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Performance Evaluaion of QoS of VoIP over WLAN and WiMAX Networks using OPNET

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تقييم أداء جودة الخدمة (*QoS*) لتقنية نقل الصوت عبر بروتوكول الإنترنت (*VoIP*) في شبكات *WLAN* وشبكات *WiMAX* باستخدام برنامج *OPNET*

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Abstract:
In recent decades the use of real-time applications like Voice over Internet Protocol (VoIP), over wireless communication technologies such as Wireless Local Area networks (WLANs) and Worldwide Interoperability for Microwave Access) have increased significantly. Because VoIP is a real-time application, it is highly sensitive to network performance and required a specific level of Quality of Service (QoS). The aim of this study is to evaluate and compare the performance of VoIP applications over WLAN and WiMAX technology. Optimized Network Engineer (OPNET Modeler) is used to conduct the experiments. VoIP QoS parameters (jitter, Packet loss, and delay) are evaluated, and the results show that VoIP performance in the WiMAX environment is better than that in the WLAN environment.

Keywords: VoIP, WLAN, WiMAX, QoS

الملخص
شهدت العقود الأخيرة زيادة ملحوظة في استخدام التطبيقات التي تعمل في الزمن الحقيقي ، مثل تقنية نقل الصوت عبر بروتوكول الإنترنت (VoIP)، وذلك عبر تقنيات الاتصالات اللاسلكية، مثل الشبكات المحلية اللاسلكية (WLAN) وتقنية التشغيل البيني العالمي للوصول عبر الموجات الدقيقة (WiMAX). ونظراً لأن تقنية VoIP تُعد من التطبيقات التي تعمل في الوقت الفعلي، فهي شديدة الحساسية لأداء الشبكة وتتطلب مستوىً محدداً من "جودة الخدمة" (QoS). تهدف هذه الدراسة إلى تقييم ومقارنة أداء تطبيقات VoIP عبر كل من تقنيتي WLAN وWiMAX، حيث تم إجراء الجزء العملي باستخدام برنامج محاكاة الشبكات (OPNET Modeler). وقد جرى تقييم معاملات جودة الخدمة (QoS) الخاصة بـ VoIP -وهي التذبذب (Jitter)، وفقدان الحزم (Packet Loss)، والتأخير (Delay)-، وأظهرت النتائج أن أداء VoIP في بيئة WiMAX أفضل منه في بيئة ..WLAN

الكلمات المفتاحية: VoIP، WLAN، WiMAX، جودة الخدمة (QoS)

Introduction

In recent decades the Internet has made significant changes the way people communicate around the world. These changes have led to the development of modern applications with low end-to-end delay and high bandwidth requirements[1] . Furthermore, a rising trend has been observed in real-time voice transmission, such as Voice over Internet Protocol (VoIP).VoIP allows users to utilize the IP-Based networks, such as the Internet a communication channel for telephone calls by transmitting voice calls in packets employing the Internet Protocol (IP) instead of using the conventional Public Switched Telephone Network (PSTN) [2]. VoIP is based on the Internet Protocol and consequently the communication technology is fundamentally digital [3]. Due to the digital nature of communication networks , users analogue voices are first digitized and then divided into packets using complex software known as codecs [4].The International Telecommunication Union (ITU) has standards for voice coding , and diverse algorithms , such as G.711, G.723 and G.729 are employed for encoding and decoding voice data [4].VoIP can be used over any IP-based network such as WiMAX , WLAN , Ethernet , and the Internet.

Wi-Fi is the common acronym for IEEE 802.11 Wireless Local Area Networks (LANs), has become a popular technology for broadband Internet connections in everyday life. .Through the provision of Wi-Fi , a huge number of citizens will gather Wi-Fi technology[5] .The worldwide Interoperability for Microwave Access (WiMAX) has become essential components of digital communication. WiMAX is designed for Metropolitan Area Network (MAN). It offers point to multipoint broadband services with a maximum of 30 miles [6] .Each of these approaches has different characteristics and serves single purposes and operates within precise frequency bands [7].

The performance of VoIP applications depends heavily on steady and widespread wireless connectivity .Therefore ,the rapid growth of wireless technologies has enlarged the demand for efficient , resilient , and ubiquitous connectivity especially for VoIP application [8]. In addition, differences in the performance of IEEE 802.11 and IEEE 802.16 may affect the performance of applications running over these technologies. Therefore, the aim of this paper is to evaluate and compare the performance of VoIP traffic over two different broadband wireless technologies using OPNET Modeler 14.5.

Related Study

This section summarizes the research were done by several researchers. From this view the authors In [9] performance of VoIP was done over WLAN (IEEE 802.11 b) , WiMAX network and also on a WLAN-WiMAX integrated network. OPNET 14.5 was used. Based on the jitter, mean opinion score (MOS), and end-to-end delay the results revealed that VoIP perform better over WiMAX network than a conventional 802.11b WLAN. In [10] , the researchers developed the JitraB model , which integrates jitter , bandwidth , network traffic , throughput ,and growth capacity to improve the Quality of Service (QoS) of VoIP. the authors used OPNET modular 14.5, Cisco Packet Tracer, and Wireshark to simulate and evaluate network performance and compare the new design with a current network. The results showed that the proposed design achieved higher throughput, lower delay, and a lower packet loss rate than the existing network. The performance of VoIP over UMTS and Wi-Fi was evaluated in [11]. The investigation has been completed using OPNET modeler. Features like WiMAX service classes, number of WLAN nodes and VoIP codecs were studied and evaluated. Performance parameters included: jitter, packet end-to-end delay, packet delay variation and mean opinion score. The results showed that WiMAX provided the best environment for VoIP performance.in [12] the researchers compared the MOS values of different codec at different user equipment application rates .The QoS metrics calculated in the proposed model were jitter , IP packet delay , IP packet loss .MAV layer delay , and physical layer throughput

VoIP Quality

There are four key areas of VoIP research: VoIP quality evaluation , enhancement of VoIP performance, VoIP protocols and traffic analysis , and security of VoIP network[13] . the aim of this study is to evaluate VoIP Quality by measuring three main metrics: latency , jitter , packet loss , and Mean Opinion Score (MOS) [10, 14].

Methodology

To conduct the experimental part of this study, a simulation-based method was selected. OPNET Modeler 14.5 was used to develop two experimental models. The first model represented VoIP over WLAN, while the second represented VoIP over WiMAX. In both networks, VoIP traffic was generated using the Application Definition and Profile Definition objects in OPNET. Three performance metrics were evaluated: jitter, end-to-end delay, and packet loss rate. Each simulation was run for 30 minutes. The simulation results were presented in graphical form

and compared. Finally, the results were exported to an Excel spreadsheet to calculate the average value of each metric

Proposed Experiment Model

Two experiment model were built on OPNET. Figure 1 illustrates WLAN model and Figure 2 shows WiMAX model.

Test1: WLAN experiment

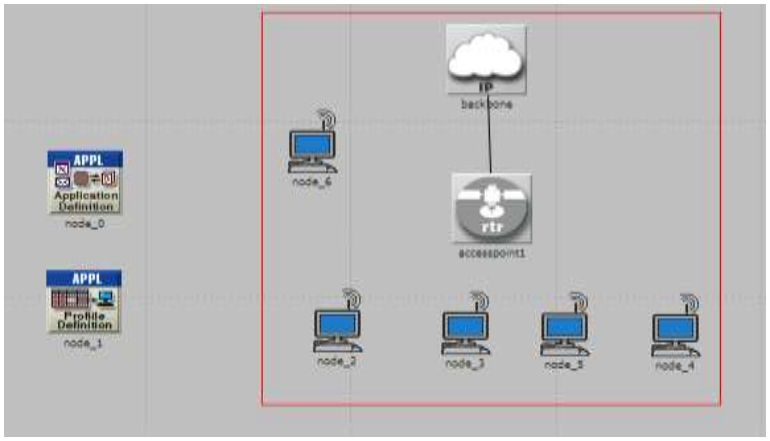


Figure 1: WLAN Model

This model consists of five wireless work stations, one access point, profile definition object and application definition object were used to generate VoIP traffic. Voice traffic sent, voice traffic received, jitter and end-to-end delay were calculated. the simulation was configured to run for 30 minutes.

Test two: WiMAX experiment

WiMAX experiment model was built using five workstation, one WiMAX tower and WiMAX configuration object. Same method was used to generate VoIP traffic as in WLAN model.

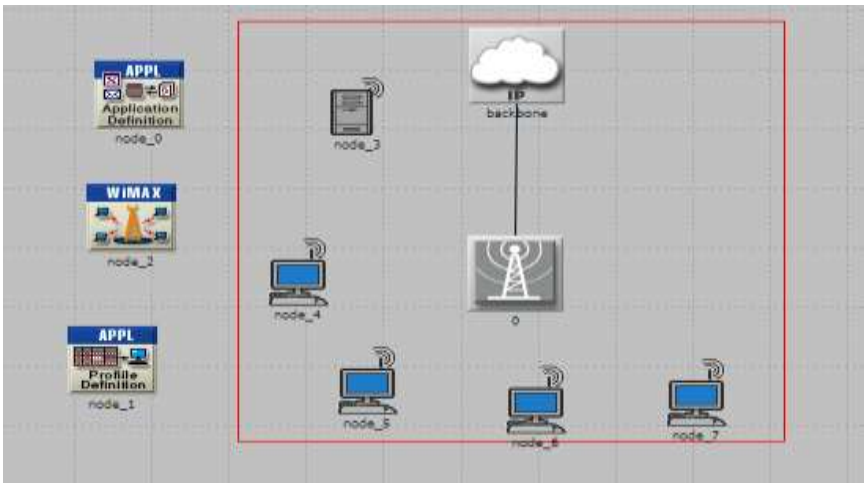
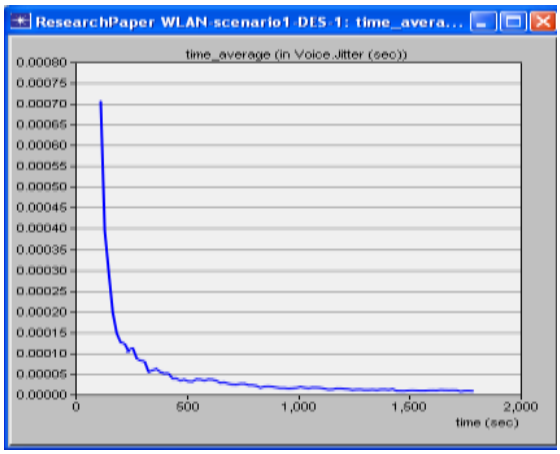


Figure 1: WiMAX Model

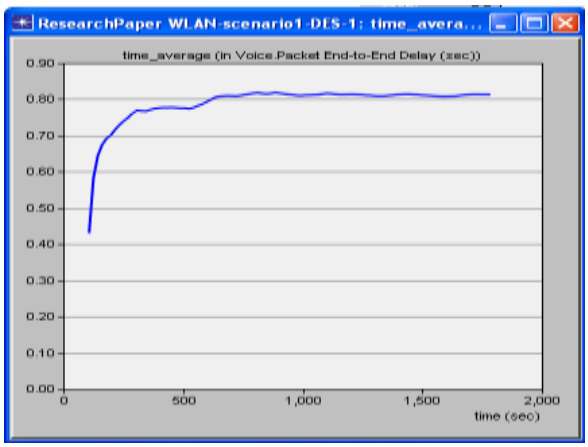
Result Analysis

In this section the results from test1 and test2 were collected from OPNET and presented in for of graphs as below.

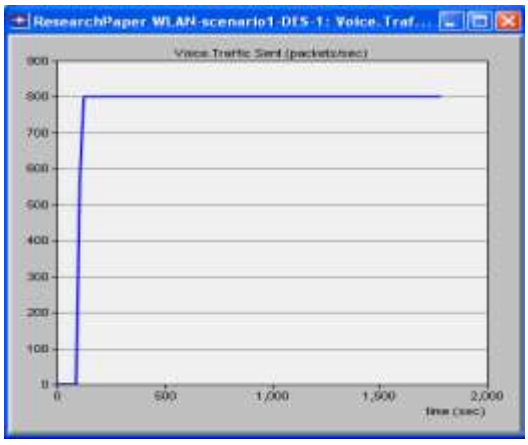
a) The result from WLAN test



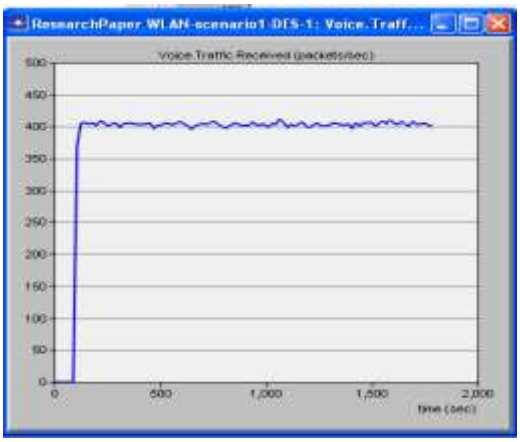
Jitter of VoIP



End-to-end delay

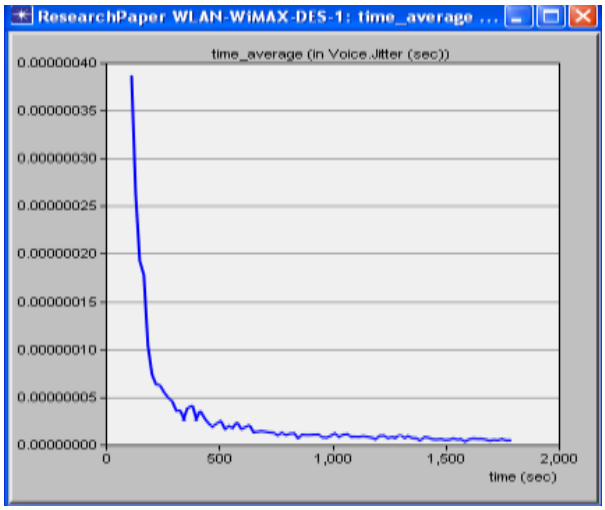


Voice Traffic Sent

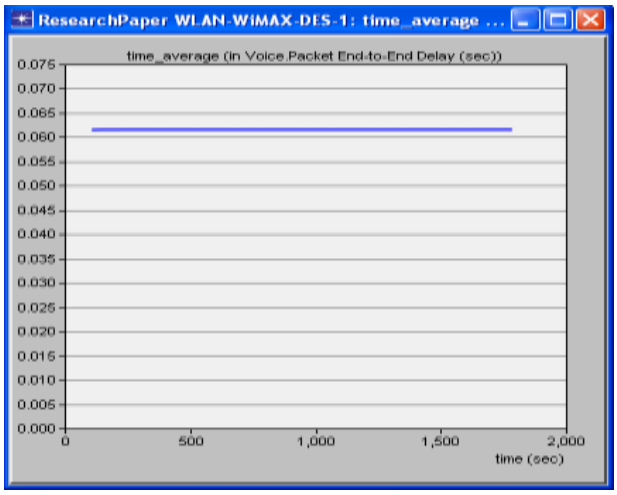


Voice Traffic Received

b) The result of WiMAX Scenario



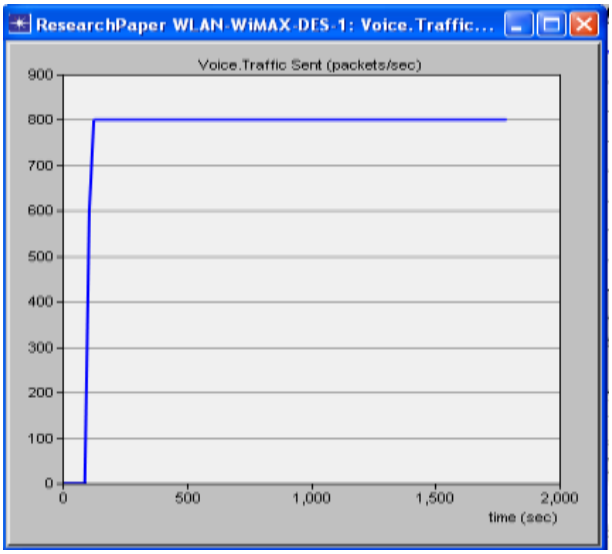
Voice Jitte



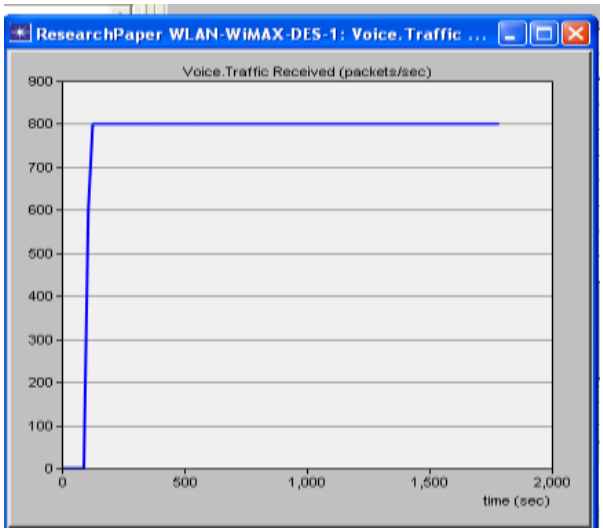
Voice Packet End-to-End delay

Result Discussion

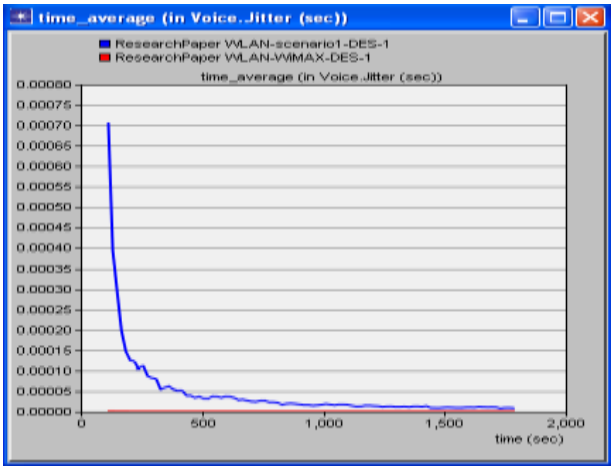
In this part the obtained graphs from WLAN and WiMAX were compared as follows: -



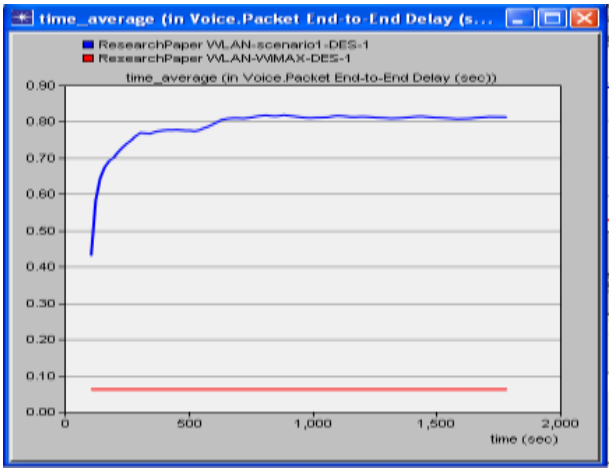
Voice Traffic Sent



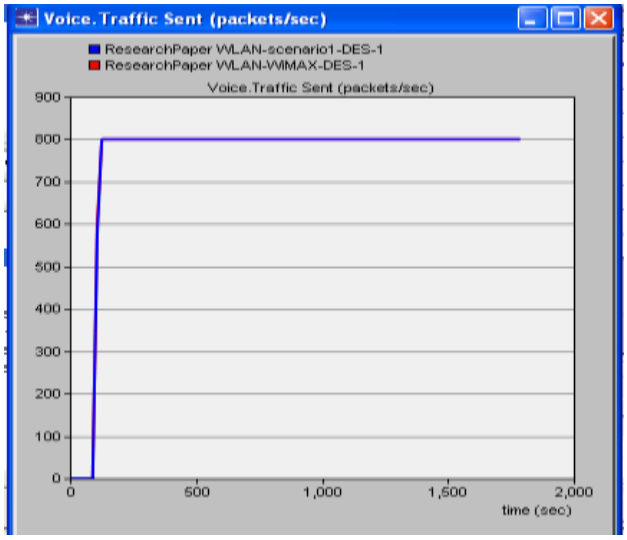
Voice Traffic Received



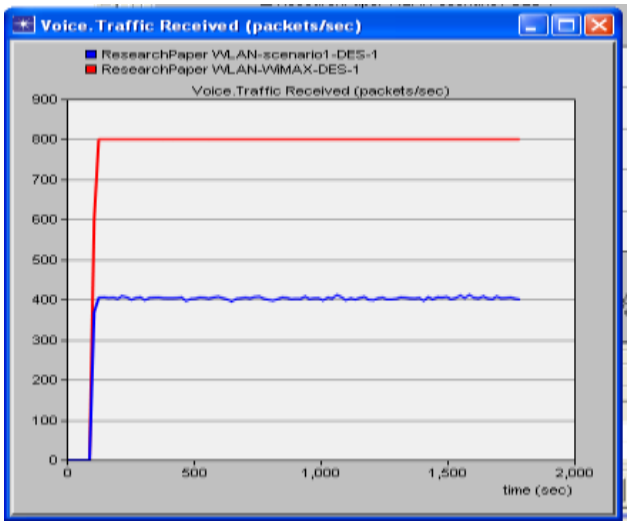
Voice traffic sent



Voice Traffic Received



Voice Jitter



Voice Packet end-to-end delay

From the above figures, in term of Jitter it is clear that both WLAN and WiMAX scenarios presented almost zero (second). Concerning the VoIP end-to-end delay WiMAX introduced delay at 0.0615 second whereas WLAN was 0.812 second.

Table1: VoIP Delay for IEEE Standards

Experiment Model	Delay (Sec)	Jitter (sec)
WLAN	0.812	0.0000086
WiMAX	0.0615	0.000000436

Regarding packet loss metric the obtained result was transferred from OPNET to excel sheet and the average packet loss was determined according to following question (((Number of sent packets – Number of received packets) / total sent packet) * 100) [15]

Table2: VoIP Packet loss For IEEE Standards

IEEE Standard	Packet sent	Packet received	Percentage of Packet loss
WLAN	74976	37912.27778	50%
WiMAX	74999	74999	0%

In term of packet loss, it is clear that WiMAX was the best for VoIP QoS. It produced 0% of packet loss rate.in contrast, WLAN results the highest packet loss rate at 50 %.

Conclusion

In this study, VoIP quality was assessed over two wireless network technologies: WLAN and WiMAX. Two simulation models were developed using OPNET Modeler 14.5. For each simulation run, VoIP performance metrics, including jitter, end-to-end delay, and packet loss, were evaluated. The results showed that WLAN exhibited a higher packet loss rate than WiMAX, at 50% and 0%, respectively. In addition, jitter was approximately zero in both networks. Finally, the end-to-end delay was 0.812 seconds for WLAN and 0.0615 seconds for WiMAX. Overall, WiMAX performed better than WLAN for VoIP applications**.**

References

[1] Karapantazis, S., and Pavlidou, F.-N.J.C.N.: 'VoIP: A comprehensive survey on a promising technology', 2009, 53, (12), pp. 2050-2090

[2] Litteral, L.A., Gold, J.B., Klika Jr, D.C., Konkle, D.B., Coddington, C.D., McHenry, J.M., and Richard III, A.A.: 'Pstn architecture for video-on-demand services', in Editor (Ed.)^(Eds.): 'Book Pstn architecture for video-on-demand services' (Google Patents, 1993, edn.), pp.

[3] Gibson, J.D., and Wei, B.: 'Tandem voice communications: digital cellular, VoIP, and voice over Wi-Fi', in Editor (Ed.)^(Eds.): 'Book Tandem voice communications: digital cellular, VoIP, and voice over Wi-Fi' (IEEE, 2004, edn.), pp. 617-621

[4] Alshomrani, S., Qamar, S., Jan, S., Khan, I., Shah, I.J.I.J.o.C.S., and Telecommunications: 'QoS of VoIP over WiMAX access networks', 2012, 3, (4), pp. 92-98

[5] Saleh, A.K., Tjahyaningtijas, H.P.A., Nurhayati, N., and Rakhmawati, L.J.I.: 'Quality of service (QOS) comparative analysis of wireless network', 2022, 5, (2), pp. 30-37

[6] Khan, A.A., and Zaman, N.: 'Comparative analysis of broadband wireless access from Wi-Fi to WiMax', in Editor (Ed.)^(Eds.): 'Book Comparative analysis of broadband wireless access from Wi-Fi to WiMax' (IEEE, 2009, edn.), pp. 8-14

[7] Fisenko, O., Adonina, L., Sosa, H.S., Arturo, S.G.G., Castro, A.S., Galarza, F.W.M., and Palomino, D.A.J.J.W.M.N.U.C.D.A.: 'Advancements in Flexible Antenna Design: Enabling Tri-Band Connectivity for WLAN, WiMAX, and 5G Applications', 2023, 14, (3), pp. 156-168

[8] Rahayu, Y., Pangestu, D.R.A., and Ku, C.H.J.I.J.E.E.E.T.: 'Compact triple-band monopole antenna with ACS-fed for IoT devices on WLAN/WiMAX/5G/V2X networks', 2025, 14, pp. 43

[9] Kundu, A., Bhunia, S., Misra, I.S., and Sanyal, S.K.: 'Comparison of VoIP performance over WiMAX, WLAN and WiMAX-WLAN integrated network using OPNET', in Editor (Ed.)^(Eds.): 'Book Comparison of VoIP performance over WiMAX, WLAN and WiMAX-WLAN integrated network using OPNET' (Springer, 2010, edn.), pp. 316-325

[10] Adjardjah, W., Kumassah, F., Abdallah, D.M., Addor, J.A.J.J.o.E.R., and Reports: 'Performance evaluation of VoIP analysis and simulation', 2023, 25, (7), pp. 176-191

[11] Sultan, S.F.A.: 'QoS of Voice over IP Networks (UMTS Wi-Fi and WiMAX)', Al-Neelain University, 2022

[12] Jaish, A.A., and Al-Shammari, B.K.J.W.J.o.E.S.: 'Quality of experience for voice over internet protocol (voip)', 2023, 11, (3), pp. 96-105

[13] Iskandar, M.I., and Gunawan, A.A.S.J.P.C.S.: 'Impact Analysis of Insufficient Destination Resources on VoIP Service Quality: Case Study', 2024, 245, pp. 247-254

[14] Singh, A.J.I.J.o.C.T., and Communication, E.: 'Enhancing VoIP quality in the era of 5G and SD-WAN', 2022, 5, (3), pp. 5140-5145

[15] Yahya, A., Abdalla, A.G.E.J.I.j.o.a.i.s., and sciences, i.: 'Enhancement of VoIP perfromance in MANET using fuzzy logic', 2020, 6, (2), pp. 40-49

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