

Research Article

Massive MIMO Wireless Solutions in Backhaul for the 5G Networks

Arun Biradar,¹ Nimmagadda Sathyanarayana Murthy,² Parul Awasthi,³ Ajeet Kumar Srivastava,³ Patan Saleem Akram,⁴ M. Lakshminarayana,⁵ Shafiqul Abidin,⁶ Vikas Rao Vadi,⁷ and Asefa Sisay⁸

¹*School of Computer Science and Engineering, REVA University, Bengaluru, Karnataka 560064, India*

²*Department of Electronics and Communications Engineering, V R Siddhartha Engineering College, Vijayawada, Andhra Pradesh 520007, India*

³*Department of Electronics and Communications Engineering, CSJM University, Kanpur, Uttar Pradesh 208024, India*

⁴*Department of Electronics and Communications Engineering, Koneru Lakshmiiah Education Foundation (Deemed to Be University), Vaddeswaram, Andhra Pradesh 522302, India*

⁵*Department of Electronics and Communications Engineering, SJM Institute of Technology, Bengaluru, Karnataka 560060, India*

⁶*Department of Computer Science and Engineering, Aligarh Muslim University, Aligarh, Uttar Pradesh 202002, India*

⁷*Department of Computer Science and IT, Bosco Technical Training Society, Don Bosco Technical School, Okhla Road, New Delhi, Delhi 110025, India*

⁸*Department of Electrical and Computer Engineering, Kombolcha Institute of Technology, Wollo University, Ethiopia*

Correspondence should be addressed to Asefa Sisay; asefasis@kiot.edu.et

Received 1 April 2022; Accepted 27 May 2022; Published 24 June 2022

Academic Editor: Mohammad Farukh Hashmi

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In general, the MIMO technology is used to transfer data from a protocol such as Wi-Fi in 5G networks. This is due to the increased bandwidth and capacity. The 802.11n protocol, which, using the technology described in it, allows you to reach speeds of up to 350 megabits/second. The quality of data transmission has improved even in areas where the reception signal is low. An external access point with a MIMO antenna is a well-known one. The WiMAX network can now transmit information at speeds of up to 40 megabits/second, using MIMO. It uses MIMO technology up to 8×8 . Thanks to this, a higher transfer rate is achieved—over 35 megabits/second. In addition, reliable and high quality connection of the best quality is guaranteed. In this paper, we continue to work and enhance technical configurations of MIMO in 5G networks. The proposed model will improve spectrum performance, improve network capability, and speed up data rates. In a saturation point, the proposed method achieves that the signal to noise interference ratio is just 42.4%, the receiver signal strength is 92.94%, the downstream traffic is 48.76%, the upstream traffic is 45.62%, the bandwidth utilization is 97.43%, the speed is 95.79%, the connectivity between the access point is 90.6%, and the network security is 96.42%.

1. Introduction

The mobile data transfer LTE generation belongs to 4G. In comparison, the speed is increased about 10 times and the efficiency of data transfer in 5G network. However, it often happens that the speed of reception and exchange of new generations is desirable [1]. It depends on the quality of

the signal coming directly from the base station. To solve this problem, external antennas are used. By design, LTE antennas can be normal and MIMO (dual) with a standard setup; speeds of up to 50 Mbps can be achieved [2]. MIMO, however, can double this speed. This is done by installing two antennas in one system (box), which is located at short distances from each other [3]. They receive and transmit the

signal to the receiver via two separate cables simultaneously. Due to this, such an increase in speed occurs [4].

The MIMO (multiple input multiple output) is a wireless communication system (Wi-Fi, WiMAX, cellular communication networks) that can significantly improve a computer's spectral efficiency, maximum data transfer rate, and network efficiency [5]. The main way to achieve the above benefits is to transfer data from source to target through multiple radio connections; this technology got its name [6].

The emission of radiation from the various wireless radio systems above 100 MHz acts like light beams in many ways. Radio waves, when propagating, meet any surface, depending on the size of the object and the barrier; some energy is absorbed, some pass through, and the rest are reflected [7]. Furthermore, the reflection and passing of the signal energies change the direction of their further propagation, and the signal itself is divided into several waves. Each of the waves reaching the receiver is called the signal propagation path [8]. Also, because different waves are reflected from different numbers of obstacles and travel different distances, different paths have different times. In a dense city building, a situation often arises between subscribers due to numerous obstacles such as buildings, trees, and cars [9]. Equipment (Ms.) and base station antennas (BTS) do not have a line of sight [10]. In this case, the reflected waves are the only way to reach the receiver signal. However, as mentioned above, many reflected signals do not have initial energy and may come with a delay [11]. The particular difficulty is that objects are not always stable, and the situation may change significantly over time. This raises the issue of multiple beams transmitting signal—one of the most important problems in wireless communication systems [12].

Its essence lies in the fact that to receive a signal, not one, but two antennas are usually located at a distance from each other [13]. Thus, the receiver does not have one, but two copies of the transmitted signal that came in different ways [14]. This makes it possible to store more power from the original signal because the waves received by one antenna may not be received by another antenna, and vice versa [15]. This radio interface arrangement can be called single input multiple output (SIMO) [16]. The reverse approach can also be used: when multiple antennas are used for transmitting and receiving one, this scheme is called multi-input single output (MISO) [17]. As a result, we come to the multi-input multioutput (MIMO) scheme. In this case, multiple transmitting and receiving antennas are installed [18]. However, unlike the above schemes, this diversity scheme not only combats the multipath propagation of the signal, but also due to the use of multiple antennas in transmission and reception, each pair of transmitting/receiving antennas can be connected in a separate path [19]. The result is that, in theory, the number of additional antennas used can increase the data rate many times over [20].

There is also a caveat about MU-MIMO technology: it does not work well with fast moving devices because the beam forming process is more complicated and less efficient [21]. Therefore, MU-MIMO does not provide meaningful benefit to devices that frequently roam your corporate network [22]. However, it should be understood that these

“problematic” devices do not affect MU-MIMO data transfer to other client devices where mobile is low or their performance in any way. The MIMO (multiple input multiple output) is a technology used in wireless communication systems (Wi-Fi, cellular networks) that improves a computer's spectral efficiency, maximum data transfer rate, and network capability [23]. The main way to achieve the above benefits is to transmit data from source to target through multiple radio connections, from which the technology derives its name [24]. Consider the background to this problem and determine the main reasons for the widespread use of MIMO technology [25].

The need for high speed connections that provide high quality service (QoS) with high fault tolerance is increasing year by year. This is greatly facilitated by the appearance of services such as VoIP () and VoD (). However, most wireless technologies do not allow to provide high quality service to the subscribers at the edge of the coverage area [26]. In cellular and other wireless communication systems, the quality of the connection and the distance from the available data rate (BTS) are rapidly declining. At the same time, the quality of services is declining, which ultimately makes it impossible to provide real-time services with high quality across the network's radio coverage [27]. To solve this problem, you can try to install the base stations as tightly as possible and arrange internal security everywhere with low signal level. However, this will require significant financial outlay, which will eventually lead to an increase in the price of the service and a decrease in competitiveness. Therefore, to solve this problem, the original invention is required, which, if possible, uses the current frequency range and does not require the creation of new network facilities. The functions usually increase when you get multiple data as input. Depending on these excessive functions, some technology jobs can be done in the amount of activities and calculation analysis in its divert settings. These functions will be helpful to make serial changes depending on its plurality. This enhanced MIMO functions are designed to include the transmitter transformation receiver volumes.

2. Literature Review

This work [1] discussed that the technology has also been used for modern Wi-Fi. MU-MIMO uses directional signal formatting (called “beam forming” in the English technical literature). The beam forming allows a wireless device (or devices) to send signals in that direction, instead of sending them roughly in all directions. Thus, it will change the focus of the signal and significantly increase the range and speed of the Wi-Fi connection. The authors in [2] discussed about the beam forming technology is available as an option with the 802.11n standard; most manufacturers have implemented proprietary versions of this technology. These vendors still offer proprietary implementations of the technology on their devices, but now if they want to support MU-MIMO technology in their 802.11ac product line, they need to add a simplified and standardized version of the directional signal technology.

They [3] discussed about the routers or access points with enabled MU-MIMO technology cannot serve unlimited streams and devices simultaneously. The router or access point has its own limit on the number of streams it can serve (often 2, 3, or 4 streams), and the number of these spatial streams access point controls the number of devices that can be served simultaneously. Therefore, an access point with support for four streams can serve up to four different devices simultaneously. The author in [4] expressed the SU-MIMO technology; only wireless devices with built-in MU-MIMO support can stream streams (rate). But, unlike the situation with SU-MIMO technology, wireless devices do not need to have multiple antennas to receive wireless routers and MU-MIMO streams from access points. If your wireless device has only one antenna, it can receive only one MU-MIMO data stream from the access point, using beam-forming to enhance reception.

They [5] discussed that more antennas will allow the wireless user device to receive more data streams simultaneously (usually one stream per antenna), which will definitely have a positive effect on the performance of this device. However, the presence of multiple antennas in one user device negatively affects the power consumption and size of this product, which is important for smartphones. The authors in [6] discussed the effort to ease the need for end-user devices; developers of MU-MIMO technology sought to shift most signal processing work to access points. This is another step forward from SU-MIMO technology, where the load of signal processing was mostly on user devices. Again, this will enable client device manufacturers to save energy, quantity, and other costs on the production of their product solutions with MU-MIMO support, which should have a very positive effect on popularizing this technology. This work [7] expresses that the MU-MIMO technology places less hardware requirements on client devices than technically complex SU-MIMO technology, and it is safe to assume that manufacturers will be more prepared to equip them. Today's laptops and tablets support MU-MIMO technology.

3. Proposed Method

To streamline MIMO technology, it is necessary to install multiple antennas on the transmitting and receiving pages. Normally an equal number of antennas are installed at the input and output of the system because in this case, the maximum boot rate is achieved. The proposed model is shown in Figure 1. "MIMO" is usually coded "AxB" to indicate the number of transmitting and receiving antennas with the technical name, where A stands for the number of antennas inside the system and B for output. For MIMO technology to work, some modifications to the transmitter configuration are required compared to conventional systems.

The data given in the transmitter area will be purchased first. This will change the transition depending on the speed and garment of antenna. This will be the possibilities that have high levels of its inputs. Furthermore, it can be sent out of the structure of the data in its browsing system. It will be ready for a number of releases. The receiver antenna is

growing. This will make many entries simultaneously process.

3.1. For Transmitting Side. A stream separator is required, which divides the data intended for transfer into several low-speed sub streams, the number of which depends on the number of antennas. For example, for input data rates of MIMO 2×2 and 100 Mbps, the separator will generate 50 Mbps 2 streams each. Also, each of these streams must be transmitted through its own antenna. One possible way to streamline MIMO technology is to send a signal with different polarities from each antenna, which helps to identify it during reception.

Based on the propagation requirements, the main spectrum band saw classified as follows:

$$A_b = \exp \left[-c \left(\frac{2\pi}{\alpha} \right) \sin \mu_d \left[e_f \cos (\rho_d) + g_f \sin (\rho_d) \right] \right], \quad (1)$$

where μ_d and ρ_d are the phases at the bands e_f and g_f .

3.2. For Receiving Side. Many antennas receive the signal from the radio. Also, the antennas on the receiving side are installed with a certain spatial diversity, which ensures diversity reception. The received signals go to the receivers, the number of which corresponds to the number of antennas and transmission paths. Also, each receiver receives signals from all the antennas of the computer. Each of these combinations separates the signal energy of its responsible path from the total flow and shown as follows:

$$AL [tB] = 20 \log (t) - [5 \log (D_a) + 5 \log (D_b) + 10 \log (f_a) + 10 \log (f_b)], \quad (2)$$

$$C = 2V_b \left[\cos^{-1} \left(\frac{V_b}{V_b + f_a} * \cos (\theta) \right) - \theta \right], \quad (3)$$

where t is the separation between the sender and receiver and V_b is the Earth's radius

Depending on the operating principle of the system, the transmitted signal may be repeated after a certain time or transmitted by other antennas with a slight delay. The above principle of the radio communication system refers to the so-called single-user MIMO (SU-MIMO), where there is only one transmitter and one receiver of information. In this case, both the transmitter and the receiver can only clearly coordinate their actions. Such a program is suitable.

Get the data given first. Then, there will be the input of the spectrum blocks there. The events are obtained in various waves that are available after the instructions are received. Based on these events is the calculation of being the primary and secondary users. These calculations allow you to log in to the second user through the prevailing holes in the event of the primary user. When the primary user comes at the time or where the applications are available, they may shift the secondary user to another location for the second user. So this

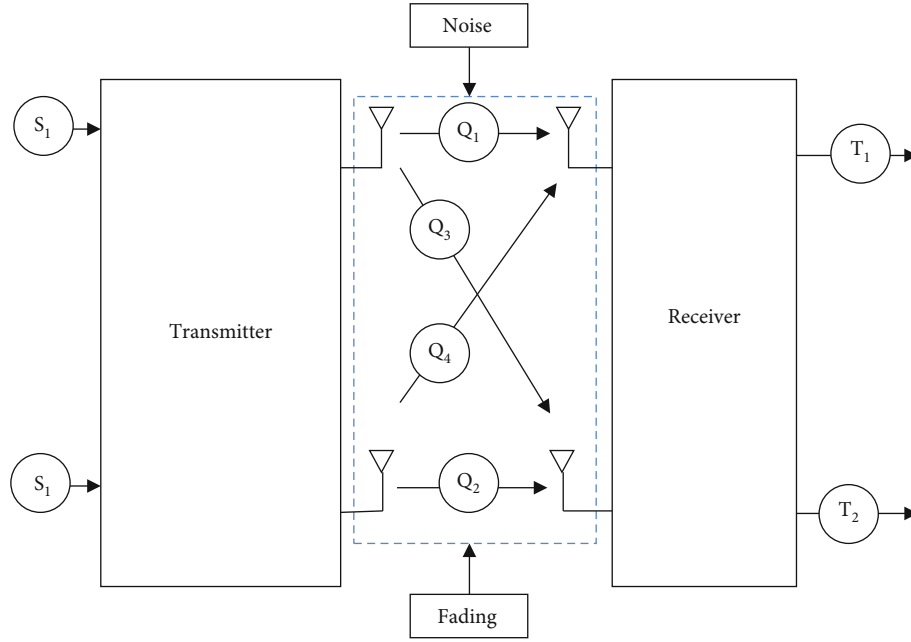
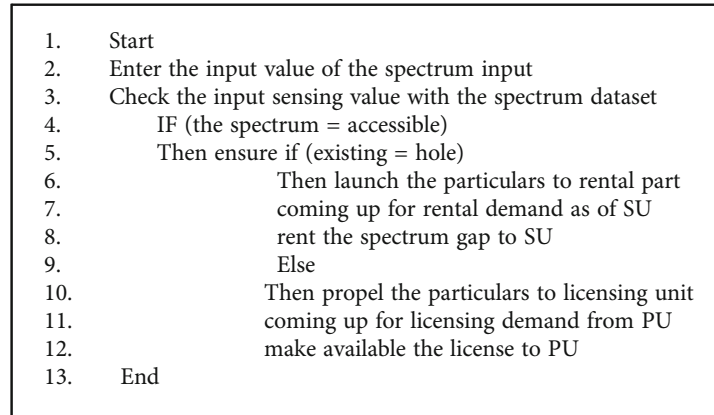


FIGURE 1: Massive MIMO.



ALGORITHM 1: Massive multi-in multiout algorithm (MMIMO).

time management and secondary user will take place regularly for switching jobs.

To simplify communications between two devices in a home office, for example. In turn, most systems, such as WI-FI, WIMAX, and cellular communication systems, are multiuser, i.e. They have a single hub and multiple remote objects, each of which requires a radio connection. In this case, two problems are solved: on the one hand, the base station sends a signal to multiple subscribers through the same antenna system (MIMO broadcast), while at the same time receiving the same signal from multiple subscribers (MIMO) through the same antennas.

4. Results and Discussions

The proposed massive MIMO model (MMIMO) was compared with the existing methods: advanced baseband processing algorithm (ABPA), millimeter-wave propagation

modeling (MWPM), MIMO scheduling schemes (MIMOSS), and efficient channel estimation model (ECEM). An unavoidable condition is the strict adherence to the geometric dimensions of all parts, without exception. The geometric dimensions of high frequency devices must be observed to the nearest millimeter and more accurately. Any deviation leads to performance distortion. The gain decreases, and the relationship between the MIMO antennas increases. Eventually, instead of amplifying the signal, its weakness will be noticed. Unfortunately, exact geometric dimensions are not widely available. The signal to noise inference ratio is given in Figure 2 and in the following equation:

$$\text{Signal to Noise Interference Ratio} = \frac{\text{RSSI}}{A + 1}. \quad (4)$$

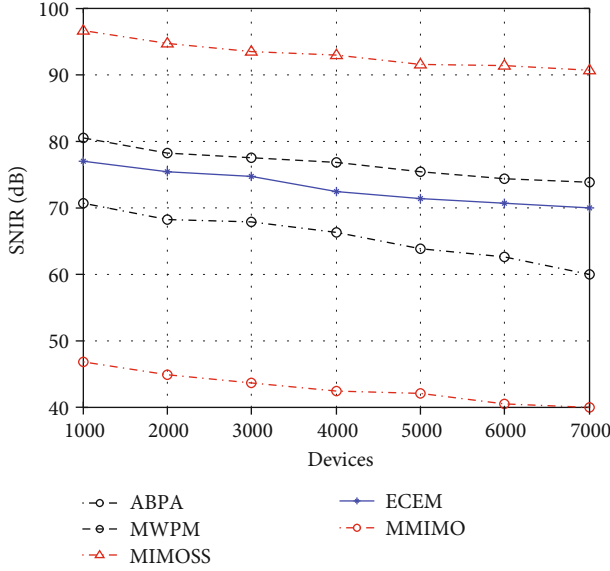


FIGURE 2: Comparison of signal to noise interference ratio.

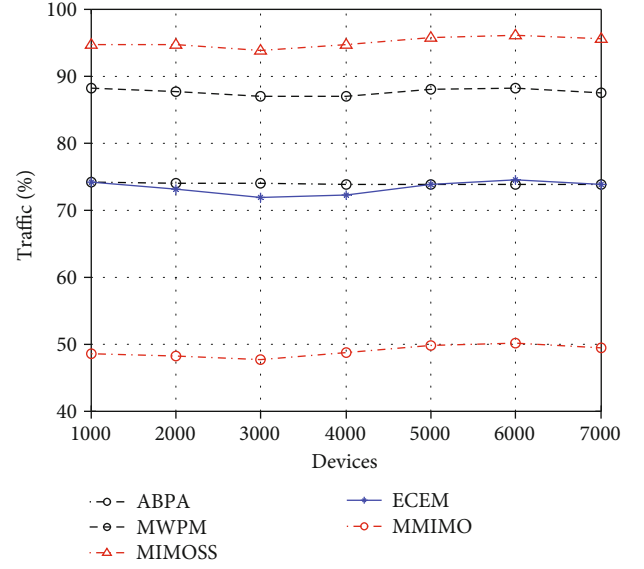


FIGURE 4: Comparison of downstream traffic.

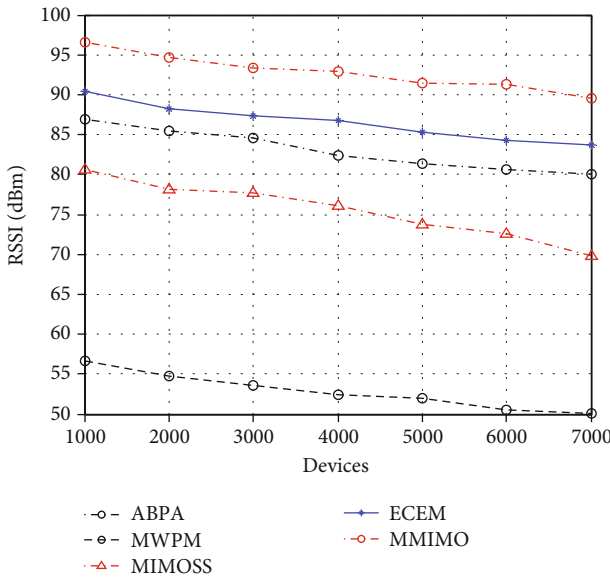


FIGURE 3: Comparison of receiver signal strength.

In saturation point, the existing methods achieve 66.15%, 76.74%, 92.94%, and 72.3% but the proposed method just gets 42.4% of signal to noise interference.

The values of RSSI were calculated and shown as follows:

$$\text{RSSI} = A_t + B(D_t) + B(D_r) - A_c - C, \quad (5)$$

$$F = H * \log(1 + \text{Signal to noise interference ratio}), \quad (6)$$

where $B(D_t)$ is the height gain of the transmitter antenna, $B(D_r)$ is the height gain of the receiver antenna, D_t is the transmitter tethered aerostat's altitude, D_r is the height of the receiver antenna, C is the connector cable loss, A is the noise figure of an antenna, and RSSI is the receiver signal strength indicator.

In saturation point, the existing methods achieve 84.33%, 52.48%, 76.15%, and 86.74% but the proposed method just gets 92.94% of receiver signal strength. On the other hand, if super strong amplification is not required, a MIMO antenna can be manufactured independently, according to the indicated dimensions, to give a positive effect, even if not larger as shown in Figure 3. The cost of materials is low, and the time spent in the presence of skills is not high. In addition, after testing many options, no one interferes with the selection of the one that is acceptable according to the test results.

In saturation point, the existing methods achieve 73.83%, 86.86%, 94.57%, and 72.24% but the proposed method just gets 48.76% of downstream traffic. Unlike SU-MIMO, MU-MIMO currently only works by transferring data from the access point to the mobile device. Wireless routers or access points can only send data to multiple users at once, even if they are one or more streams each. When wireless devices (such as smart phones, tablets, or laptops) send data to a wireless router or access point, they can send multiple streams individually using SU-MIMO technology. MU-MIMO technology is particularly useful in networks that download more data than users' upload as shown in Figure 4.

In saturation point, the existing methods achieve 77.93%, 81.52%, 91.9%, and 74.13% but the proposed method just gets 45.62% of upstream traffic. SU-MIMO technology operates on both the 2.4 GHz and 5 GHz frequency bands. 802.11ac Wave 2 2nd generation wireless routers and access points can only serve multiple users simultaneously on the frequency band 5 GHz aside; of course, it is a pity that the new technology cannot be used on the shorter and busier 2.4 GHz frequency bands as shown in Figure 5. But, on the other hand, there are more and more dual-band wireless devices on the market that support MU-MIMO technology that can be used to deploy high performance corporate Wi-Fi networks.

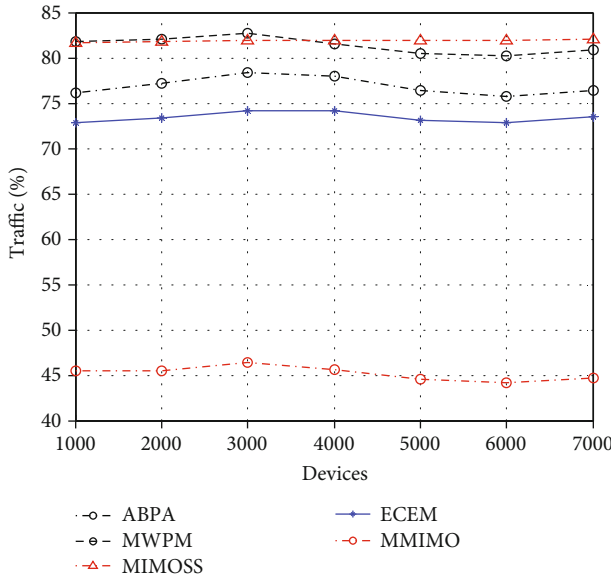


FIGURE 5: Comparison of upstream traffic.

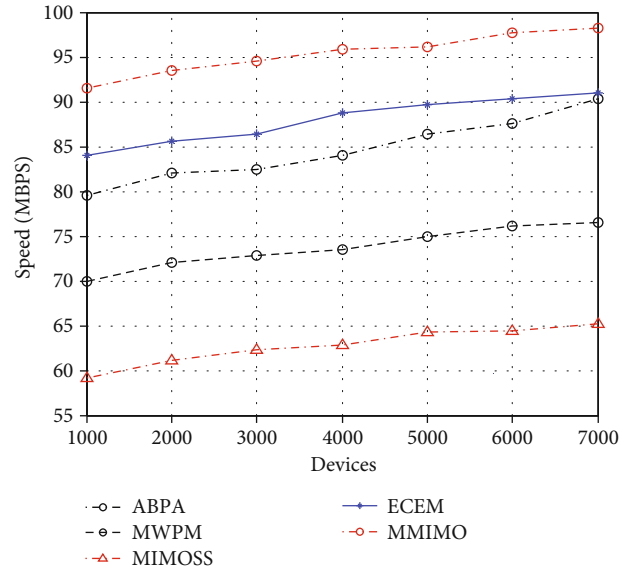


FIGURE 7: Comparison of speed.

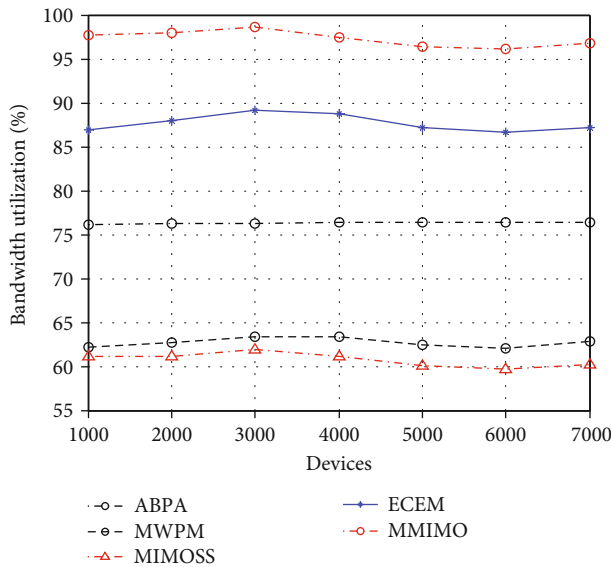


FIGURE 6: Comparison of bandwidth utilization.

In saturation point, the existing methods achieve 76.34%, 63.42%, 61.16%, and 88.75% but the proposed method just gets 97.43% of bandwidth utilization. As the Wi-Fi connection speed increases, obviously the wireless network bandwidth also increased. As devices deliver faster, the network has more time to serve more client devices as shown in Figure 6. Thus, MU-MIMO technology can greatly improve the performance of wireless networks with a greater number of connected devices such as high traffic or public Wi-Fi networks.

In saturation point, the existing methods achieve 84.02%, 73.54%, 62.79%, and 88.69% but the proposed method just gets 95.79% of speed. This is great news as the number of smart phones and other mobile devices with

Wi-Fi connectivity is likely to continue to increase. One way to expand the Wi-Fi bandwidth is to connect two adjacent channels into a channel that is twice as wide, doubling the speed of the Wi-Fi connection between the device and the access point as shown in Figure 7. The 802.11n standard provided support for channels up to 40 MHz wide, while in the original specification of the 802.11ac standard, the supported channel width was increased to 80 MHz. The updated 802.11ac Wave 2 standard supports 160 MHz channels.

In saturation point, the existing methods achieve 68.44%, 69.61%, 72.19%, and 77.07% but the proposed method just gets 90.6% of access point connections. An interesting side effect of MU-MIMO technology is that the router or access point encrypts the data before sending it over the air. It is very difficult to decode data sent using MU-MIMO technology because it is not clear which part of the code is in which spatial stream as shown in Figure 8. Although specialized devices were later developed to allow other devices to intercept transmitted traffic, today, MU-MIMO technology effectively hides data from nearby listening devices.

In saturation point, the existing methods achieve 66.63%, 68.92%, 68.33%, and 72.75% but the proposed method just gets 96.42% of access point connections. Therefore, the new technology helps to improve Wi-Fi security, which is especially true for public Wi-Fi networks such as open wireless networks, privately accessed points, or simplified user authentication mode (preshared key (PSK)) based on WPA or WPA2 Wi-Fi security technologies as shown in Figure 9. However, it should not be forgotten that the use of wider channels in the wireless network increases the chance of interference in cochannels. However, even if your wireless network uses narrower 20 MHz or 40 MHz channels, MU-MIMO can still run faster. However, this will depend on how many client devices are required and how many streams each of these devices can handle. Therefore,

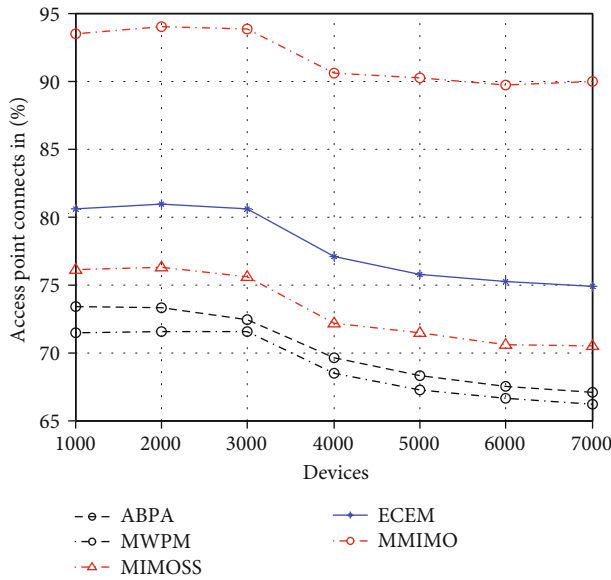


FIGURE 8: Comparison of access point connects.

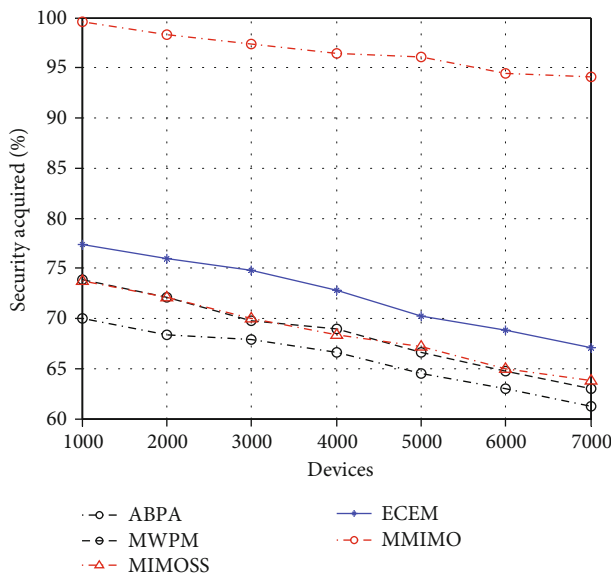


FIGURE 9: Comparison of security.

the use of MU-MIMO technology is more than double the efficiency of the outgoing wireless connection for each device, even if there are no wide corresponding channels.

5. Conclusion

The major improvements include the ability to improve performance without increasing bandwidth. So, the device distributes the various streaming information in single channel. The quality of the transmitted signal and the data transfer rate are getting better. This is because technology first encrypts the data and then retrieves it on the receiving page. The signal transmission speed is twice as high. Due to the use of two independent cables, several speed parameters are increased, through which information is distributed

simultaneously and obtained in the form of a digital stream. The spectrum quality of the following systems has been improved.

Data Availability

The data used to support the findings of this study are included within the article. Further data or information is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Acknowledgments

The authors appreciate the supports from Kombolcha Institute of Technology, Wollo University, Ethiopia, for the research and preparation of the manuscript.

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