Cawangan Melaka

PCMJ

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volume 1

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Progress in Computing and Mathematics Journal
College of Computing, Informatics, and Mathematics
Universiti Teknologi MARA Cawangan Melaka, Kampus Jasin
77300, Merlimau, Melaka Bandaraya Bersejarah

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EDITORS

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PREFACE

Welcome to the inaugural volume of the **Progress in Computing and Mathematics Journal (PCMJ)**, a publication proudly presented by the College of Computing, Informatics, and Mathematics at UiTM Cawangan Melaka.

This journal represents a significant step in our commitment to fostering a vibrant research culture, initially providing a crucial platform for our undergraduate students to showcase their intellectual curiosity, dedication to scholarly pursuit, and potential to contribute to the broader academic discourse in the fields of computing and mathematics. However, we envision PCMJ evolving into a beacon for researchers both nationally and internationally. We aspire to cultivate a space where groundbreaking research and innovative ideas converge, fostering collaboration and intellectual exchange among established scholars and emerging talents alike.

The manuscripts featured in this first volume, predominantly authored by our undergraduate students, are a testament to the hard work and dedication of these budding researchers, as well as the guidance and support provided by their faculty mentors. They cover a diverse range of topics, reflecting the breadth and depth of research interests within our college, and set the stage for the high-quality scholarship we aim to attract in future volumes.

As editors, we are honored to have played a role in bringing this journal to fruition. We extend our sincere gratitude to all the authors, reviewers, and members of the editorial board for their invaluable contributions. We also acknowledge the unwavering support of the college administration in making this initiative possible.

We hope that PCMJ will inspire future generations of students and researchers to embrace research and innovation, to push the boundaries of knowledge, and to make their mark on the world of computing and mathematics.

Editors
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UiTM Cawangan Melaka

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NETWORK PERFORMANCE ANALYSIS ON DIFFERENT ISP USING ONLINE CLASS PLATFORM ON DIFFERENT DEVICES

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Abstract

The ubiquity of online education underscores the critical importance of reliable and efficient network performance in facilitating seamless learning experiences for students. This project delves into the realm of Internet Service Provider (ISP) performance analysis within the context of online education, focusing on the evaluation of latency, packet loss, and jitter across multiple ISPs using the Google Meet online platform. Leveraging PingPlotter as a monitoring tool, network performance metrics were systematically assessed over a period of five days, encompassing various time intervals reflective of peak usage periods. The project's methodology involved conducting tests across different devices, including laptops and smartphones, to capture diverse network environments and user experiences. Findings revealed significant variations in ISP performance, with implications for network reliability and quality of service in online education settings. The project concludes with recommendations for future research endeavours aimed at enhancing network infrastructure and optimizing online learning environments. Through its systematic approach and empirical insights, this project contributes to the ongoing discourse on ISP performance analysis and its impact on digital education.

Keywords: Internet Service Provider, Online Meeting Platform, Network performance, PingPlotter

INTRODUCTION

In the swiftly evolving landscape of education, the shift towards online learning has become increasingly prevalent, with platforms like Google Meet serving as integral components of the virtual classroom. However, concerns about the quality of online learning persist, underscoring the critical importance of reliable network performance. This project endeavors to analyze the performance of online classes from a network perspective, delving into the intricacies of Quality of Service (QoS) within Google Meet.

The digital learning movement aimed to revolutionize society with seamless digital technology use yet concerns about the quality of online learning persist (Ismail & Ismail, 2021).

Quality of Service (QoS) delivered by platforms like Google Meet is paramount to the effectiveness of remote education. This project investigates QoS within Google Meet, focusing on how different Internet Service Providers (ISPs) contribute to the learning experience. The study evaluates performance metrics using Google Meet, emphasizing factors such as latency, jitter, and packet loss.

The project aims to determine superior ISP performance among Celcom, Unifi Mobile, and Hotlink by objectively measuring and comparing their performance, focusing on latency and overall network reliability (Bebortta & Das, 2020). Additionally, the study assesses device reliability between laptops and phones, considering hardware, software, and usage conditions. To maximize the quality of remote education, this research aims to determine the most efficient combination of ISPs and online learning platforms.

Objectives include analyzing network performance parameters, evaluating device reliability, and identifying superior ISP performance in the Lipat Kajang Impian area. The study analyzes QoS using Google Meet, focusing on Celcom, Unifi Mobile, and Hotlink ISPs, and devices such as laptops and phones. Geography studies will focus on the Lipat Kajang Impian area, considering variables like signal strength and stability. The study also explores online learning environments and employs PingPlotter for network performance analysis.

The evaluation of ISPs aims to provide consumers with information to choose the best ISP for online needs, ultimately improving user experience and internet connectivity. Additionally, the project highlights device performance under various network circumstances, guiding users toward optimal device options for online learning. By exploring these variables, the research aims to contribute valuable insights to enhance the overall quality and reliability of online education

.**LITERATURE REVIEW**

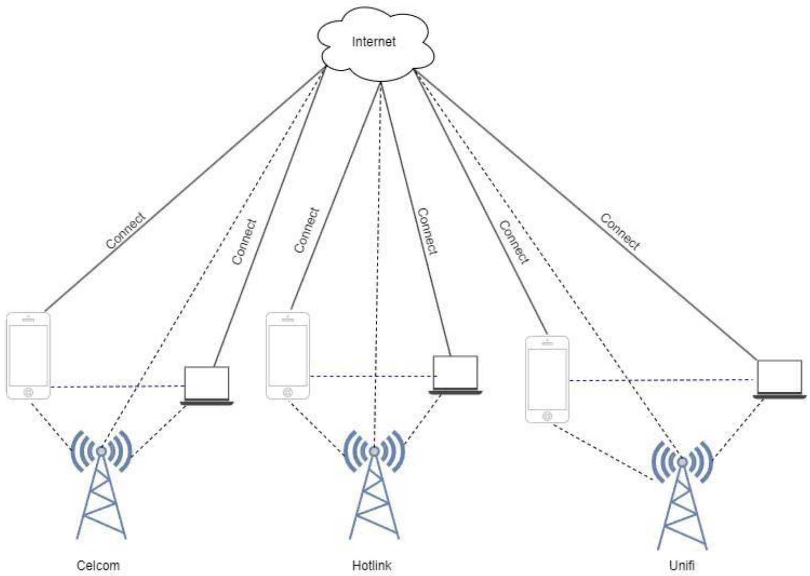

Figure 1: Star Topology Diagram

The network topology depicted involves service providers Celcom, Hotlink, and Unifi, with a laptop connecting to the internet through a smartphone tethering hotspot (Hepler, 2023). This setup utilizes cellular networks to communicate with cell towers representing various network infrastructures. The smartphone establishes a connection to the internet via cellular data and creates a personal hotspot through tethering, allowing the laptop to connect to the internet. Depending on usage, this setup may consume significant cellular data.

Mobile networks have evolved through generations, offering faster speeds and increased bandwidth (Viswanathan, 2021). From 1G to 5G, each generation introduces advancements in voice and data communication. Mobile networks operate through cells, with each cell containing a tower and operating on distinct frequencies to minimize interference (Barker, 2024). Mobile networks facilitate communication across Local Area Networks (LANs), Wide Area Networks (WANs), and Personal Area Networks (PANs), each serving different coverage and purpose.

Network performance encompasses various metrics, including bandwidth, latency, throughput, network availability, packet loss, and jitter (Rouse, 2015). Bandwidth defines the maximum data transfer rate, while latency measures data travel time between points (Gillis, 2020). Throughput quantifies actual data transfer, while network availability ensures operational status (Hayes, 2022). Jitter reflects fluctuations in data packet time gaps, impacting real-time communication (Shukla, 2022).

PingPlotter serves as a robust network monitoring tool, efficiently identifying and resolving network issues by analyzing packet data and visualizing network quality. In Malaysia, ISPs like Celcom, Maxis, and Unifi offer various internet plans, including fiber, wireless, and mobile broadband, catering to diverse user needs (Twin, 2022; Jodee, 2023). Celcom, Maxis, and Unifi are prominent ISPs, providing mobile and broadband services with extensive coverage and diverse plan options.

Quality of Service (QoS) is vital for managing and prioritizing data traffic, ensuring optimal service levels for voice, video, and standard data (Zelleke, 2023). QoS mechanisms, including Integrated Services (IntServ) and Differentiated Services (DiffServ), optimize packet processing and bandwidth allocation, enhancing network performance (Howard, 2023; Fitzpatrick, 2016). QoS measures bandwidth, delay, loss, and jitter, critical for real-time multimedia applications and networks with limited capacity.

METHODOLOGY

During the planning phase, the research goals and parameters are carefully outlined to set the direction for the study. This includes defining the research objectives, selecting target Internet service providers (ISPs), online platforms, and devices for evaluation. Metrics for assessing network performance, such as jitter, packet loss, and latency, are established. Additionally, a detailed research schedule is developed to ensure a systematic and well-executed process

In the design phase, a structured framework is created to identify the best Internet service provider (ISP) for online learning environments. Criteria for evaluating ISP performance, including packet loss, latency, and overall network reliability, are defined. The experimental setup simulates real-world online class scenarios to closely reflect actual usage patterns.

Suitable monitoring tools are selected to record and analyze ISP performance across different devices and online platforms.

Strong procedures for data collection and analysis are developed to systematically test and assess ISP performance under controlled conditions. Factors like network congestion and device specifications are carefully controlled to ensure consistency and reliability in the assessment process. An experimental plan is crafted to guide the execution of experiments and data collection in an organized manner.

Overall, the design phase lays the groundwork for selecting the optimal ISP for online learning environments. The goal is to gain valuable insights into ISP performance data and determine which provider offers the most reliable and effective network services. By adhering to recognized standards and employing rigorous methodologies, the study aims to achieve its research objectives and contribute to a deeper understanding of ISP performance in online education contexts.

Table 1: Hardware Specifications

Hardware	Specification
Laptop	HP Pavillion Processor Intel® Core™ i5 -9300H CPU @2.40 GHz NVIDIA GeForce GTX 1050 Windows 10 Intel® Wireless-AC 9650 160MHz
Laptop	Illegear ONYX AMD Ryzen 7 4800H NVIDIA GeForce RTX 2060 Windows 10 Intel® Wi-Fi AX200 160MHz
Laptop	Asus TUF AMD Ryzen 5 3550H NVIDIA GeForce GTX 1650 Windows 10
Phone	Iphone XS Hexa-core (2x2.5 GHz Vortex + 4x1.6 GHz Tempest) Apple GPU (4-core graphics) 256GB 4GB RAM
Phone	Iphone XS Plus Hexa-core (2x2.5 GHz Vortex + 4x1.6 GHz Tempest) Apple GPU (4-core graphics) 64GB 4GB RAM

Tablet	Ipad 10th Gen Hexa-core (2x3.0 GHz Firestorm + 4x1.8 GHz Icestorm) Apple GPU (4-core graphics) 64GB 4GB RAM

From table 1 Both laptops and phones will serve as the testing apparatus to measure network performance. To utilize the mobile phone as a wireless access point, we will be leveraging its wireless hotspot capability. Since students may only connect using their phone's hotspot to link to their laptop, we will utilize this common setup. Furthermore, we will conduct network tests using the phones and laptops respectively.

Table 2: Software Requirements

Description	Software	Function
Operating System	Windows 10	Utilized in the project's execution method
Application	PingPlotter	Used to measure the latency,packet loss and jitter of the ISP based on the online platform
	Google Meet	Live video conferencing online platform

From table 2 incorporating PingPlotter for network monitoring and Google Meet as the online platform provides real-time insights into network performance during online classes.

From figure 1, The network diagram depicts connectivity elements, including the Internet represented by a cloud symbol, linked to three cellular towers labelled "Celcom," "Hotlink," and "Unifi," denoting different internet service providers. Each tower connects to a smartphone, indicating mobile internet access. The smartphones share their internet connection with laptops via tethering, facilitating internet access using mobile data. The connections between smartphones and laptops symbolize tethering, achievable via Wi-Fi, Bluetooth, or USB, useful in areas lacking reliable Wi-Fi. This diagram elucidates data flow from the Internet to end-user devices through diverse service providers and devices.

In the implementation phase, the testing period spans 5 days, divided into morning, afternoon, and evening sessions to align with UiTM students' typical class schedules. The location at Lipat Kajang Impian ensures a localized assessment of network performance, with PingPlotter used to monitor latency, packet loss, and jitter during Google Meet sessions. This focused evaluation aims to provide insights into network reliability and efficiency for online classes.

During the testing and evaluation phase, collected data undergoes meticulous cleaning and organization to facilitate analysis. Quantitative data may undergo statistical analyses, while qualitative data could be subjected to content analysis. Findings are interpreted in light of the research question and design, with conclusions presented alongside discussions on their implications, always mindful of ethical considerations.

In the documentation phase, comprehensive recording of data collection and analysis procedures is essential for maintaining transparency and facilitating reproducibility. Documentation extends to a thorough compilation of findings, conclusions, and broader implications, enhancing accessibility through visual aids like tables and figures. By prioritizing meticulous documentation practices, researchers uphold academic integrity and contribute to the advancement of knowledge in their respective fields.

RESULT AND DISCUSSION

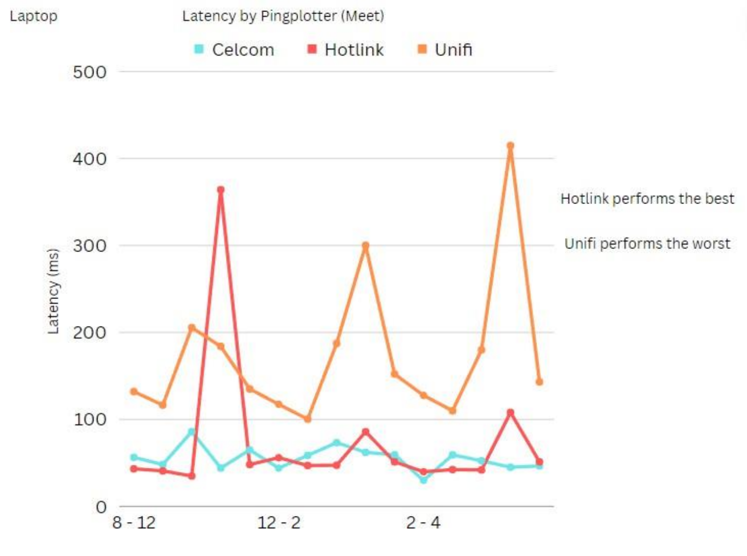

Figure 2 Laptop Latency Comparison

Figure 2 illustrates latency issues across three internet service providers: Celcom, Hotlink, and Unifi. Latency refers to data transmission delays, with lower values indicating better network performance. Hotlink consistently shows the lowest latency, staying below 100 ms, indicating superior performance. Celcom exhibits moderate performance with latency below 200 ms, while Unifi experiences significant spikes, nearing 500 ms during mid-day periods. It's crucial to consider various factors influencing latency, including network conditions and device specifications. While Hotlink appears superior in this snapshot, network performance can vary, emphasizing the need for comprehensive evaluation across different conditions and data points.

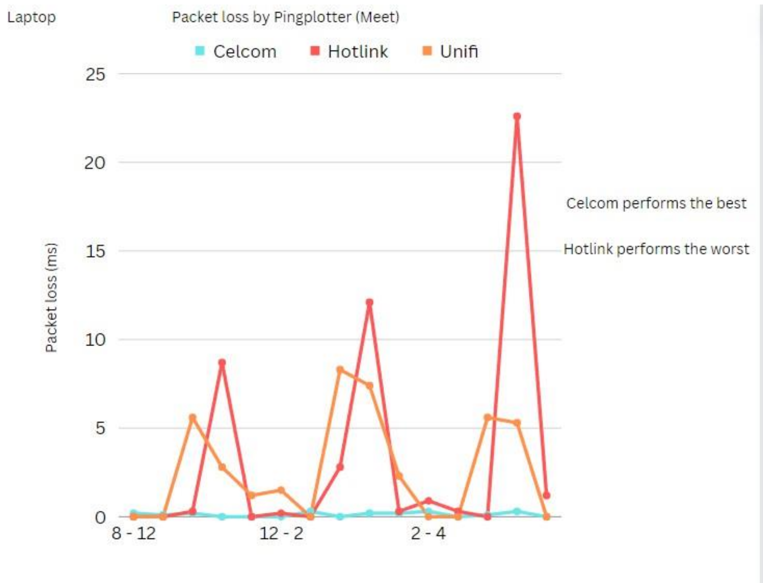

Figure 3 Laptop Packet Loss Comparison

Figure 3 shows packet loss issues across Celcom, Hotlink, and Unifi internet service providers (ISPs). Packet loss represents the number of data packets that don't reach their destination, impacting online applications and gaming. Celcom consistently demonstrates the lowest packet loss, indicating better performance. Hotlink experiences spikes in packet loss, especially between 2-4, indicating poorer performance during these times. Unifi's performance lies between Celcom and Hotlink, with varying packet loss levels. This graph highlights the importance of evaluating packet loss across different ISPs and time periods for comprehensive network performance analysis.

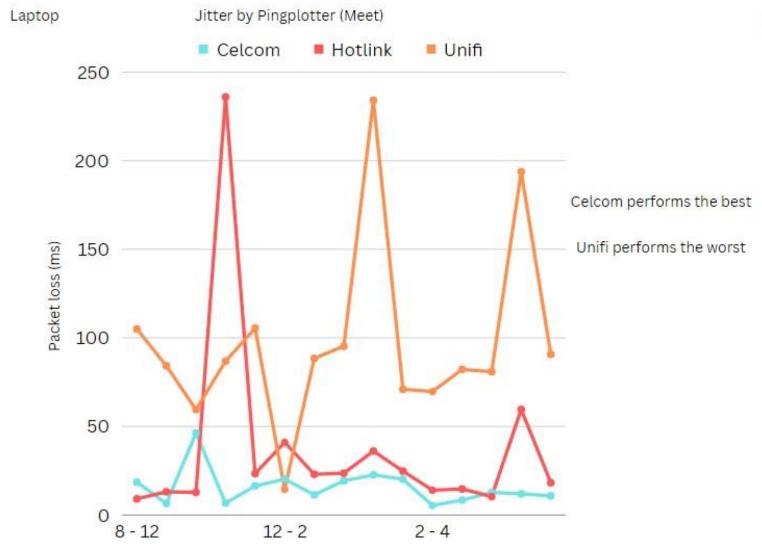

Figure 4: Laptop Jitter Comparison

Figure 4 displays jitter measurements for Celcom, Hotlink, and Unifi internet service providers (ISPs) at different times of the day: 8-12, 12-2, and 2-4. Celcom consistently shows the lowest jitter, indicating better performance, while Unifi experiences significant spikes, suggesting poorer performance during those times. Hotlink's performance lies between Celcom and Unifi, with varying jitter levels. It's crucial to consider various factors influencing jitter, such as network conditions and device specifications. While Celcom performs better in this snapshot, overall network performance evaluation should encompass diverse conditions and data points for accuracy.

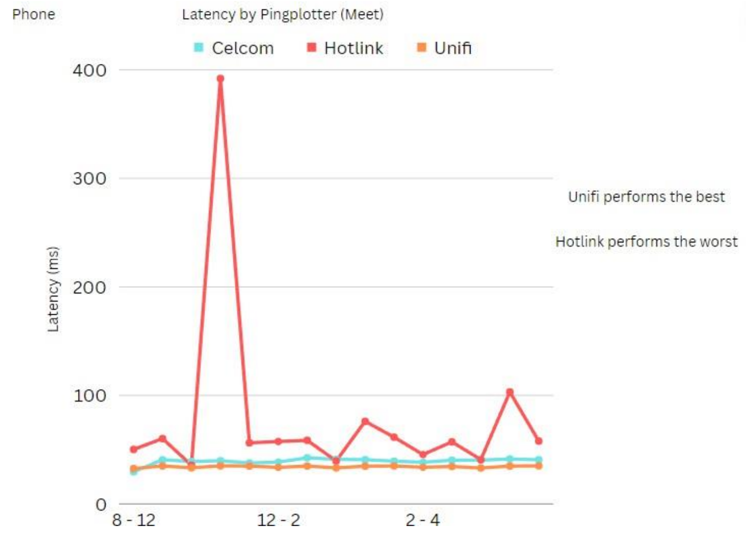

Figure 5: Phone Latency Comparison

Figure 4.7 shows latency issues for Celcom, Hotlink, and Unifi internet service providers (ISPs) at different times: 8:00-12:00, 12:00-14:00, and 14:00-18:00. Latency, measured in milliseconds (ms), represents the delay in data transmission, with lower values indicating better performance. Unifi consistently demonstrates the lowest latency, indicating superior performance, while Hotlink experiences significant spikes, particularly between 12:00 and 14:00, suggesting poorer performance. Celcom's performance falls between Unifi's consistent low latency and Hotlink's high spikes.

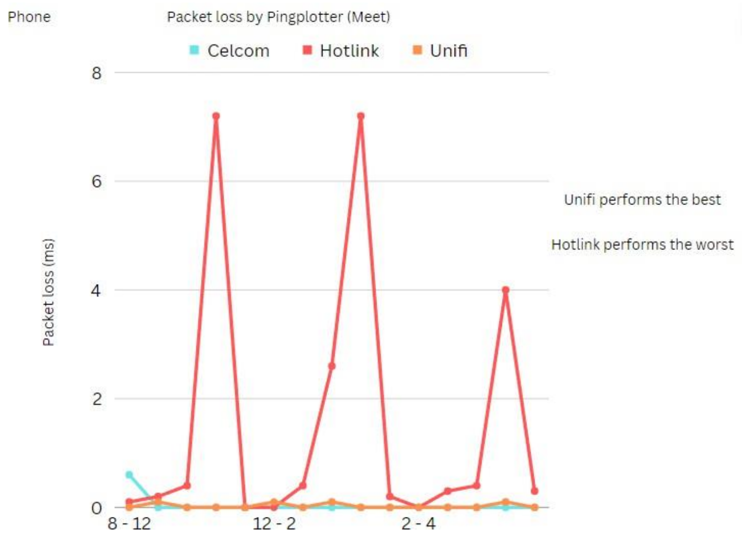

Figure 6: Phone Packet Loss Comparison

Figure 4.8 displays packet loss issues for Celcom, Hotlink, and Unifi internet service providers (ISPs). Packet loss refers to the failure of data packets to reach their destination, often expressed as a percentage. This loss can impact the performance of online applications and gaming. The graph measures packet loss at three different times: 8:00-12:00, 12:00-14:00, and 14:00-18:00. Unifi consistently shows the lowest packet loss, indicating the best performance. In contrast, Hotlink experiences significant spikes in packet loss, especially between 12:00 and 14:00, suggesting the worst performance. Celcom's performance lies between Unifi's low packet loss and Hotlink's high spikes.

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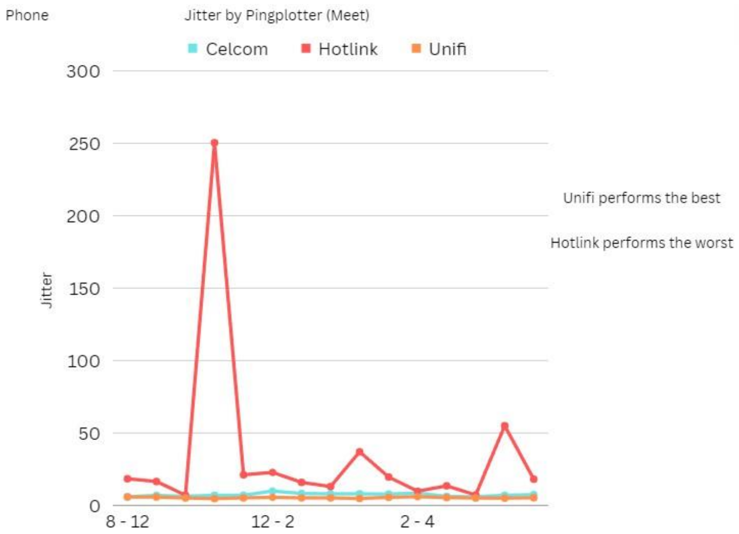

Figure 7: Phone Jitter Comparison

Figure 4.9 shows jitter issues for Celcom, Hotlink, and Unifi internet service providers (ISPs). Jitter refers to the variation in latency over time, with lower values indicating better network performance. The graph measures jitter at three different times: 8:00-12:00, 12:00-14:00, and 14:00-18:00. Unifi consistently demonstrates the lowest jitter across all time periods, indicating the best performance. Conversely, Hotlink experiences significant spikes in jitter, especially between 12:00 and 14:00, indicating the worst performance. Celcom's performance falls between Unifi's low jitter and Hotlink's high spikes.

Table 3: Network Parameter Comparison Summarized

		Celcom	Hotlink	Unifi
Latency	Laptop	Second	Best	Third
	Phone	Second	Third	Best
Packet Loss	Laptop	Best	Third	Second
	Phone	Second	Third	Best
Jitter	Laptop	Best	Second	Third
	Phone	Second	Third	Best

Table 3 presents a comparative analysis of three network providers: Celcom, Hotlink, and Unifi, focusing on latency, packet loss, and jitter. Hotlink consistently performs best in latency and packet loss across laptops and phones, followed by Celcom, while Unifi ranks third in these aspects. However, Celcom leads in jitter on laptops, while Unifi excels on phones. Notably, network performance on laptops connected to phone hotspots depends on the phone's network provider. For instance, a Hotlink phone hotspot may impact laptop performance negatively despite Hotlink's overall performance, while a Unifi hotspot could enhance performance due to Unifi's better metrics. Various factors, including battery level, signal strength, and device connections, affect hotspot performance. While these rankings offer insights, they are context-specific and may not represent providers' overall performance across different conditions. A comprehensive evaluation considering diverse factors is essential for informed decision-making when selecting a network provider.

CONCLUSION

The conclusion highlights the meticulous examination conducted to understand network performance in online education. It emphasizes the importance of reliable network infrastructure for seamless online learning experiences. The research provides valuable insights for educators, administrators, and Internet Service Providers (ISPs) to optimize network reliability and address disruptions. The project sets the stage for future research to refine network infrastructure and enhance online education quality, contributing to pedagogical innovation and digital learning advancement.

The summary encapsulates the project's focus on evaluating ISP performance in online education using Google Meet across various devices. It outlines the methodology, including network performance tests and analysis of key metrics like latency, packet loss, and jitter. The study aims to empower stakeholders with insights to improve network reliability and enhance the online learning experience. It concludes by affirming the project's contribution to the discourse on ISP performance in digital education.

The limitation section identifies constraints such as device availability, limited tools like PingPlotter, and a small sample size. These limitations may impact the study's generalizability and statistical power. The section emphasizes the need for resource allocation, alternative methodologies, and careful interpretation of results to address these constraints in future research.

The future work section proposes recommendations to address limitations and expand the project's scope. Suggestions include increasing the sample size, exploring alternative testing tools, implementing longitudinal studies, collaborating with ISPs and educational institutions, and incorporating user feedback mechanisms. These recommendations aim to enhance the understanding of ISP performance in online education and contribute to ongoing improvements in network infrastructure and service delivery.

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