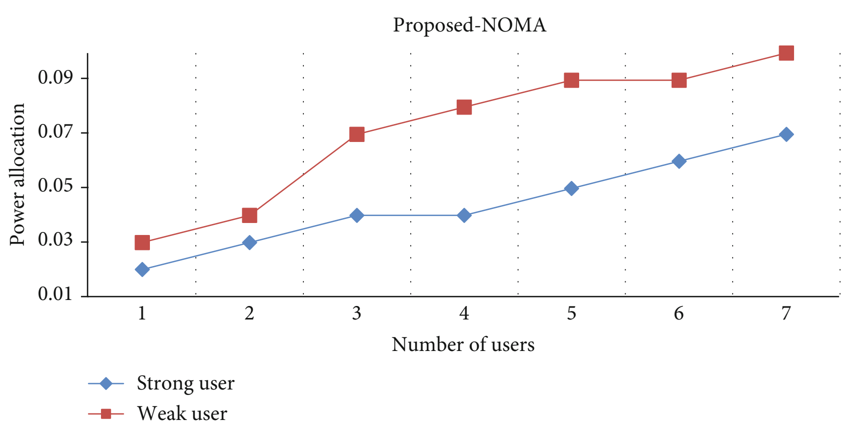

Figure 4: Proposed NOMA.

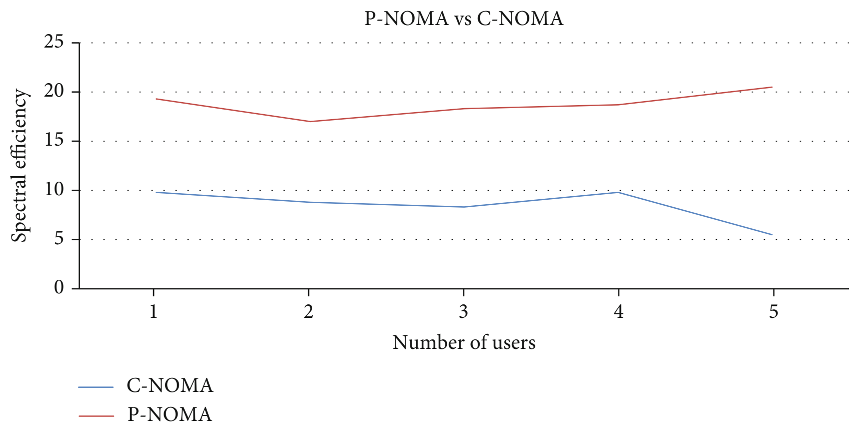

Figure 5: P-NOMA vs. C-NOMA spectral efficiency.

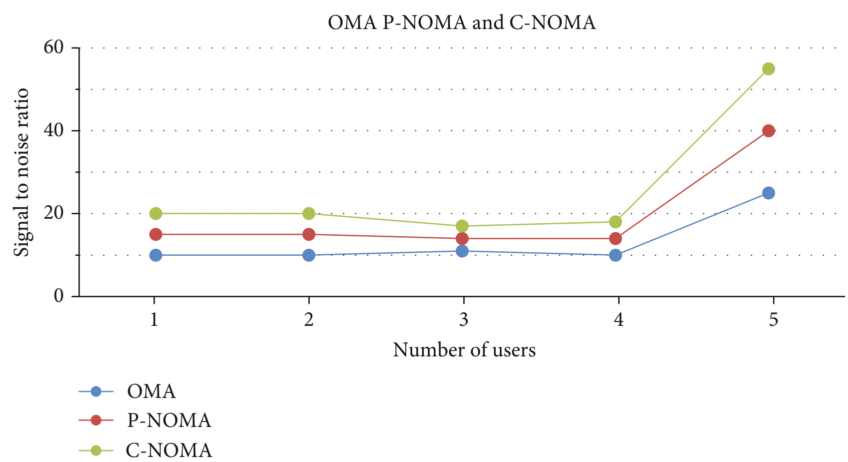

Figure 6: OMA P-NOMA and C-NOMA signal-t- noise ratio.

is higher than the other two, means that the OMA has a clear benefit over NOMA. Therefore, we cannot deny the significance of OMA. Besides, the evident results clearly state the ratio of noise for all the three 10, 15, and 20 percent, respectively; nonetheless, as the user increase, the ratio of noise also increases, and at the end, the value is reported 28, 40, and 55%, which means OMA services cannot be neglected.

4.5. Rate Pairs. Two users have been taken into the network to analyze the boundary of the attainable rate region for these users. Here, we are considering an asymmetric downlink channel so that the users are at equal distance to the BS: SNR1 = SNR2 = 10 dB. Figure 7 depicts the boundary of available rate regions R1 and R2 for the NOMA and OFDMA. As demonstrated in the figure, NOMA obtains higher rate pairs than the OFDMA because of low fairness. Hence, it is certain that by looking to start where both start with almost 0 percent and end with 3 and 7% percent. NOMA can work better than OMA when users are clustered, and the following result has proved it.

4.6. Massive MIMO NOMA User Cluster SINR vs. Current NOMA SINR. The comparison of signal interference noise ratio between massive MIMO NOMA cluster and current NOMA is being shown in Figure 8. Total power is set 30 dBm in simulation, and users are set as 12 for MIMO NOMA cluster (2 users per cluster) and 6 for current NOMA. During decoding information, the current NOMA signal-to-noise ratio has been recorded at the highest minimum 2.5 and a maximum of nearly 4.

The current NOMA users face a high interference ratio that causes computational complexity as signal interference cancellation SIC will be applied on each user to cancel the noise ratio. The more the user transmits the data, the more time SIC would take to cancel/reduce the noise ratio. On the other hand, the massive MIMO NOMA signal interference ratio is a minimum 2 while the maximum 2.5 clearly states the superiority of massive MIMO NOMA. Here, the SIC is applied on the whole cluster instead of an individual user to cancel the noise, which ultimately helps in low computational complexity. The SINR rate achieved by MIMO NOMA cluster is shown in Figure 9.

5. Discussion

First, by allocating power to the weak and strong user in propose NOMA, we have found that a weak user requires more power than a strong user to maintain connectivity since it

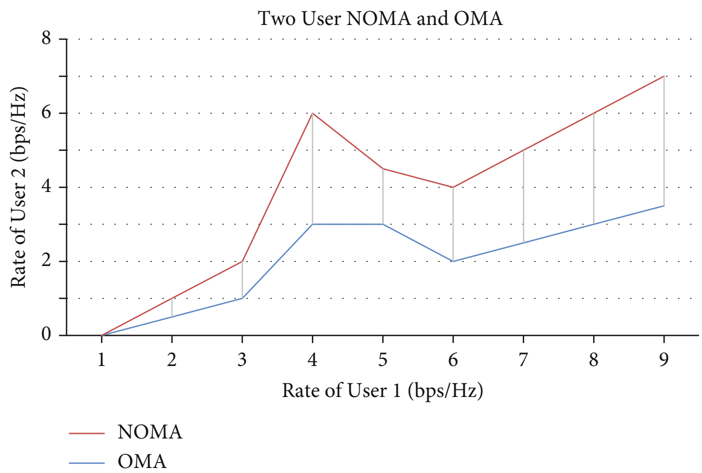

Figure 7: NOMA and OFDMA pair rate for downlink NOMA, i.e., SNR1 = SNR2 = 10 dB.

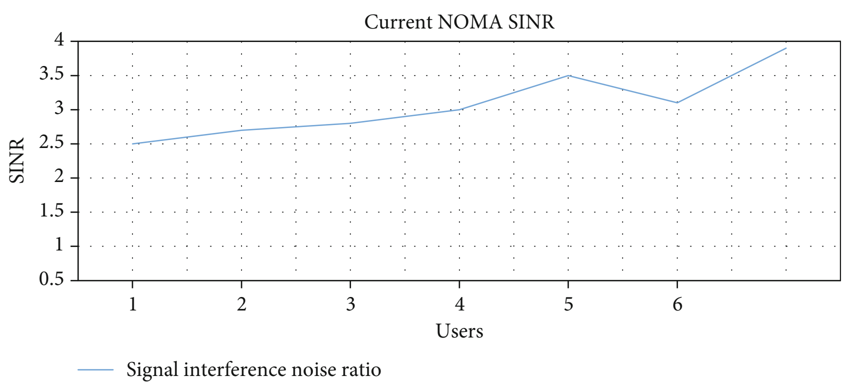

Figure 8: SINR rate achieved by current NOMA.

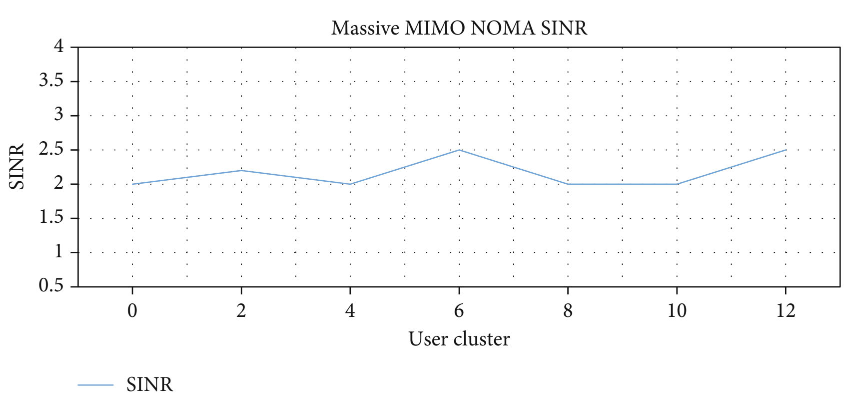

Figure 9: SINR rate achieved by MIMO NOMA cluster.

has greater chances of losing connection. However, in the current NOMA, users are allocated equal power, which leads to low-performance issues. Therefore, the proposed NOMA system is suggested for the future 5G challenges as it helps in gaining high performance compared to the current NOMA. Second, by comparing P-NOMA with C-NOMA, we found that spectral efficiency could be gained with P-NOMA because the power would be allocated to the whole cluster rather than individual user, which automatically led to spectral efficiency gain. On the other hand, in C-NOMA, each user requires power to decode its information separately, leading to low spectral efficiency. Third, by taking the signal-to-noise ratio in P-NOMA, C-NOMA, and OMA, we have clearly seen that the noise ratio is quite high in P-NOMA and C-NOMA compared to OMA service of OMA cannot be ignored. Fourth, two users are taken in a network to check the pairing rate by considering downlink using NOMA and OMA. Finally, current NOMA and massive MIMO NOMA with SINR ratio are being tested. The massive MIMO NOMA, noise ratio was far less than the current NOMA signal inference ratio. By considering the following results of P-NOMA users' power requirement (strong signal users power consumption 0.07, weak user power consumption 0.1), current NOMA users' power requirement (weak signal user 0.06, strong signal user 0.07), spectral efficiency ratio for P-NOMA and C-NOMA (21%, 5%), signal-to-noise ratio OMA, P-NOMA, and C-NOMA (28, 40, 55%), user rate pairs NOMA, OMA (7, 3), and C-NOMA, and massive MIMO NOMA SINR (4.0, 2.5), the simulation result has clearly stated that NOMA has gained a higher rate than OMA. Thus, it is clear by taking all the simulation results into account that the PROPOSE-NOMA will render certain advantages such as high connectivity, better spectral efficiency, and less interference ratio. 5G is incomplete. Without taking these new parameters, one cannot attain the objective of higher spectral efficiency and reduction in computational complexity, which has been proved by the above results that these parameters must be considered.

6. Conclusion

In this article, some of the prior problems have been addressed with the solution, like signal-to-noise ratio is one of the most significant factors in 5G. The key objective behind the introduction of SIC is to avoid interference between users, ultimately leading to enhancement in spectral efficiency. Therefore, the proposed NOMA with SIC and OMA with MIMO will ensure the connectivity of more than one user simultaneously without interference and help provide massive connectivity. Aside from that, the advent of clustering will benefit 5G by grouping users into clusters. As a result, it will reduce computational complexity, hence avoiding computational complexity and improving spectral efficiency. These parameters must be considered (such as NOMA with MIMO, NOMA with OMA, SIC, and clustering).

Data Availability

The data that support the findings of this study are available upon request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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