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Performance Evaluation of Wireless Network Technologies Based on Throughput, Latency and Packet Loss

Dambo Itari[1], Obhuo Benjamin[1], Ezimora Okezie Anthony[2]
Department of General Studies,
College of Health Technology, Bayelsa State, Nigeria
Covenant Polytechnic, Aba. Computer Science Department
Email: anidam43@gmail.com,
Benjao2003@yahoo.com tonydivine2020@gmail.com
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Abstract
The modern world has seen the rise of wireless network technologies which facilitate connectivity of mobile devices, computers, smart devices, industrial equipment, and other applications. The widespread adoption of wireless network technologies requires developing effective ways of analyzing their performance and efficiency. Thus, the current paper is dedicated to the evaluation of the performance of wireless network technologies with respect to throughput, latency, and packet loss. By throughput, one means the amount of successfully transmitted data by a network during a certain period. Latency implies the delay caused during data transmission, and packet loss means packets that do not reach their destination. Throughput, latency, and packet loss can be considered effective parameters for evaluating the performance of wireless communication technologies. Some previous studies analyzed various wireless network technologies such as Wi-Fi, Wi-Fi 6, Wi-Fi 7, LTE, 5G, IEEE 802.11ax, and multi-connectivity networks. Besides, some studies focused on the analysis of the performance of wireless networks in high-density environments, in industrial environments, in mobile communication, in private networks, remote control systems, and Internet of Things applications. In the current paper, wireless network technologies will be analyzed using synthetic data concerning network performance. Specifically, Wi-Fi, Wi-Fi 6, Wi-Fi 7, LTE, and 5G.

Keywords: *Wireless networks, throughput, latency, packet loss, Wi-Fi, 5G, network performance*

1. Introduction

Wireless network technologies are becoming increasingly vital in modern communication and information networks. Wireless network technologies facilitate the exchange of information by enabling computers, mobiles, sensors, and other networked devices to communicate without physical wired connections. The wide range of wireless network technologies has been widely adopted in homes, learning institutions, businesses, hospitals, industries, transport networks, and other areas (Sultan et al., 2022; Sathya et al., 2024). With the growing rate of adoption of wireless network technologies, there is the need to assess the performance of wireless networks. Users seek for networks that offer efficient data transmission, quick responses, and effective communication. However, the performance of wireless networks depends on various factors such as network traffic, network interference, signal strength, distance between the devices, the number of devices in the network, configuration of the network, and wireless network technologies used (Rady et al., 2024; Simiyu et al., 2025). The performance of the wireless network could be analyzed using different performance metrics. Some of these metrics include throughput, latency, and packet loss. Throughput is the amount of information that passes through the network successfully during a particular time frame. This metric is crucial for applications which need the transmission of a huge amount of data like video streaming, file transferring, cloud computing, and multimedia communications. The importance of the metric in analyzing the performance of the network has been studied in literature focusing on modern network optimization and wireless communication (Sawant, 2021; Kar et al., 2025). Latency is the period taken by the information to move from one point to another point within the network. Latency is essential for applications which require quick response and fast communication like video conference, online games, industry automation, and remote controls. Literature on advanced wireless technologies has looked at the metric in detail as one of the most crucial metrics of network performance (Alauthman & Shraa, 2025; Zhang et al., 2025). Packet loss occurs when transmitted data packets fail to reach their intended destination. It may result from network congestion, interference, transmission errors, weak signals, or limited network resources. A high level of packet loss can reduce communication reliability and affect applications that depend on continuous data transmission Loss of packets takes place when data packets do not arrive at their desired destination point. This can be caused by congestion, interference, transmission errors, low signals, or shortage of network resources. High packet loss is likely to lower the reliability of communications and cause problems for applications using continuous data transmission. Research on direct and hotspot internet connections has examined latency and packet loss as important measures for assessing Quality of Service and network selection (Gbigbidje et al., 2025). The development of Wi-Fi technologies has further increased the importance of wireless network performance evaluation. Newer Wi-Fi standards have been developed to provide improved data rates, efficiency, capacity, and performance. For example, the performance of Wi-Fi 6 has been investigated in an industrial outdoor robotic environment, where reliable wireless communication is important for operational activities (Rady et al., 2024). Wi-Fi 7 has also been examined in high-density wireless environments, with attention to performance and latency under demanding network conditions (Alauthman & Shraa, 2025).

Wireless communication is also important in industrial environments, where connected devices need to exchange information efficiently and reliably. Industrial Internet of Things (IIoT) environments may contain numerous sensors, controllers, machines, and other connected devices. Performance evaluation of IEEE 802.11ax in IIoT environments has considered throughput, latency, and packet loss as measures for determining the effectiveness of wireless communication (Simiyu et al., 2025). Wireless network performance can also vary according to the environment in which the technology is deployed. Different situations can demand various things from wireless networks including high-density situations, industrial settings, mobile communication cases, and remote communication technologies. Studies have been carried out regarding wireless network slicing to understand the role played by Wi-Fi and 5G wireless technologies in ensuring reliable communication in extreme conditions and emphasizing on the need to consider such performance indicators as throughput, latency, and packet loss (Limani et al., 2025).

Hence, it may not be sufficient to evaluate the performance of wireless networks based on a single indicator since one network may have high throughput levels but high latency and another low latency but packet loss in certain conditions. Considering all three performance indicators is important to get a comprehensive assessment of wireless network performance (Sultan et al., 2022; Gbigbidje et al., 2025; Sathya et al., 2024).

This study seeks to evaluate the performance of wireless network technologies through the consideration of throughput, latency, and packet loss. It looks at what affects the performance of wireless networks, evaluates the technologies in various network situations and evaluates them on the basis of the identified measures of performance.

2. Related Works

The wireless network technology has been developed greatly in relation to the growing demand for fast, reliable, and flexible communication. The modern wireless networks consist of various types of Wi-Fi technology, LTE, 5G, and other wireless communication technologies. They can show different performance depending on the technology, environment of operation, network load, and communication needs. Therefore, the studies have been performed concerning different wireless technologies based on the performance metrics like throughput, latency, packet loss, reliability, and data rate. The performance of wireless networks means the efficiency of the process of transmitting the data and providing the communication service by a wireless network. The performance evaluation is required since the performance of the same wireless technology may differ depending on different factors. Such factors as interference, distance, congestion, signal strength, number of devices, network configuration, etc. affect the behavior of a wireless network. The researches regarding the Wi-Fi 6 in the industrial environment prove the importance of the practical performance evaluation of wireless technologies (Rady et al., 2024).

2.1. Wireless Network Technologies

Wireless network technologies permit the communication process between devices using radio waves instead of physical mediums. One of the most popular technologies is Wi-Fi technology, which has advanced to various levels to enhance the quality of data transmission and efficiency of the network. The recent advancements include Wi-Fi 6 and Wi-Fi 7, technologies that have been designed to cater for networks with large amounts of connected devices.

The performance of Wi-Fi technologies has been assessed under different conditions of usage. Real-time assessment of Wi-Fi networks has shown that it is necessary to assess the performance of a network during the process of real communication and not just on the basis of theoretical assessments (Sultan et al., 2022). Moreover, Wi-Fi 6 technology has been assessed in the field of an industrial outdoor robotic network, where communication is an important factor in robotics (Rady et al., 2024). The emergence of Wi-Fi 7 is yet another advancement in wireless technology, where the performance of such technology is investigated under the conditions of high density. The conditions of high density can impose heavy loads on wireless technologies since a large number of devices compete for network resources. Performance testing of such technologies in these conditions gives the information on how wireless technologies perform when there is a growing demand on networks (Alauthman & Shraa, 2025).

Mobile wireless technologies have also been advanced from the earlier cellular technologies to LTE and 5G. 5G is expected to meet applications that need high-speed data transmission with low latency and higher connectivity. Comparative study between Wi-Fi 6 and 5G private LAN technologies proves the significance of assessing performance of wireless technologies (Sathya et al., 2024).

2.2. Wireless Network Performance

Wireless network performance is an indication of the performance of the wireless communication system in terms of delivering data among interconnected devices. This performance may be affected either technically or environmentally. Factors such as traffic on the network, network interference, distance, signal strength, network configuration, and the number of devices on the network will determine the performance of the wireless communication system (Rady et al., 2024; Simiyu et al., 2025). Performance evaluation is a means through which wireless network performance can be evaluated.

2.3. Throughput

Throughput refers to the amount of data successfully transmitted through a network within a particular time frame. It is usually measured in bits per second, such as Mbps and Gbps. Throughput gives an idea of how much data is actually transmitted through the network in certain operational conditions. High throughput plays a critical role in the context of services that require a lot of data. Data transmission can be useful for video streaming, cloud computing, file transfer, multimedia application, and other bandwidth-intensive services. Nevertheless, maximum possible speed of data transmission of a particular wireless technology does not mean that the actual throughput will be that high. Modern network research has also analyzed the link between the throughput and other performance parameters. Optimization of networks took into account the performance parameter of throughput along with latency since improvement in one of the performance parameters does not imply improvement in the other (Sawant, 2021). The same is true for research conducted in the area of 5G multi-connectivity to achieve high-throughput and reliable communication (Kar et al., 2025).

2.4. Latency

Latency is the delay experienced while transporting the data from one point to another. It is usually measured in milliseconds (ms). Low latency means that data is transmitted and the response is received in a very short period of time. Latency becomes important for applications that involve fast interactive communication. Applications such as remote control, industrial automation, online games, video conferencing, and many other similar applications can be affected by high latency. Studies on Wi-Fi 7 have studied latency under high density networks and how the network condition affects the latency of communications (Alauthman & Shraa, 2025).

Latency has been considered in researches involving 5G and multi-connectivity networks. The introduction of 5G technology was due to the requirement for an application involving fast and responsive communication. Consequently, studies on 5G multi-connectivity have focused on techniques for facilitating low latency communications (Kar et al., 2025).

Latency is very important for performance since a network with very high throughput may not necessarily have good performance for applications that require responsiveness. Therefore, latency has to be considered together with throughput when assessing wireless network technologies.

2.5. Packet Loss

Loss of packet happens when packets sent through the network fail to reach their destination point. It is typically stated in percentage and depends on the total number of packets being sent. Low packet loss means successful delivery of packets, while high packet loss shows problems with communication. There are many reasons for packet loss; it can be caused by congestion, interference, fading of the signal, errors in transmission, and lack of resources in the network. Packet loss can harm applications requiring reliable communication. Thus, packet loss in video or voice communication may lead to pauses or poor communication.

Research was conducted about packet loss along with latency in order to evaluate internet connection and Quality of Service. Direct and hotspot internet were compared using latency and packet loss to reveal their performance and suitability for network choice (Gbigbidje et al., 2025). There are also studies conducted in relation to LTE and 5G networks about packet loss and delay (Alauthman & Al-Hyari, 2025). Packet loss is, therefore, a very important aspect of wireless network evaluation. The analysis of packet loss in combination with throughput and latency reveals much about network performance and communication.

2.6. Factors Influencing Wireless Network Performance

Various factors can affect the performance of a wireless network. One such factor is network congestion. In case many devices use the same network resources, then the bandwidth may be distributed among many users, thus affecting the throughput rate and introducing latency.

Another factor that affects performance is interference. Since wireless networks work through radio signals, the presence of interference from other wireless devices or sources can affect the quality of signals and packet transmissions, leading to reduced throughput and increased packet loss. Also, the distance between two devices is another factor that can affect performance. With increased distances between a wireless device and an access point or base station, signal strength can reduce. Such poor signal strength will affect data transmission and increase communication errors. Lastly, the number of devices that are connected is another factor that can affect performance. For high density areas, the demands on network resources will be higher. Thus, various studies involving the performance of Wi-Fi 7 have been conducted in high density environments, where many devices are connected at once (Alauthman & Shraa, 2025).

One of such studies involves the comparative performance analysis of Wi-Fi 6 and 5G private LAN technologies (Sathya et al., The study provides useful evidence for understanding how different wireless technologies can be evaluated using measurable network performance indicators. Wi-Fi 6 has also been examined in an industrial outdoor robotic environment, providing information about wireless performance in a practical industrial setting (Rady et al., 2024). This is relevant because industrial environments may present challenges that are different from those encountered in ordinary indoor wireless networks. Research on Wi-Fi 7 has focused on high-density wireless environments and examined performance and latency under conditions involving substantial network demand (Alauthman & Shraa, 2025). Similarly, LTE and 5G performance has been examined using parameters including packet loss and delay, providing information about the behaviour of mobile wireless networks (Alauthman & Al-Hyari, 2025). Wireless technologies have also been investigated in disaster-response and IIoT environments. Research on network slicing has examined Wi-Fi and 5G communication for reliable disaster-response applications (Limani et al., 2025). In IIoT environments, IEEE 802.11ax has been evaluated using throughput, latency, and packet loss to examine wireless performance (Simiyu et al., 2025).

Overall, the reviewed studies demonstrate that throughput, latency, and packet loss are useful measures for evaluating wireless network performance. However, differences in technologies, environments, network conditions, and evaluation methods mean that wireless technologies cannot always be assessed using a single performance measure. A combined consideration of throughput, latency, and packet loss provides a more comprehensive basis for evaluating and comparing wireless network technologies. The reviewed studies provide substantial information on the performance of wireless technologies, including Wi-Fi, Wi-Fi 6, Wi-Fi 7, LTE, 5G, and IEEE 802.11ax. However, many studies focus on particular technologies or operating environments, with attention given to individual performance measures such as throughput, latency, or packet loss.

There is limited research that applies a common synthetic dataset to directly compare Wi-Fi, Wi-Fi 6, Wi-Fi 7, LTE, and 5G using these three performance parameters within a single evaluation framework. This study addresses this gap by providing a comparative evaluation of these wireless technologies using synthetic performance data based on throughput, latency, and packet loss under different network conditions.

3.0. Research Methodology

This study adopted a comparative evaluation approach to assess the performance of five wireless network technologies based on throughput, latency, and packet loss, a synthetic dataset was used to represent performance observations for Wi-Fi, Wi-Fi 6. Wi-Fi 7, LTE, and 5G.

3.1 Research Design

This study adopts a quantitative research design based on the generation and analysis of synthetic wireless network performance data. The design provides a structured approach for examining and comparing the performance of different wireless network technologies based on throughput, latency, and packet loss. Synthetic data are used to represent different network technologies and network conditions in a controlled manner.

3.2. Sources of Data

The study uses synthetic data generated to represent wireless network under different network conditions. The dataset contains performance measurements for Wi-Fi, Wi-Fi 6, Wi-Fi 7, LTE, and 5G wireless technologies. The data include throughput, latency, and packet loss, which correspond to the three main performance parameters examined in the study. Different network conditions, including low, moderate, and high traffic conditions, are represented in the dataset. The synthetic dataset was generated for the purpose of conducting a comparative evaluation of wireless network performance.

Table 1: Synthetic Dataset for Wireless Network Performance Evaluation

Technology	Observation	Throughput (Mbps)	Latency (ms)	Packet Loss (%)
Wi-Fi	1	48.6	21.3	3.1
Wi-Fi	2	52.4	19.8	2.7
Wi-Fi	3	55.1	18.9	2.5
Wi-Fi 6	1	71.2	14.6	2.0
Wi-Fi 6	2	75.8	13.2	1.8
Wi-Fi 6	3	78.4	12.7	1.7
Wi-Fi 7	1	91.5	9.4	1.3
Wi-Fi 7	2	95.2	8.8	1.1
Wi-Fi 7	3	98.1	8.2	1.0
LTE	1	42.6	25.3	3.6
LTE	2	45.1	24.1	3.3
LTE	3	47.3	23.5	3.1
5G	1	84.7	11.5	1.7
5G	2	88.3	10.8	1.5
5G	3	91.2	10.1	1.3

3.3. Wireless Technologies Considered

The study considers the following major wireless technologies:

- Wi-Fi| General wireless network performance
- Wi-Fi 6| Industrial and high-performance wireless environments
- Wi-Fi 7| High-density wireless environments
- LTE| Mobile wireless communication
- 5G| High-speed and low-latency communication
- IEEE 802.11ax| Industrial IoT environments
- 5G Multi-connectivity| High-throughput and reliable communication
- Wi-Fi/5G Network Slicing| Reliable communication in specialized environments

3.4. Performance Parameters

The study evaluates wireless network technologies using three major performance parameters: throughput, latency, and packet loss.

Table 2: Performance Parameters

Performance Parameters	Meaning	Unit of Measurement	Importance
Throughput	Amount of data successfully transmitted	Mbps or Gbps	Indicates data transmission capacity
Latency	Time taken for data to travel between communicating devices	Milliseconds (ms)	Indicated communication delay
Packet loss	Data packets that fail to reach their intended destination	Percentage (%)	Indicates transmission reliability

4.0. Results and Discussion

The results of this study are based on the findings reported in the reviewed studies on wireless network performance. This study considered different wireless technologies and network environments, including Wi-Fi, Wi-Fi 6, Wi-Fi 7, LTE, 5G, IEEE 802.11ax, and 5G multi-connectivity. The results are discussed using throughput, latency, and packet loss as the major performance measures. Because the reviewed studies used different devices, network configurations, environments, traffic conditions, and experimental procedures, the reported values are not treated as measurements from one common experiment. Instead, the findings are used to identify performance patterns and differences across wireless technologies, while the comparative evaluation is based on synthetic data.

4.1. Performance Based on Throughput

Throughput can be used as a key performance indicator for wireless networks because it represents the amount of data that could be transferred successfully in certain time periods. The importance

of having high throughput is evident in cases when applications require the transfer of large amounts of data.
As seen from the reviewed articles, wireless technologies can provide distinct throughput properties based on the technology type and environmental conditions. 5G and multi-connectivity studies have especially highlighted their capabilities to ensure high-throughput connection (Kar et al., 2025; Zhang et al., 2025). Wi-Fi technologies also allow the provision of considerable possibilities for the transfer of data. The transition from previous Wi-Fi technologies to Wi-Fi 6 and Wi-Fi 7 has been made with the aim of enhancing capacity and efficiency of performance (Rady et al., 2024; Alauthman & Shraa, 2025).

Table 3: Comparison of throughput-related characteristics of wireless technologies

Performance Parameter	Wi-Fi/Wi-Fi 6	Wi-Fi 7	LTE	5G	5G Multi-connectivity
Throughput	Important	Highly-capacity focus	Important	High-speed focus	Highly-capacity focus
Latency	Varies with condition	Low-latency optimization	Varies with condition	Low-latency capability	Low-latency focus
Packet Loss	Affected by wireless conditions	Influenced by network density	Can occur under poor conditions	Depends on network conditions	Reliability-oriented
Major Application Area	Local networks	High-density networks	Mobile communication	Mobile/private networks	Reliable high-performance

4.2. Performance Based on Latency

Latency measures the delay experienced during data transmission and is important for real-time and interactive applications. Wi-Fi 7 has been investigated in high-density environments, where increasing network density can affect communication delay (Alauthman & Shraa, 2025).
Similarly, 5G technologies have been studied because of their ability to support communication with relatively low latency. Research on 5G multi-connectivity has particularly considered the combination of high throughput and reliable low-latency communication (Kar et al., 2025).
Studies involving remote-control applications have also examined wireless technologies based on latency, packet loss, and data rate. Such studies demonstrate that latency becomes especially important when wireless communication is used for applications where delays can affect system responsiveness (Zhang et al., 2025). In this study, latency is used as one of the key performance parameters for evaluating the selected wireless technologies. Lower latency indicates faster data transmission and reduced communication delay, which is particularly relevant to applications requiring responsive network communication.

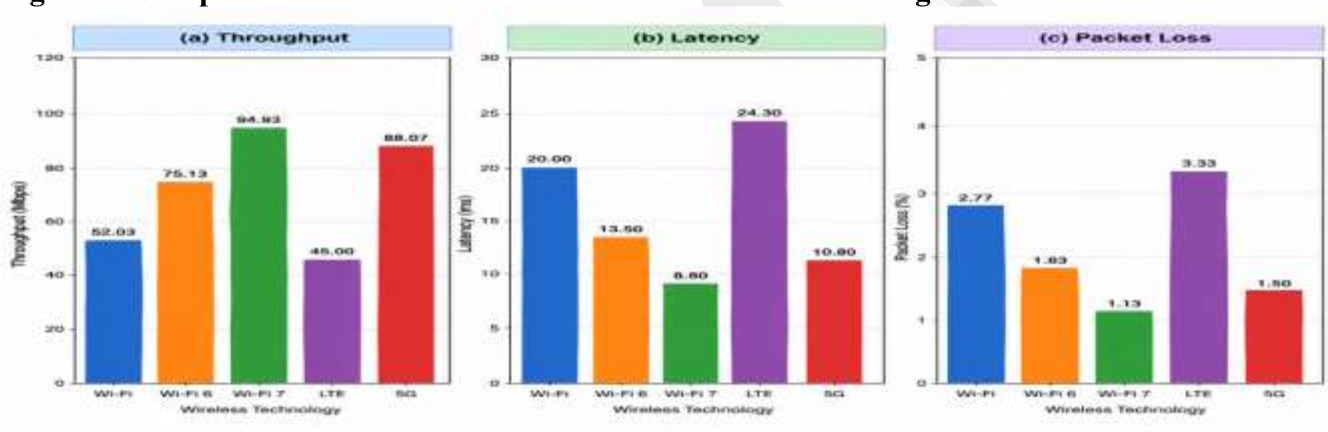
4.3. Performance Based on Packet Loss

Packet loss occurs when data packets transmitted across a network fail to reach their destination. It is an important indicator of communication reliability because packet loss can affect the quality of data transmission. Packet loss can be influenced by network conditions, congestion, interference, wireless signal quality, and the characteristics of the communication technology. Research comparing direct and hotspot internet connections examined latency and packet loss as important indicators for network selection and quality of service (Gbigbidje et al., 2025).

Packet loss has also been examined in LTE and 5G smartphone communication. The findings demonstrate the importance of considering packet loss together with delay when evaluating wireless network performance (Alauthman & Al-Hyari, 2025).

In this study, packet loss is used as one of the key performance parameters for evaluating the selected wireless technologies. The comparison considers the extent to which each technology successfully delivers transmitted packets to their intended destination. Lower packet loss indicates more reliable packet delivery, while higher packet loss indicates greater transmission loss and potential degradation in network performance. The packet-loss results therefore provide a basis for comparing the reliability of the selected wireless technologies under the conditions considered in this study.

Figure 1: Comparative Performance of Wireless Network Technologies



The comparative performance graph presents the performance of five wireless technologies: Wi-Fi, Wi-Fi 6, Wi-Fi 7, LTE, and 5G, based on throughput, latency, and packet loss. Throughput is the measure of the quantity of data that can be transferred, and a higher throughput indicates high capability in transferring data. The technology with the highest throughput is Wi-Fi 7 at 94.93 Mbps, while LTE technology has the lowest throughput at 45.00 Mbps. Latency refers to the delay that occurs during data transfer, and low values indicate fast data transfer. The technology with the lowest mean latency is Wi-Fi 7 at 8.80 ms, while the technology with the highest mean latency is LTE at 24.30 ms. Packet loss refers to the percentage of packets that do not make it to their destination, and low packet loss indicates reliable delivery of packets. Wi-Fi 7 has the lowest mean packet loss at 1.13%, while LTE has the highest packet loss at 3.33%.

Table 4: Mean Performance of Wireless Network Technologies

Wireless Technology	Mean Throughput (Mbps)	Mean Latency (ms)	Mean Packet Loss (%)
Wi-Fi	52.03	20.00	2.77
Wi-Fi 6	75.13	13.50	1.83
Wi-Fi 7	94.93	8.80	1.13
LTE	45.00	24.30	3.33

5G	88.07	10.80	1.50

Comparative analysis shows different values of the technologies based on the three performance indicators. On the issue of throughput, the mean values vary between 45.00 Mbps for LTE to 94.93 Mbps for Wi-Fi 7. Wi-Fi 6 and 5G also have relatively high values of throughput at 75.13 Mbps and 88.07 Mbps, respectively. On latency, the mean values vary between 8.80 ms for Wi-Fi 7 to 24.30 ms for LTE. Wi-Fi 6 and 5G have recorded mean values of latency at 13.50 ms and 10.80 ms, respectively, while Wi-Fi has 20.00 ms. The packet-loss results also show differences among the technologies. Wi-Fi 7 recorded a mean packet loss of 1.13%, followed by 5G at 1.50% and Wi-Fi 6 at 1.83%. Wi-Fi and LTE recorded higher mean packet-loss values of 2.77% and 3.33%, respectively.

4.4. Discussion of Findings

According to the research results, there are variances in terms of wireless network performance depending on the technologies used and network conditions. It can be seen in synthetic data that throughput, latency, and packet loss are important parameters when analyzing the variances.

The results also prove that higher network traffic conditions may affect the performance of wireless technologies. Higher traffic is connected to lower throughput and higher latency and packet loss in the created dataset. In addition, the results of the research investigate the performance of wireless technologies in different operating conditions using Wi-Fi, Wi-Fi 6, Wi-Fi 7, LTE, and 5G '.The performance patterns of the technologies have been created using a simulation tool.

5.0. Conclusion

This research assessed the performance of various wireless networks through their throughput, latency, and packet loss. The technologies covered in the study include Wi-Fi, Wi-Fi 6, Wi-Fi 7, LTE, and 5G in various network settings using generated data.

From the generated data, the findings show that there is variation in the performance of wireless networks with respect to technology and conditions of the network. It was revealed that throughput, latency, and packet loss can be effective tools to assess data transmission capacity, delay of communication, and reliability of data transmission respectively. There is also an indication that increasing network traffic could affect the performance of the network such that the throughput would be reduced whereas latency and packet loss would increase in the process.

It is clear that various performance factors should be considered in the evaluation of wireless network technologies since examining one factor such as throughput alone could give an incomplete assessment of the network. Moreover, the study also emphasizes the importance of analyzing several performance criteria to assess the performance of wireless technologies. Analyzing only throughput might not give a clear view of network performance since one technology can have a good throughput but may suffer from higher latency and packet loss under some network conditions.

In summary, the study presents an analysis of wireless technologies based on throughput, latency, and packet loss. Furthermore, the analysis clearly brings out the significance of network conditions in wireless performance measurement.

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