Simulation-Based Performance Comparison of Wired and Wireless Networks for Office Use

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DOI: **https://doi.org/10.47772/IJRISS.2026.10100470**

Received: 20 January 2026; Accepted: 30 January 2026; Published: 13 February 2026

ABSTRACT

The increasing importance of digital connectivity and data-driven processes has made selecting the right network infrastructure in office settings crucial. As organizations expand and adopt more devices and services, managing network performance and reliability becomes increasingly complex. This study aims to address key concerns businesses face when deciding on the most suitable network setup for office use. The study analyzes and compares wired and wireless NetSim simulations with 25 users, single-floor office layout, measuring key performance metrics such as latency, throughput, and jitter under similar simulated conditions. The study consists of three main processes: project planning and requirements analysis, network design, and simulation preparation. The results show that wired networks consistently outperform wireless networks in terms of throughput, latency, and jitter. While wireless throughput was slightly higher under light load, wired networks achieved up to 3.4 times higher throughput under heavy traffic, with latency 78 - 115 times lower and jitter up to 224 times lower. Besides, the findings demonstrate that wired networks provide superior reliability and performance, particularly under high-load conditions, making them more suitable for performance-critical office environments.

Keywords: Office Use Case, Network Simulator, Netsim, Throughput, Latency, Jitter

INTRODUCTION

Information technology constantly changing in today's world, and computer networks are essential to connecting this digital world together. The rapid evolution of digital technologies has placed increasing demands on networking infrastructure, particularly in office environments where stable and efficient communication systems are critical to daily operations. Selecting between wired and wireless network solutions is crucial choice that can affect the scalability, flexibility, and efficiency of an organisation. Every type has benefits of its own. A wired network is known as a system that makes use of physical connections, such as cables or wires, to create communication between devices. Therefore, this network relies on a wired infrastructure to transmit data and support connectivity. While a wireless network operates without the need of a physical network. The choice between wired and wireless networks should be based on a careful evaluation of the organization requirements by understanding the strength and limitation of each network type. Office setups may differ in design, but the underlying need for proper network planning and configuration remains consistent. This project emphasizes the importance of understanding these differences to optimise network performance and reliability. By implement the configuration and analysing within network simulation tools, the organization can gain visions into the strengths and weaknesses of each network type, ultimately aiding in the selection of the most suitable infrastructure for their specific organizational needs. The rest of this paper is structured as follows. Section 2 is the related work of the previous literature review. Section 3 outlines the methodology of this study. Section 4 presents the results and analysis from the study, while Section 5 discusses implementation and implications of the results, as well as the limitations of the study. This section also concludes the paper and provides several suggestions for future research.

RELATED WORK

In this section, office use case, network overview, and network simulator are explained.

Office Use Case

The office use case shows small office environments and their networking details and more about defining, the application, and the typical use cases of small businesses. [1] classified a business in the services sector having 5 - 75 employees, while in manufacturing sector - 5 - 200 employees. Taking into account this classification and since the study is based on a 25-user office, this small office use case can be viewed as a representative of a recommended typical office. It is relevant due to the fact that small offices rely on basic network infrastructure to support day-to-day operations such as communication, collaboration, or resource sharing. These operations are essential for the facilitation of productivity [2]. The emphasis on supporting a basic network clearly demonstrates, as a service provider, the benefits of addressing a well-designed network with cost-effective, scalable, and flexible solutions that support both wired and wireless networking options and infrastructures. With small businesses aim to reduce operational efficiency while ensuring potential for growth.

Network Overview

A network is a group of interconnected devices that may exchange data and communicate with one another, including computers, printers, servers, and phones [3]. Wired techniques, such as Ethernet cables, or wireless techniques, like Wi-Fi, can be used to create these connections [4]. According to [5], a network's primary function is to give users a common platform for resource sharing and data exchange, which is essential to modern life. In the context of office environments, where stable connectivity and consistent data flow are essential for daily operations, understanding these metrics becomes critical. This comparison not only informs infrastructure decisions but also aligns with the increasing demand for balance performance and flexibility. According to [6], a wired network is a type of networking configuration. The most common type of wired network is a local area network, or LAN. A local area network is the most prevalent kind of wired network. While [7] describe that wired networks, devices are connected directly to network switches and routers using physical media, usually Ethernet cables. They are well known for offering dependable, fast connections with less interruption and low latency. Physical wires are no longer necessary when devices are connected using radio waves in a wireless network. This increases mobility inside the network's service area. [8] claimed that instead of using cables to transport data, a wireless network uses the air. The most popular method for connecting laptops, phones, and other devices without requiring physical plugging in is Wi-Fi. Wireless configurations are essential for companies that require flexibility in order to maintain communication between their staff and clients

In order to compare the performance of wired and wireless networks effectively, performance metrics should be measured. According to [9], there are multiple methods for evaluating network performance (both in number and kind). As stated by [10], these performance metrics determine the amount of data was transmitted and its reliable efficiency. According to [11], an understanding of all these performance parameters is required to improve subsequent network operations. The three key performance metrics chosen for this study are jitter, throughput, and latency. These metrics were selected because they clearly show a network's responsiveness, efficiency, and stability, which are vital for office network performance in real-life settings. Latency measures the delay in data transmission and is especially important for real-time applications like VoIP or video calls. Throughput indicates how much useful data is successfully transferred over time, showing how well the network handles user demand and traffic. Jitter measures the variation in packet arrival times and is crucial for time-sensitive services, as high jitter can cause choppy audio or video and uneven performance [9] and [10].

Network Simulator

Network simulation is essential for testing the performance of wired and wireless networks, allowing researchers and professionals to try out different setups without needing to build physical systems [12]. Network simulators are being widely used in academic as well as industrial research for performance evaluation of wired and wireless networks [13]. The simulators allow researchers to measure important performance metrics such as throughput, latency, and jitter in a controlled environment without the need for any physical infrastructure. Several simulation tools have been used in previous studies to analyse the performance of networks. For example, NetSim has been extensively used in the study of 5G and IoT networks due to its simplicity and extensive results analysis [14]. The aspect that NetSim has the capability to simulate wired and wireless environments makes it suitable for the analysis of office networks where the integration of the two technologies is common.

There have been other works using tools such as NS2 and NS3 in analysing TCP congestion and routing protocols in wired and wireless networks. These simulators, though, usually need elaborate scripting and are less friendly for students and entry-level researchers. OMNET++ and OPNET were also used in large-scale simulations but might not have the flexibility or ease necessary for small to medium office network performance analysis [15]. According to [16], NetSim has gained popularity since it has built-in support for recent network technologies like SDN, MANETs, and 5G NR and also provides support for exporting results in an academic-friendly format. Studies using NetSim have demonstrated accurate and efficient simulation of hybrid network environments with the ability to visualize packet flows and system performance metrics in real time

METHODLOGY

This project consists of three main processes: project planning and requirements analysis, network design, and simulation preparation. These processes are illustrated in Figure 1.

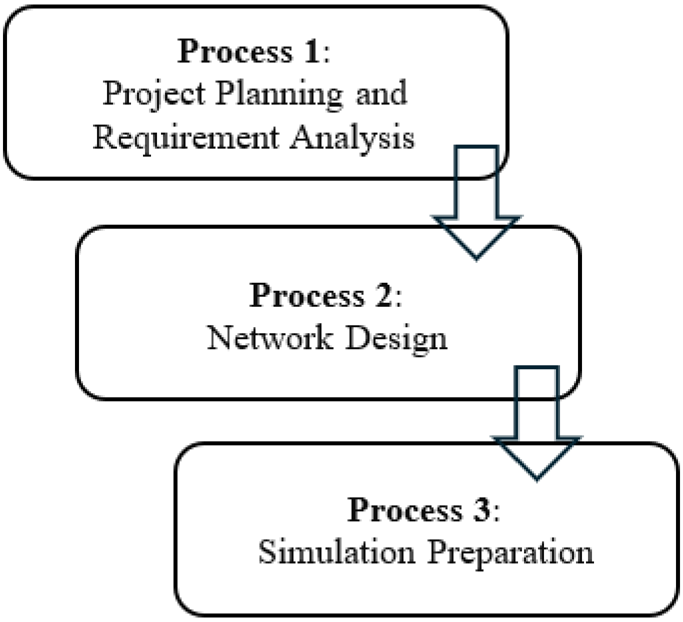

Figure 1: Project design process

The description about each process will be explained below.

Project Planning and Requirement Analysis

The process is to establish a clear direction for designing and simulating wired and wireless networks for a small office environment with 25 users. Figure 2 illustrates the typical initial work for project planning and requirements analysis in a small office network design project. The first step is to identify the background and research questions. Then, define objectives and scope. Afterward, look at related works & office needs, identify office applications, and investigate network technologies & metrics. The proposed network targets a single-floor office consisting of 23 users distributed across three departments: Human Resources (HR), Sales, and Information Technology (IT). To ensure secure and efficient traffic management, VLAN segmentation is implemented using VLAN 10, VLAN 20, and VLAN 30. The network simulation is conducted using the NetSim Academic Version.

Performance evaluation is based on key metrics, including throughput to measure data transfer efficiency, latency to assess transmission delays, and jitter to evaluate variations in packet arrival times. Several common office

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue I January 2026

applications are tested, namely web services, email, video conferencing, and Voice over IP (VoIP). Additionally, the network design employs Class C private IP addressing (192.168.10.0/24) with Variable Length Subnet Masking (VLSM) to enable efficient subnet allocation. This approach provides a strong foundation for evaluating network performance in real-world office scenarios and supports informed decision-making for network infrastructure optimization. This will provide a foundation for evaluating network performance in real-world office scenarios, helping decision-makers optimize their infrastructure.

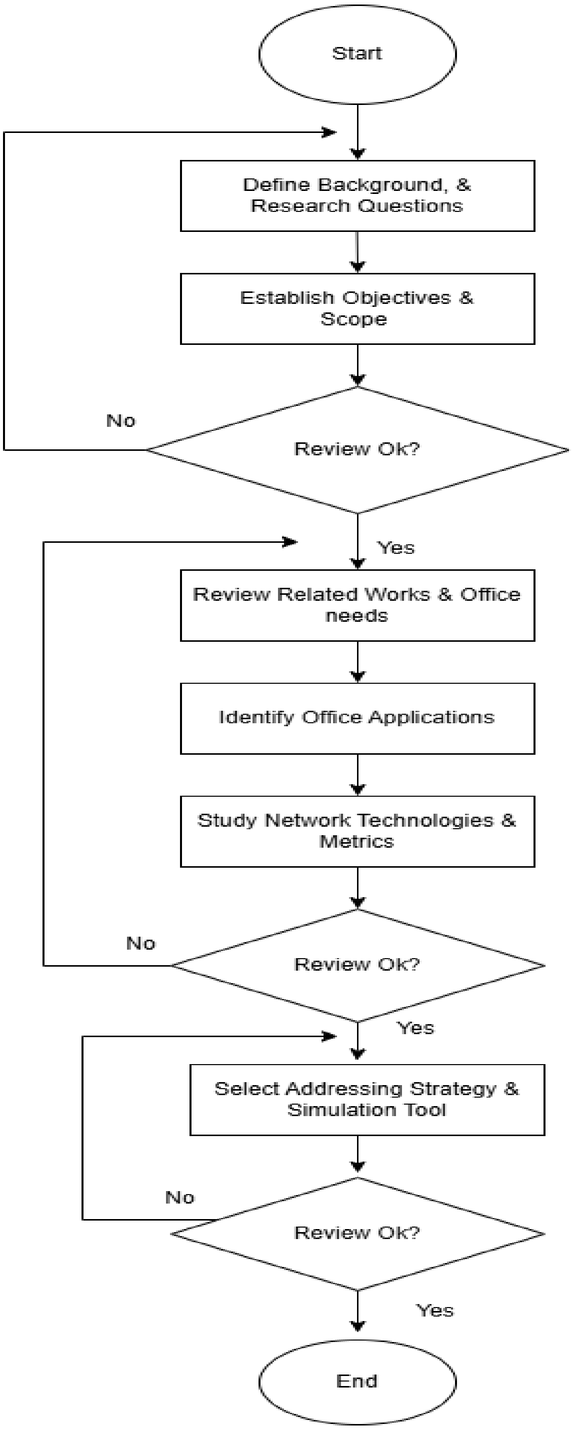

Figure 2: Project planning and requirement analysis process

Network Design

The details of the previous planning stage are brought to life as a functioning network architecture. The topology is sketched out, a VLAN segmentation is suggested, IP addressing is documented and device locations listed so that the network can be built with future scalability and office-security taken into consideration for a small office with 23-users. The process of network design is shown in Figure 3.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue I January 2026

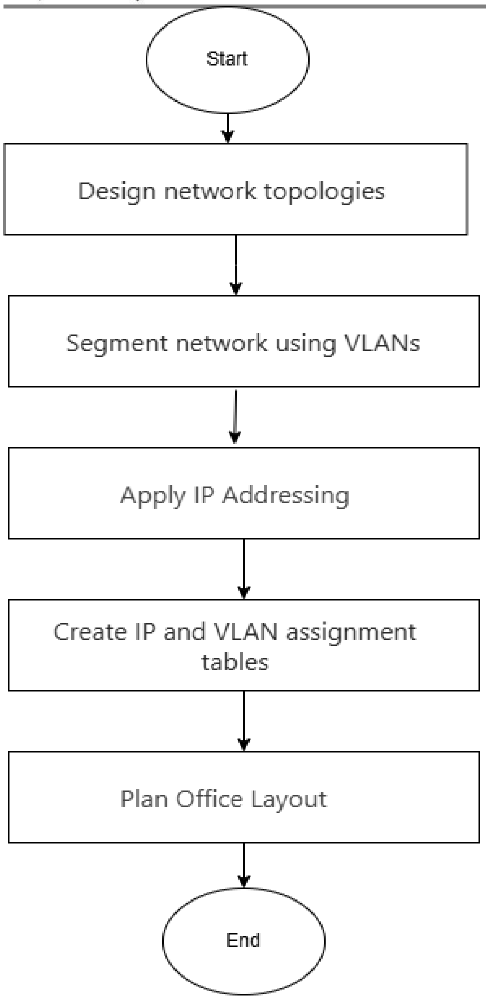

Figure 3: Network design process

Simulation preparation

This phase consists of translating the design into a working simulation using NetSim Academic. The simulation setup accurately depicts the planned office layout, including the 23 users, a single floor office, the finalized IP addressing scheme, VLAN configurations, and topology designs. The process of simulation preparation is shown in Figure 4.

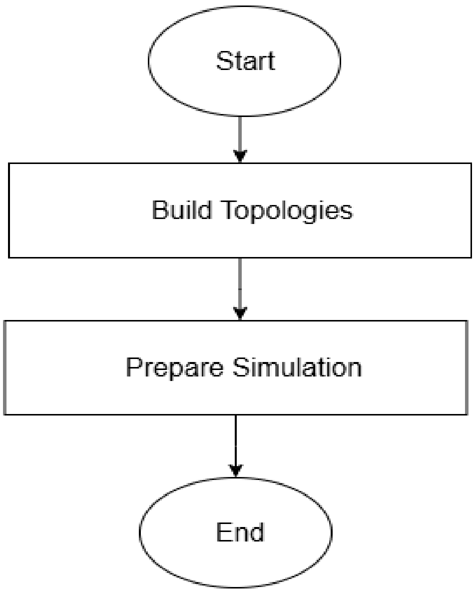

Figure 4: Simulation preparation process

RESULT & ANALYSIS

This section presents the results obtained from the study and provides an analysis of the findings based on the network parameters

Network Parameters

Three performance parameters used in this study throughput, latency, and jitter align with the project scope and the standard metrics recorded by NetSim Academic Version 14.2. The formulas below are based on general networking performance definitions found in existing studies.

Throughput

Throughput measures the rate at which data is successfully delivered to the destination over a given period. It is one of the most critical indicators of network efficiency and will later be used to evaluate the performance of wired and wireless technologies. Analytical formula:

$$\text{Throughput} = \frac{\text{Total Data Received (bits)}}{\text{Simulation Time (seconds)}}$$

Latency

Latency measures the time taken for a packet to travel from the sender to the receiver. Analytical formula:

$$\text{Latency} = T_{arrival} - T_{send}$$

Jitter

Jitter measures the variation in packet delay. It is especially important for real-time traffic such as video streaming and VoIP.

$$\text{Jitter} = L_n - L_{n-1}$$

Wired and Wireless Scenario Design and Simulation

Six simulations were designed, as shown in Table 1, consisting of three wired scenarios (W1–W3) and three wireless scenarios (WL1–WL3), to represent realistic workloads in a 23-user small office environment. The scenarios were kept consistent across both network types to enable a fair comparison, in line with approaches adopted in previous studies comparing wired and wireless network performance.

Table 1: Simulation scenario design and research justification

Scenario	Description	Justification	References
Normal Traffic Load (W1 & WL-1)	Mixed office traffic: HTTP, email, FTP, database, moderate VoIP/video	Realistic mixed-traffic scenarios in small campus networks with similar apps and users	[17]
Heavy Traffic Load (W2 & WL-2)	Increased packet rates and sessions to simulate peak-hour congestion	High-load/bursty traffic tests to show jitter and throughput degradation	[18]

INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN SOCIAL SCIENCE (IJRISS)
ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue I January 2026

Real-Time Application Stress Test (W3 & WL-3)	High volume of VoIP and video conferencing to stress latency and jitter.	Stress testing for real- time applications in office-like environments	[19]
Simulation Duration (All Scenarios)	120 seconds to model representative office workload periods	Modern simulation studies for performance comparison often use 120-180 second durations as they provide sufficient data points while being computationally efficient. This is standard in academic research using tools like NetSim.	[20]

Table 1 shows the evaluation network performance under three scenarios to reflect typical office conditions. The normal traffic load (W1 & WL-1) simulated mixed office traffic, including HTTP, email, FTP, and database applications, along with moderate VoIP and video usage, representing realistic small-campus network conditions with similar applications and user behavior [17]. The heavy traffic load (W2 & WL-2) increased packet rates and active sessions to emulate peak-hour congestion, assessing the network's ability to handle high-load and bursty traffic while observing potential throughput degradation and jitter [18]. For the real-time application stress test (W3 & WL-3), the simulation generated high volumes of VoIP and video conferencing traffic, specifically targeting latency and jitter performance under demanding conditions typical of office-like environments [19]. Each scenario was simulated for 120 seconds, a duration commonly adopted in modern performance studies to capture sufficient data points while remaining computationally efficient, aligning with standard practices in academic research using tools such as NetSim [20].

Wired Network Performance Result

This section presents the performance results of the wired network. The wired network in Netsim after configuration is shown in Figure 5.

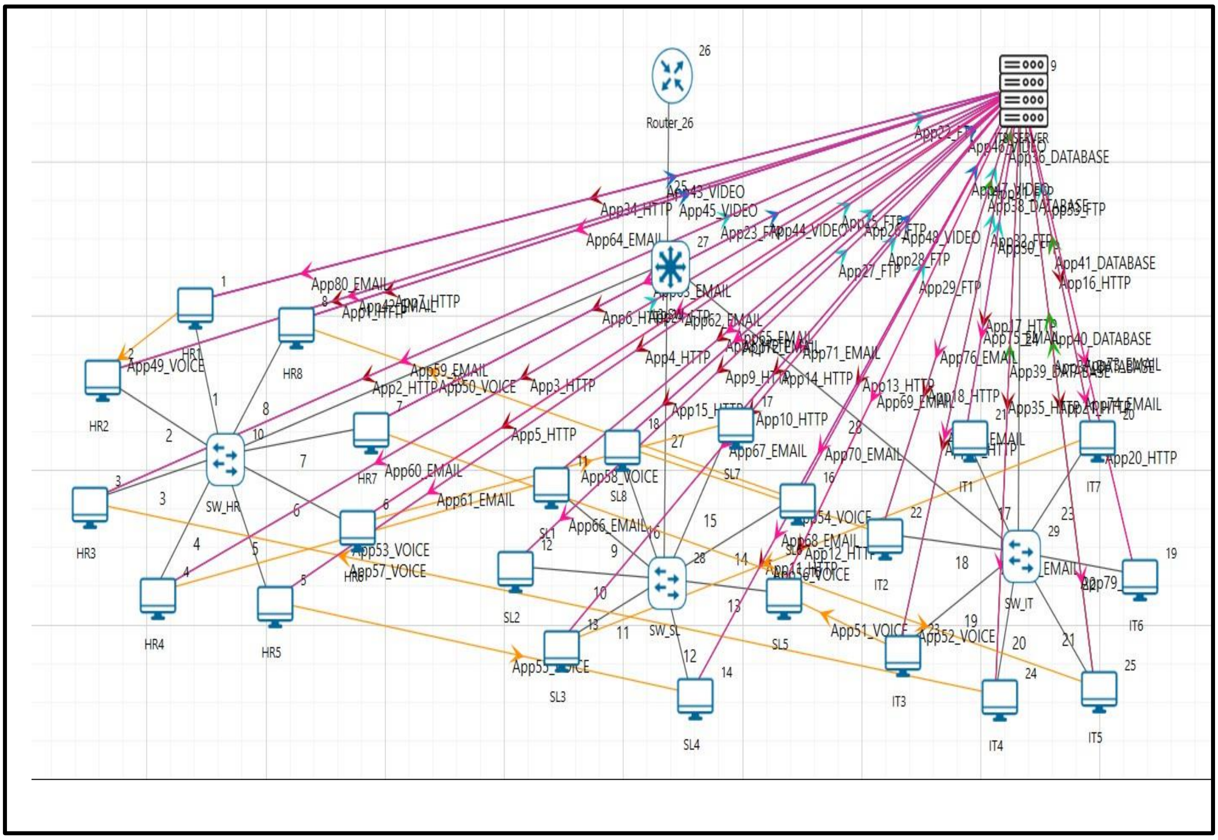

Figure 5: Wired network in Netsim after configuration

Result Scenario W1: Normal Traffic Load (Mix Traffic)

The raw simulation data generated by NetSim for each application in Scenario W1 is presented in Figure 6. This data includes detailed metrics such as throughput, latency, and jitter per application instance.

App. ID	App. Name	Src. ID	Dest. ID	Gen. Rate (Mbp:	Thput. (Mbps)	Delay (µs)	Jitter (µs)	Pkts. Gen.	Pkts. Recd.	Payload Gen. (B)	Payload Recd. (E
8	App8_HTTP	9	11	0.266670	0.265228	66272.226308	2671.772253	2730	2730	3900000	3900000
9	App9_HTTP	12	9	0.266670	0.001974	39501.780513	70944.618517	39	39	29250	29250
9	App9_HTTP	9	12	0.266670	0.263178	54166.894829	2722.422100	2730	2730	3900000	3900000
10	App10_HTTP	13	9	0.266670	0.001989	17049.009229	24193.855230	39	39	29250	29250
10	App10_HTTP	9	13	0.266670	0.265136	57968.298905	2852.789296	2730	2730	3900000	3900000
11	App11_HTTP	14	9	0.266670	0.001989	17320.584614	24757.326397	39	39	29250	29250
11	App11_HTTP	9	14	0.266670	0.265086	66632.491894	3149.408818	2730	2730	3900000	3900000
12	App12_HTTP	15	9	0.266670	0.001988	18068.787691	25105.589540	39	39	29250	29250
12	App12_HTTP	9	15	0.266670	0.265046	65756.022863	2541.994525	2730	2730	3900000	3900000
13	App13_HTTP	16	9	0.266670	0.001989	17318.886152	25040.251413	39	39	29250	29250
13	App13_HTTP	9	16	0.266670	0.265094	74031.779688	3015.905807	2730	2730	3900000	3900000
14	App14_HTTP	17	9	0.266670	0.001988	18347.715249	24297.688832	39	39	29250	29250
14	App14_HTTP	9	17	0.266670	0.265023	66962.499784	2891.510618	2730	2730	3900000	3900000
15	App15_HTTP	18	9	0.266670	0.001988	18616.800378	24472.895652	39	39	29250	29250

Figure 6: Raw data from Netsim after run the simulation

For clearer comparison, the average performance metrics per application category and the overall network are summarized in Table 2.

Table 2: Performance metrics per application category and overall network

Metric	HTTP	FTP	Database	Email	Video	Voice	Overall Network (Average)
Average throughput (Mbps)	0.043	0.087	0.040	0.040	0.052	0.064	0.054
Average Latency (Ms)	4.877	45.744	18.630	10.802	1.263	0.324	13.607
Average Jitter (Ms)	5.402	2.644	4.923	4.039	1.868	0.331	3.201

Result Scenario W2: Heavy Traffic Load

The performance under heavy traffic conditions Scenario W2 in Netsim is shown in Figure 7, which breaks down throughput, latency, and jitter values for each application type.

Application Metrics

End-to-end performance of applications running across the network.

App. ID	App. Name	Src. ID	Dest. ID	Gen. Rate (Mbp:	Thput. (Mbps)	Delay (µs)	Jitter (µs)	Pkts. Gen.	Pkts. Recd.	Payload Gen. (B)	Payload Recd. (E
1	App1_HTTP	2	9	0.266670	0.001990	14616.227691	21472.431576	39	39	29250	29250
1	App1_HTTP	9	2	0.266670	0.265352	49504.907968	3377.479216	2730	2730	3900000	3900000
2	App2_HTTP	3	9	0.266670	0.001990	15457.829742	21298.642105	39	39	29250	29250
2	App2_HTTP	9	3	0.266670	0.265265	68604.554253	2668.315720	2730	2730	3900000	3900000
3	App3_HTTP	4	9	0.266670	0.001990	15349.171281	21193.421050	39	39	29250	29250
3	App3_HTTP	9	4	0.266670	0.265285	63299.831090	2757.638666	2730	2730	3900000	3900000
4	App4_HTTP	5	9	0.266670	0.001989	15931.442050	21031.783152	39	39	29250	29250
4	App4_HTTP	9	5	0.266670	0.265222	72744.458637	2770.542352	2730	2730	3900000	3900000
5	App5_HTTP	6	9	0.266670	0.001989	16847.530255	20085.096839	39	39	29250	29250
5	App5_HTTP	9	6	0.266670	0.265153	81859.475021	3460.845561	2730	2730	3900000	3900000
6	App6_HTTP	7	9	0.266670	0.000000	0.000000	0.000000	1	0	750	0
7	App7_HTTP	8	9	0.266670	0.001989	16911.936409	19258.616839	39	39	29250	29250
7	App7_HTTP	9	8	0.266670	0.265133	70227.349159	3084.756385	2730	2730	3900000	3900000
8	App8_HTTP	11	9	0.266670	0.001990	14871.817435	21090.237892	39	39	29250	29250

Figure 7: Raw data from Netsim after run the simulation

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue I January 2026

For clearer comparison, the average performance metrics per application category and the overall network are summarized in Table 3.

Table 3: Performance metrics per application category and overall network

Metric	HTTP	FTP	Database	Email	Video	Voice	Overall Network (Average)
Average throughput (Mbps)	0.146	1.118	2.017	0.201	0.747	0.064	0.715
Average Latency (Ms)	40.258	791.952	146.006	43.205	7.891	2.094	171.901
Average Jitter (Ms)	16.065	3.483	1.988	4.263	1.004	1.495	4.716

Result Scenario W3: Real-Time Application Stress Test

App. ID	App. Name	Src. ID	Dest. ID	Gen. Rate (Mbp:	Thput. (Mbps)	Delay (µs)	Jitter (µs)	Pkts. Gen.	Pkts. Recd.	Payload Gen. (B)	Payload Recd. (E
1	App1_HTTP	2	9	0.100000	0.005988	2086.705455	2739.527316	99	99	74250	74250
1	App1_HTTP	9	2	0.100000	0.099789	8855.323023	2885.045123	891	891	1237500	1237500
2	App2_HTTP	3	9	0.100000	0.005986	2258.754448	2665.752238	99	99	74250	74250
2	App2_HTTP	9	3	0.100000	0.099772	14197.697307	6383.972394	891	891	1237500	1237500
3	App3_HTTP	4	9	0.100000	0.005986	2310.189245	2588.088476	99	99	74250	74250
3	App3_HTTP	9	4	0.100000	0.099768	4668.333264	1901.103382	891	891	1237500	1237500
4	App4_HTTP	5	9	0.100000	0.005986	2332.479346	2503.638135	99	99	74250	74250
4	App4_HTTP	9	5	0.100000	0.099765	11250.242751	4122.739090	891	891	1237500	1237500
5	App5_HTTP	6	9	0.100000	0.005927	12340.380408	13398.714798	98	98	73500	73500
5	App5_HTTP	9	6	0.100000	0.098779	7506.357105	1721.705119	882	882	1225000	1225000
6	App6_HTTP	7	9	0.100000	0.000000	0.000000	0.000000	1	0	750	0
7	App7_HTTP	8	9	0.100000	0.005986	2387.595306	2638.712428	99	99	74250	74250
7	App7_HTTP	9	8	0.100000	0.099760	6790.954250	5280.057869	891	891	1237500	1237500
8	App8_HTTP	11	9	0.100000	0.005987	2184.747475	2987.564613	99	99	74250	74250

Figure below shows the per-application metrics, such as throughput, latency, and jitter, produced by NetSim for the real-time application stress test (Scenario W3).

Figure 8: Raw data from Netsim after run the simulation

For clearer comparison, the average performance metrics per application category and the overall network are summarized in Table 4.

Table 4: Performance metrics per application category and overall network

Metric	HTTP	FTP	Database	Email	Video	Voice	Overall Network (Average)
Average Throughput (Mbps)	0.053	0.213	0.203	0.101	0.400	0.064	0.172
Average Latency (ms)	6.902	98.613	36.757	21.005	0.934	0.444	27.442
Average Jitter (ms)	6.534	2.544	4.067	3.654	0.477	0.363	2.940

Wireless Network Performance Result

This section presents the performance results of the wired network. The wired network in Netsim after configuration is shown in Figure 9.

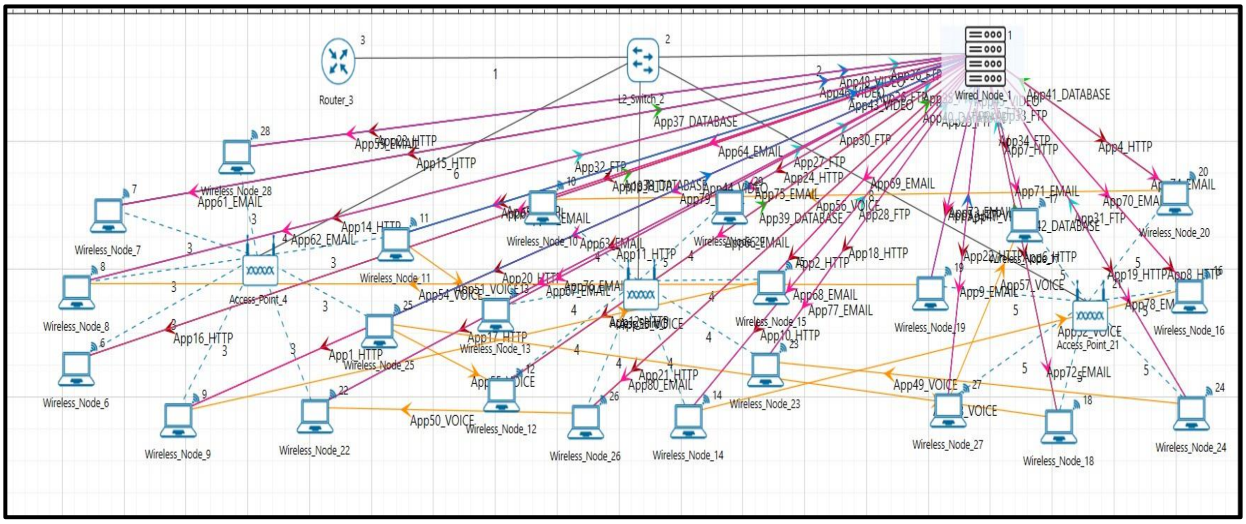

Figure 9: Wireless network in Netsim after configuration

Result Scenario WL1: Normal Traffic Load (Mix Traffic)

Wireless performance under normal load (Scenario WL1) is depicted in Figure 10 showing application-specific throughput, latency, and jitter data.

App. ID	App. Name	Src. ID	Dest. ID	Gen. Rate (Mbp:	Thput. (Mbps)	Delay (µs)	Jitter (µs)	Pkts. Gen.	Pkts. Recd.	Payload Gen. (B)	Payload Recd. (E
1	App1_HTTP	9	1	0.080000	0.005708	51207.984596	62046.189088	114	114	85500	85500
1	App1_HTTP	1	9	0.080000	0.076091	83054.236561	27143.019750	798	798	1140000	1140000
2	App2_HTTP	15	1	0.080000	0.005521	86839.089400	125244.571275	110	110	82500	82500
2	App2_HTTP	1	15	0.080000	0.073604	66188.885143	20132.868691	770	770	1100000	1100000
3	App3_HTTP	11	1	0.080000	0.005455	99940.611266	153677.093954	109	109	81750	81750
3	App3_HTTP	1	11	0.080000	0.072724	70970.993695	20597.158828	763	763	1090000	1090000
4	App4_HTTP	20	1	0.080000	0.003268	836043.996571	79977.930532	64	63	48000	47250
4	App4_HTTP	1	20	0.080000	0.041784	1418987.009233	268198.907397	441	437	630000	624380
5	App5_HTTP	19	1	0.080000	0.003149	905254.593484	97889.000770	63	62	47250	46500
5	App5_HTTP	1	19	0.080000	0.041298	1319180.376965	236893.097280	434	423	620000	604380
6	App6_HTTP	18	1	0.080000	0.003205	871874.769190	93945.648419	64	63	48000	47250
6	App6_HTTP	1	18	0.080000	0.042048	1283691.714167	233156.499016	441	430	630000	614380
7	App7_HTTP	17	1	0.080000	0.000000	0.000000	0.000000	1	0	750	0
8	App8_HTTP	16	1	0.080000	0.003230	857375.537581	141572.793262	63	62	47250	46500

Figure 10: Raw data from Netsim after run the simulation

For clearer comparison, the average performance metrics per application category and the overall network are summarized in Table 5.

Table 5: Performance metrics per application category and overall network

Metric	HTTP	FTP	Database	Email	Video	Voice	Overall Network (Average)
Average throughput (Mbps)	0.035	0.080	0.040	0.038	0.069	0.122	0.064
Average Latency (Ms)	374.052	2971.721	1120.542	1361.225	7.465	523.407	1059.735
Average Jitter (Ms)	97.801	320.030	405.681	146.343	7.881	8.963	164.450

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue I January 2026

Result Scenario WL2: Heavy Traffic Load

App. ID	App. Name	Src. ID	Dest. ID	Gen. Rate (Mbp:	Thput. (Mbps)	Delay (µs)	Jitter (µs)	Pkts. Gen.	Pkts. Recd.	Payload Gen. (B)	Payload Recd. (E
1	App1_HTTP	9	1	0.266670	0.000985	3089895.785444	586308.924939	19	18	14250	13500
1	App1_HTTP	1	9	0.266670	0.100521	14284437.560618	947635.606438	1260	1039	1800000	1485260
2	App2_HTTP	15	1	0.266670	0.000806	4445243.493867	898030.803286	16	15	12000	11250
2	App2_HTTP	1	15	0.266670	0.063260	12141538.873289	1143854.373789	1050	648	1500000	927160
3	App3_HTTP	11	1	0.266670	0.000991	3051699.650667	574566.861628	19	18	14250	13500
3	App3_HTTP	1	11	0.266670	0.097428	14128971.311690	1076703.647288	1260	1018	1800000	1455040
4	App4_HTTP	20	1	0.266670	0.000659	6104656.865417	1970904.083853	13	12	9750	9000
4	App4_HTTP	1	20	0.266670	0.048727	17258580.463301	1462818.032005	840	485	1200000	694020
5	App5_HTTP	19	1	0.266670	0.000666	6003637.294750	1954662.975464	13	12	9750	9000
5	App5_HTTP	1	19	0.266670	0.053042	17095650.397745	1162912.511615	840	531	1200000	758980
6	App6_HTTP	18	1	0.266670	0.000612	6795938.235250	2007340.367273	12	12	9000	9000
6	App6_HTTP	1	18	0.266670	0.048456	11342586.340098	783733.879712	840	467	1200000	668180
7	App7_HTTP	17	1	0.266670	0.000000	0.000000	0.000000	1	0	750	0
8	App8_HTTP	16	1	0.266670	0.000667	5997324.404167	1953461.585636	13	12	9750	9000

Figure 11 captures the detailed per-application results for the heavy traffic wireless scenario (WL2), highlighting the impact of congestion on throughput, latency, and jitter.

Figure 11: Raw data from Netsim after run the simulation

For clearer comparison, the average performance metrics per application category and the overall network are summarized in Table 6.

Table 6: Performance metrics per application category and overall network

Metric	HTTP	FTP	Database	Email	Video	Voice	Overall Network (Average)
Average throughput (Mbps)	0.032	0.015	0.219	0.012	0.888	0.105	0.032
Average Latency (Ms)	9528.949	26941.899	34964.533	38549.082	633.170	7827.878	19740.918
Average Jitter (Ms)	1471.684	3868.257	4304.026	2249.991	4.112	12.279	1985.058

Result Scenario WL3: Real-Time Application Stress Test

The real-time stress test results for the wireless network Scenario WL3 are presented in Figure 12, with breakdowns of throughput, latency, and jitter across all applications.

App. ID	App. Name	Src. ID	Dest. ID	Gen. Rate (Mbp:	Thput. (Mbps)	Delay (µs)	Jitter (µs)	Pkts. Gen.	Pkts. Recd.	Payload Gen. (B)	Payload Recd.
17	App17_HTTP	22	1	0.100000	0.004171	438417.061341	181722.190073	69	68	51750	51000
17	App17_HTTP	1	22	0.100000	0.067820	737797.268396	149630.123393	612	606	850000	841880
18	App18_HTTP	23	1	0.100000	0.003268	835734.559377	205123.990000	54	53	40500	39750
18	App18_HTTP	1	23	0.100000	0.053496	1304671.001727	224169.170954	477	462	662500	641880
19	App19_HTTP	24	1	0.100000	0.001963	2056815.641500	361804.463355	33	32	24750	24000
19	App19_HTTP	1	24	0.100000	0.031164	3118732.370964	466483.497293	288	271	400000	377100
20	App20_HTTP	25	1	0.100000	0.004255	410078.979667	152222.404749	70	69	52500	51750
20	App20_HTTP	1	25	0.100000	0.069183	670763.425270	132788.282998	621	615	862500	854380
21	App21_HTTP	26	1	0.100000	0.003322	806035.365278	187115.615347	55	54	41250	40500
21	App21_HTTP	1	26	0.100000	0.054120	1336188.674181	236864.272677	486	469	675000	652100
22	App22_HTTP	27	1	0.100000	0.001956	2067373.002531	365759.738148	33	32	24750	24000
22	App22_HTTP	1	27	0.100000	0.031069	3168343.338750	484609.554698	288	271	400000	377100
23	App23_HTTP	28	1	0.100000	0.004050	481325.934970	242559.611611	67	67	50250	50250
23	App23_HTTP	1	28	0.100000	0.066374	705928.641818	157868.591441	603	594	837500	825000

Figure 12: Raw data from Netsim after run the simulation

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue I January 2026

For clearer comparison, the average performance metrics per application category and the overall network are summarized in Table 7.

Table 7: Performance metrics per application category and overall network

Metric	HTTP	FTP	Database	Email	Video	Voice	Overall Network (Average)
Average throughput (Mbps)	0.027	0.132	0.132	0.042	0.502	0.118	0.159
Average Latency(Ms)	1521.446	8960.580	10435.989	12276.378	15.150	1947.141	5859.447
Average Jitter Ms)	380.865	842.468	1861.683	852.589	4.322	8.900	658.471

Overall Result

This section is a comparative analysis of wired and wireless network performance in three scenarios of traffic loads: normal load, heavy load, and real-time application stress. The paper focuses on three metrics-throughput, latency, and jitter-that outline the fundamental differences between wired and wireless networks in a simulated office environment.

Throughput result

Figure 13 shows comparison between the average throughput of wired and wireless networks under normal, heavy, and real-time stress loads.

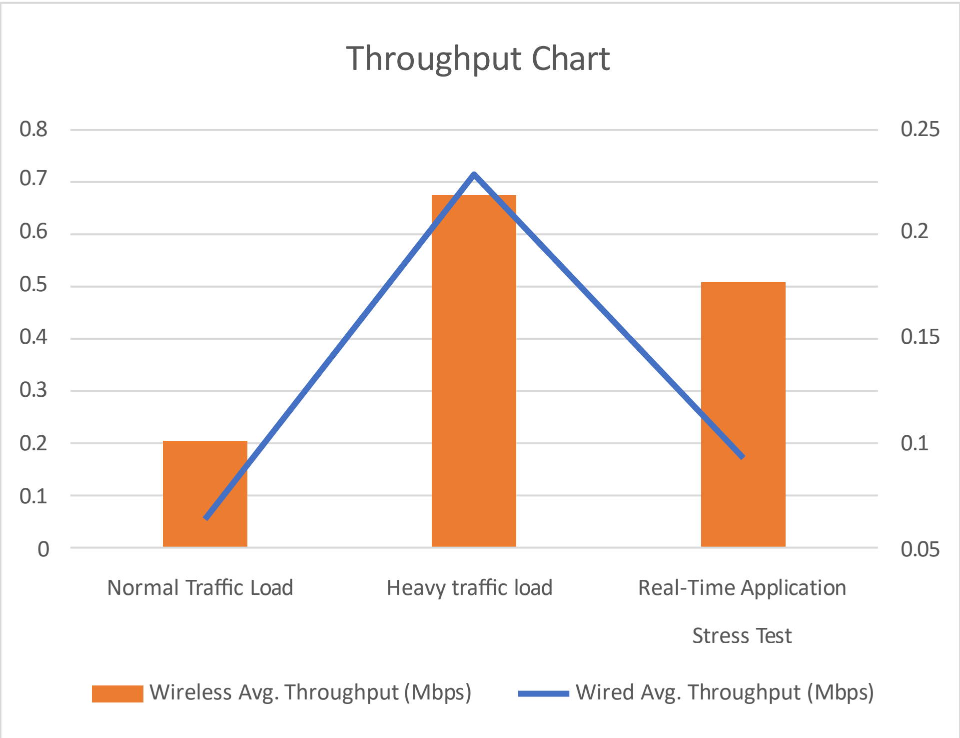

Figure 13: Wired and wireless throughput chart

INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN SOCIAL SCIENCE (IJRISS)
ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue I January 2026

Latency result

Figure 14 illustrates the average latency for both network types across the three scenarios. Note the logarithmic scale used to accommodate the wide range of values.

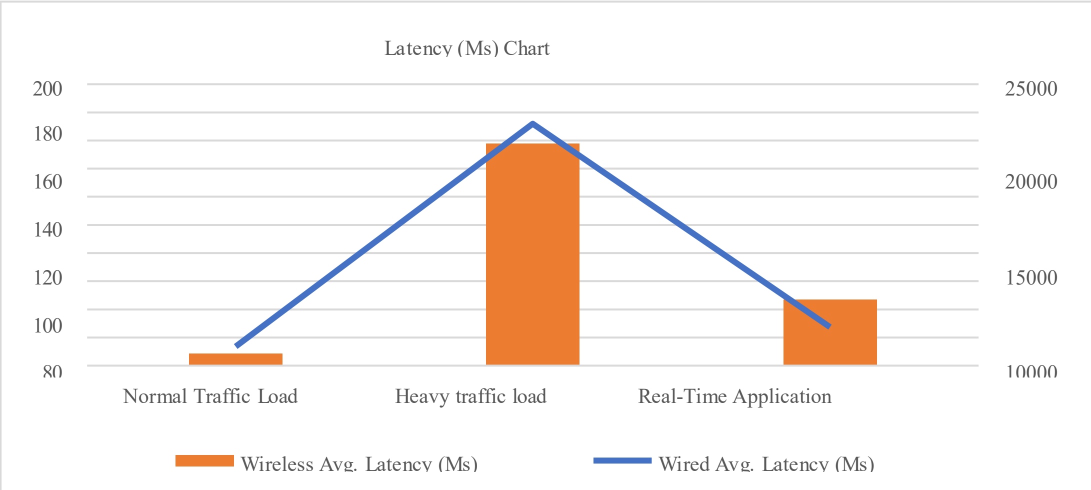

Figure 14: Wired and wireless latency chart

Jitter Result

Figure 15 shows jitter performance across scenarios, demonstrating packet delivery consistency.

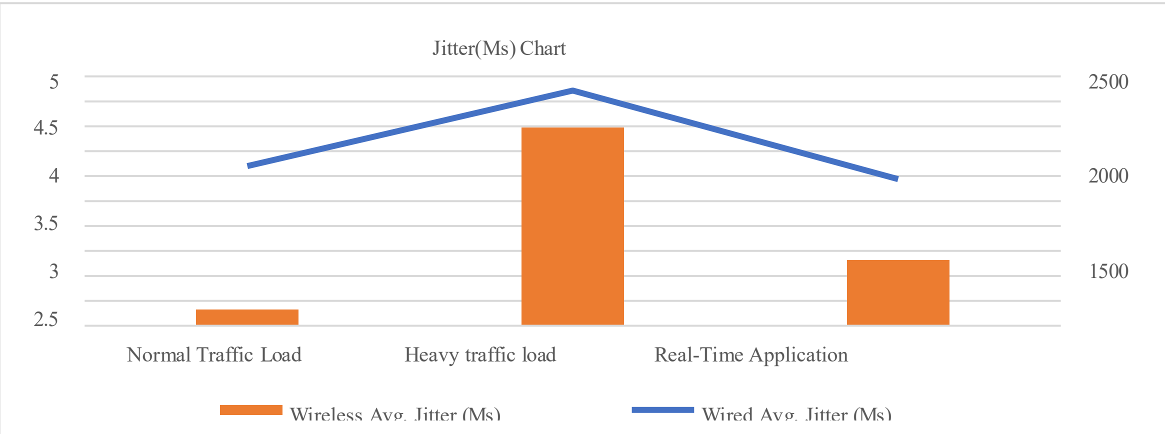

Figure 15: Wired and wireless jitter chart

Overall result

Table below summarizes the overall performance results for both wired and wireless connections.

Table 8: Overall result for wired and wireless performance

Scenario	Throughput (Mbps)			Latency (Ms)			Jitter (Ms)		
	Wired Avg.	Wireless Avg.	% Difference	Wired Avg.	Wireless Avg.	% Difference	Wired Avg.	Wireless Avg.	% Difference
Normal Traffic Load	0.0544	0.064	17.65	13.607	1059.735	7,689.92	3.201	164.45	5,038.27

Heavy traffic load	0.715	0.211	-70.49	171.901	19740.918	11,385.11	4.716	985.058	41,989.32
Real-Time Application Stress Test	0.172	0.159	-7.56	27.442	5859.447	21,250.52	2.94	658.471	22,296.99

Table 8 shows the overall result for wired and wireless performance. A positive percentage difference indicates that the wireless network recorded a higher value than the wired network for the given performance metric, while a negative percentage difference indicates that the wireless network recorded a lower value than the wired network. In every evaluated case, wired networks show better and more consistent throughput. Under typical circumstances, wireless throughput (0.064 Mbps) somewhat outperformed cable (0.054 Mbps), however this advantage drastically reversed under load. Wired networks achieved 0.715 Mbps during periods of high traffic, while wireless networks only managed 0.211 Mbps, indicating a 3.4 times performance advantage for wired connectivity. These results are similar with research by Goh & Chua (2024), who found that dedicated bandwidth and the lack of medium contention in wired Ethernet consistently result in greater sustainable throughput. Furthermore, Singh et al. (2015) found that congestion and retransmission overhead were the main factors limiting wireless throughput in shared- medium contexts. These findings are supported by the observed throughput decrease in wireless networks under load.

The latency was much lower and more predictable in wired networks, making them a primary building block for real-time applications. The wireless latency was generally high, ranging from 78 times higher 1,059.7 ms vs. 13.6 ms in normal loading conditions to 115 times higher 19,740.9 ms vs. 171.9 ms in heavy loading conditions. The large disparity in latency is in line with the findings given by Ada Computer Science in 2025, which highlights deterministic packet delivery and the absence of medium access delay as the primary strength of wired networks. Moreover, the findings are also a testament to the claims proposed by Rogier in 2024, which pointed out that the wireless latency is proportional to the network load with an exponential relationship, and the wired latency is not affected by the load conditions.

Wired networks support considerably more reliable delivery of packets and exhibit negligible timing variability. Jitter values in the wireless network supported between 164.45ms and 1,985.06ms. In contrast, the values supported in the wired network stayed between 2.94ms to 4.72ms. This is 224 times more favourable to the wired network. These findings support the conclusions of Murthy (2024), who concluded that variable propagation delay and channel access schemes significantly influence the values of wireless network jitter. These values further support the TETCOS (2021) documentation regarding network performance metrics. According to the documentation, the metrics related to jitter significantly differentiate between wired and wireless media. These values considerably influence the application area involving real-time stress testing.

Wired networks categorically outshine their wireless counterparts in terms of dependability, predictability, and applications where performance matters. The wired setup offers significantly better performance under heavy loads 3.4 times advantage, very low latency 78–115 times improvement, and very low jitter 224 times lower. The aforementioned overall performances confirm the paradigm proposed by Subedi (2020), who suggested the necessity of a wired infrastructure in an office network. Additionally, the results obtained for performance degradation in the wireless networks under heavy loads confirm the principles of hierarchical networks proposed by Smera & Sandeep (2022), suggesting wired backbones and selective use of wireless networks for performance-critical networks.

DISCUSSION

The performance of wired and wireless networks in a small office simulation was successfully compared in this experiment. Important discoveries show that wired networks are perfect for real-time and data-intensive applications because they provide better stability, lower latency, and consistent jitter. Despite being adaptable and practical, wireless networks showed notable performance loss under high and real-time loads, especially in delay and jitter. Network planners at small businesses can use the study's practical foundation to make well-informed decisions based on scalability, affordability, and performance needs. This study also provides a reusable foundation for future network performance research by using a structured simulation methodology.

While this study provides valuable insights into wired and wireless network performance in a small office environment, it is limited to a 25-user network and only simulates Wi-Fi 5 (802.11ac) without considering newer standards or interference from other devices. These factors may influence performance in larger or more complex networks. Future studies could address these limitations by incorporating larger user counts, advanced Wi-Fi standards, and realistic interference sources to further validate and extend these findings

ACKNOWLEDGEMENT

The authors would like to thank Universiti Teknikal Malaysia Melaka (UTeM) for the support.

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