

# Analysis of the Implementation of the Hierarchical Token Bucket Queuing Method for Internet Bandwidth Management at the Indonesian College of Economics, Makassar

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ARTICLE INFORMATION	ABSTRACT
Received : 10 – 06 – 2024 Revised : 05 – 03 – 2025 Published : 25 – 04 – 2025	The internet network can be considered a concept in which multiple computers within a higher education institution are able to interact and share data and information globally. It plays a crucial role in supporting student access to learning resources, particularly at the Indonesian College of Economics Makassar (STIKI). This research aims to implement bandwidth management using the Hierarchical Token Bucket (HTB) method. The HTB method is implemented through a MikroTik Router RB941 using the Simple Queue technique. Based on the analysis of internet usage at STIKI, users are classified into four categories: lecturers, students, the institution (foundation), and guests. The bandwidth requirements analysis revealed that lecturers required a maximum bandwidth limit of 10 Mbps, students 13 Mbps, the foundation 8 Mbps, and guests 5 Mbps. The performance testing parameters used in this study include throughput, delay, jitter, and packet loss. The results of the testing indicated improvements in the network performance at STIKI following the application of the HTB method. Average throughput increased from 688 Kbps to 1149 Kbps, packet loss decreased from 0.05% to 0.0%, delay was reduced from 118.676 ms to 56.197 ms, and jitter improved from 119.08 ms to 56.04 ms. These results demonstrate that each parameter experienced performance improvement after the implementation of the HTB method.
Keywords: Bandwidth Management Hierarchical Token Bucket (HTB) Throughput Packet Loss Delay Jitter	

## I. Introduction

The internet has become a highly influential and essential aspect of modern life, serving as a fundamental need for communities around the world. In the current era, the internet can be seen as a network concept that enables multiple computers within a university to interact and share data and information globally [1], facilitating student access to learning resources—particularly at the Indonesian College of Economics Makassar (STIKI).

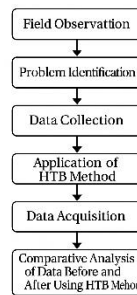
Internet usage within the campus network is extensive, involving approximately 30 to 100 users daily who are connected via cable or Wi-Fi hotspots across the campus area. Due to the high number of students, lecturers, and staff utilizing the internet simultaneously, the campus network experiences heavy and irregular traffic, which leads to slow data transfer speeds during web browsing, downloading, and uploading activities [2]. The Wi-Fi infrastructure at STIKI provides a total bandwidth of 40 Mbps, primarily available near the campus library, and internet access is facilitated via the public hotspot service provided by WiFi.id.

Data collection at STIKI revealed significant network delays, particularly during download and upload processes. This delay is largely attributed to congestion caused by a high volume of simultaneous users. One of the primary causes of such congestion is poor bandwidth management. Therefore, this study proposes the implementation of Hierarchical Token Bucket (HTB) queuing as a method to efficiently manage and allocate bandwidth.

Previous research has explored the use of the HTB method in various contexts, such as at SMK Negeri 22 by M.I. Ichwan, FTI UKSW by Pello, the Rectorate of Institut Shanti Bhuna by Nurcahyo, and SMP Negeri 5 Semarang by Alfon Indra Wijaya and Y. Putra with a case study at STIMIK ASIA Malang [3][4]. Building upon these studies, further research is necessary. This study, therefore, focuses on the topic: “Analysis of the Implementation of the Hierarchical Token Bucket Queuing Method for Internet Bandwidth Management at the Indonesian College of Economics, Makassar».

## II. Method

This section describes the stages of the research conducted. The research methodology consists of the following phases:

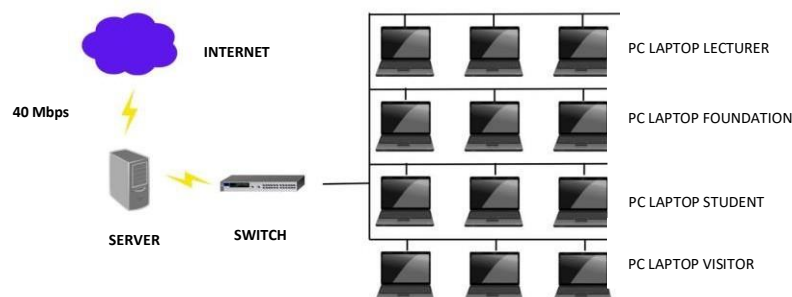


**Figure 1.** Research flow

- **Field Observation:** At this stage, the researcher submitted a research request and conducted direct observation at the research location, namely the Indonesian College of Economics Makassar (STIKI). The purpose of this stage was to obtain a clear understanding of the actual issues that would form the basis of the research.
- **Problem Identification:** In this phase, the researcher identified the issues occurring at the research site in order to determine the causes of the problems and find appropriate solutions to resolve them effectively.
- **Data Collection:** During the data collection phase, the researcher conducted interviews and gathered relevant data, including the network topology at STIKI, bandwidth allocation details, and specifications of the equipment used.
- **Implementation of the HTB Method:** Following the observation, problem identification, and data collection phases, the next step involved applying the Hierarchical Token Bucket (HTB) method for bandwidth management.
- **Data Acquisition:** The collected data included results from bandwidth tests, throughput tests, delay tests, jitter tests, and packet loss tests. The procedures for measuring throughput, delay, jitter, and packet loss were carried out using appropriate network testing tools.
- **Comparative Analysis of Pre- and Post-HTB Implementation:** Once the required data had been gathered, a comparative analysis was conducted to assess the differences in performance before and after implementing the Hierarchical Token Bucket (HTB) method. The results were then organized into tables to clearly illustrate the improvements across each parameter.

### A. Device Design

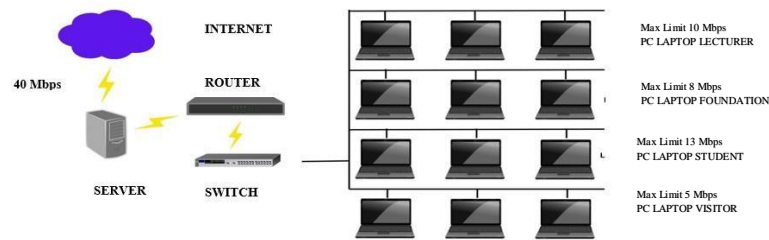
This study applies bandwidth management using the Hierarchical Token Bucket (HTB) method at the Indonesian College of Economics Makassar (STIKI). The following figures present the network topology before and after the implementation of bandwidth management using the HTB method:



**Figure 2.** Network Topology Before HTB Implementation

**Figure 1** illustrates the network topology at STIKI's administrative area prior to the implementation of bandwidth management using the HTB method. The internet connection is provided through WiFi ID with a bandwidth capacity of 40 Mbps, which is distributed to client computers via a switch.

After applying bandwidth management using the Hierarchical Token Bucket (HTB) method, a MikroTik RB941 router was added to the network to handle the HTB configuration. The updated network topology after HTB implementation is shown in **Figure 2**.



**Figure 3.** Network Topology After HTB Implementation

## B. Location and Duration

This research was conducted at the Indonesian College of Economics Makassar (STIKI) as the object of study. The research period took place from November 2023 to April 2024.

## C. Materials and Tools

The following equipment and tools were used to measure and analyze the computer network at STIKI:

### 1. Hardware

- a. Laptop/PC
- b. MikroTik router
- c. Hotspot device

### 2. Software

- a. Windows 10 Operating System
- b. Google chrome
- c. Wireshark software
- d. Winbox software
- e. Microsoft Office (Word and Excel) – for data processing and report writing

## D. Data Analysis Technique

The collected measurement data was analyzed using Microsoft Excel to calculate the values of each parameter. The analysis refers to THIPON standards to evaluate the quality of the computer network. The stages of network quality testing based on each parameter are as follows:

### 1. Throughput Test

**Table 1.** Throughput Category

Category	Throughput	Indeks
Very Good	>2.1 Mbps	4
Good	1200 - 2.1 Mbps	3
Currently	338 - 1200 Kbps	2
Bad	0 - 338 Kbps	1

The purpose of using the throughput parameter in this study is to determine the extent of bandwidth utilization when using network services. Throughput indicates the average amount of data successfully transferred compared to the total available bandwidth during the data transfer process. The throughput value can be calculated using the following formula:

$$\text{Throughput} = \frac{\text{packet received}(kb)}{\text{time transmitted}(s)} \quad (1)$$

### 2. Packet Loss Test

**Table 2.** Packet Loss Category

Category	Packet Loss (%)	Indeks
Very Good	$\leq 3$	4
Good	$>3$ s/d 15	3
Currently	$>15$ s/d 25	2
Bad	$>25$	1

Packet loss refers to the proportion of lost IP packets compared to the total number of IP packets transmitted from the source to the destination. This metric is used to assess the reliability of data transmission within a network.

$$\text{Packet Loss} = \frac{(\text{Packet transmitted} - \text{Packet received})}{\text{Packet transmitted}} \quad (2)$$

### 3. Delay Test

**Table 3.** Delay Category

Category	Big Delay (ms)	Indeks
Bad	$>450$	1
Currently	$>300$ s/d 450	2
Good	$>150$ s/d 300	3
Very Good	$\leq 150$	4

Network delay is calculated as the average time required for a data packet to travel from the transmitter to the receiver. Delay is a key parameter in Quality of Service (QoS) testing, as it reflects the time needed for data packets to reach their destination. The delay value can be calculated using the following formula:

$$\text{Delay} = \frac{\text{Total delay}}{\text{Total number of packages}} \quad (3)$$

### 4. Jitter Test

**Table 4.** Jitter Category

Category	Jitter
Very Good	0 ms
Good	75 ms
Currently	125 ms
Bad	225 ms

The jitter parameter in this study is used to assess the stability of the IP network. A lower jitter value indicates a more stable and higher-quality network, while a higher jitter value signifies an unstable or poor-quality connection. Jitter refers to the variation in packet arrival times, which can negatively impact real-time communications such as video calls and voice over IP (VoIP). The jitter value can be calculated using the following formula:

$$\text{Jitter} = \frac{\text{Total variasi delay}}{\text{Total packets received} - 1} \quad (4)$$

## III. Results and Discussion

### A. Research Results

#### 1) Data Collection Before HTB Implementation

This stage involves the collection of data related to Throughput, Packet Loss, Delay, and Jitter before the implementation of bandwidth management using the HTB method.

##### a. Throughput Analysis

Throughput is categorized as very good if its value is greater than 2.1 Mbps (2100 Kbps), good if it ranges between 1200 Kbps and 2100 Kbps, fair if it falls between 338 Kbps and 1200 Kbps, and poor if the value is between 0 and 338 Kbps.

**Table 5.** Throughput Analysis Before HTB Implementation

NO	Observation Time	Room	X – Throughput Value (Kbps)	Indeks	Category
1	08 Mei 2024	Lecturer Room	506 Kbps	2	Fair
2	14 May 2024	Administrative Office	479 Kbps	2	Fair
3	15 May 2024	Classroom B	715 Kbps	2	Fair
4	16 May 2024	Classroom C	1055 Kbps	2	Fair

## b. Packet Loss Analysis

Packet loss is classified as very good when the value is less than 3%, good when it ranges between 15% and 25%, and poor when the packet loss exceeds 25%.

**Table 6.** Packet Loss Analysis Before HTB Implementation

NO	Observation Time	Room	X – Packet Loss Value (%)	Indeks	Category
1	08 Mei 2024	Lecturer Room	0,0	4	Very Good
2	14 May 2024	Administrative Office	0,2	4	Very Good
3	15 May 2024	Classroom B	0,2	4	Very Good
4	16 May 2024	Classroom C	0,0	4	Very Good

## c. Delay Analysis

Delay is categorized as very good when the value is less than 150 ms, good if it ranges between 150 ms and 300 ms, fair if it is between 300 ms and 450 ms, and poor if the delay exceeds 450 ms.

**Table 7.** Delay Analysis Before HTB Implementation

NO	Observation Time	Room	X – Delay Value (MS)	Indeks	Category
1	08 Mei 2024	Lecturer Room	138,705 ms	2	Very Good
2	14 May 2024	Administrative Office	88,597 ms	2	Very Good
3	15 May 2024	Classroom B	97,284 ms	2	Very Good
4	16 May 2024	Classroom C	151,838 ms	2	Very Good

## d. Jitter Analysis

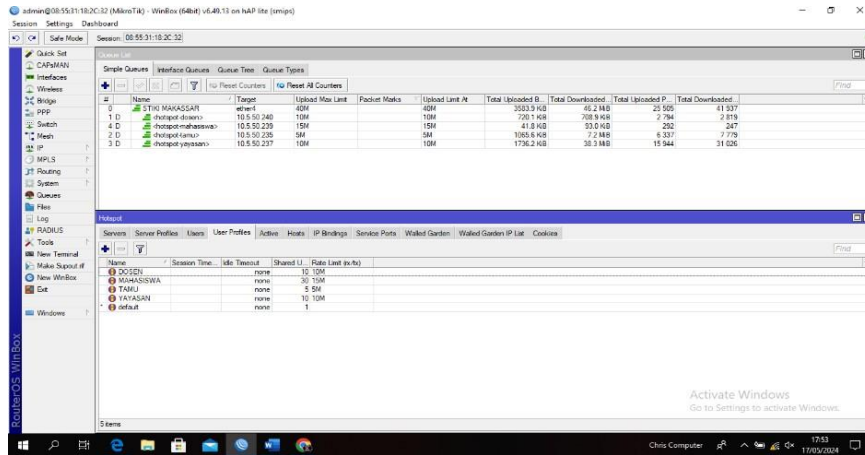
Jitter is categorized as very good when the value is equal to 0, good when the value is less than 75 ms, fair when it is less than 125 ms, and poor when it is less than 225 ms.

**Table 8.** Jitter Analysis Before HTB Implementation

NO	Observation Time	Room	X – Jitter Value (MS)	Indeks	Category
1	08 Mei 2024	Lecturer Room	138,701 ms	2	Fair
2	14 May 2024	Administrative Office	88,562 ms	2	Fair
3	15 May 2024	Classroom B	97,276 ms	1	Good
4	16 May 2024	Classroom C	151,827 ms	2	Fair

## 2) Bandwidth Management Implementation Using the HTB Method

In **Figure 3**, the Winbox tool is shown as a utility used to remotely access the MikroTik RB941 server, where configuration is carried out in the Queue List by creating a hierarchical structure. The parent queue is labeled "STIKI Makassar", with child queues for foundation (yayasan), lecturers (dosen), students (mahasiswa), and guests (tamu). Bandwidth is then allocated to each group according to the defined network topology.



**Figure 3.** HTB Bandwidth Management Configuration in Winbox

After configuring the hierarchy by creating parent and child queues, bandwidth management is carried out by allocating network speed limits to the child tokens that have been set in MikroTik via Winbox. Each child token is assigned a maximum bandwidth limit (Max Limit). The configured child tokens are as follows:

a. Foundation Token

After applying bandwidth management using the Winbox tool to remotely access the MikroTik RB941 server, the child queue named "foundation" was configured with a Max Limit of 10 Mbps. This ensures that the foundation's bandwidth usage does not exceed 10 Mbps during normal network conditions

b. Lecturer Token

The child queue for the "lecturer" user group was also configured with a Max Limit of 10 Mbps, ensuring stable and fair bandwidth distribution when the network is not under heavy load.

c. Student Token

For the "student" group, the child queue was configured with a Max Limit of 15 Mbps, considering the typically higher usage demands from students.

d. Guest Token

The "guest" group was allocated a Max Limit of 5 Mbps, providing limited but sufficient access for non-registered users or temporary visitors.

3) Data Collection After HTB Implementation

a. Throughput Analysis

Throughput is classified as very good when the value exceeds 2.1 Mbps (2100 Kbps), good when it ranges from 1200 Kbps to 2100 Kbps, fair if it falls between 338 Kbps and 1200 Kbps, and poor if it ranges from 0 to 338 Kbps.

**Table 9.** Throughput Analysis After HTB Implementation

NO	Observation Time	Room	X – Throughput Value (Kbps)	Indeks	Category
1	08 Mei 2024	Lecturer Room	1213 Kbps	3	Good
2	14 May 2024	Administrative Office	1753 Kbps	3	Good
3	15 May 2024	Classroom B	1149 Kbps	2	Fair
4	16 May 2024	Classroom C	1697 Kbps	3	Good

b. Packet Loss Analysis

Packet loss is categorized as very good when the value is less than 3%, good if it ranges between 15% and 25%, and poor if the packet loss value exceeds 25%.

**Table 10.** Packet Loss Analysis After HTB Implementation

NO	Observation Time	Room	X – Packet Loss Value (%)	Indeks	Category
1	08 Mei 2024	Lecturer Room	0,0	4	Very Good
2	14 May 2024	Administrative Office	0,0	4	Very Good
3	15 May 2024	Classroom B	0,0	4	Very Good
4	16 May 2024	Classroom C	0,0	4	Very Good

## c. Delay Analysis

Delay is categorized as very good when the value is less than 150 ms, good when it ranges from 150 ms to 300 ms, fair if it is between 300 ms and 450 ms, and poor if the delay exceeds 450 ms.

**Table 11.** Delay Analysis After HTB Implementation

NO	Observation Time	Room	X – Delay Value (MS)	Indeks	Category
1	08 Mei 2024	Lecturer Room	31,9178 ms	4	Very Good
2	14 May 2024	Administrative Office	60,742 ms	4	Very Good
3	15 May 2024	Classroom B	69,456 ms	4	Very Good
4	16 May 2024	Classroom C	62,696 ms	4	Very Good

## d. Jitter Analysis

Jitter is classified as very good when the value is equal to 0, good if it is less than 75 ms, fair if it is less than 125 ms, and poor if the jitter value is less than 225 ms.

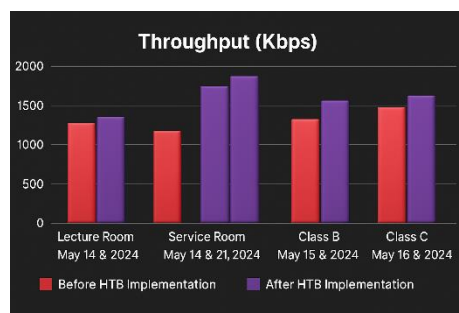
**Table 12.** Jitter Analysis After HTB Implementation

NO	Observation Time	Room	X – Jitter Value (MS)	Indeks	Category
1	08 Mei 2024	Lecturer Room	31,017 ms	3	Good
2	14 May 2024	Administrative Office	60,733 ms	3	Good
3	15 May 2024	Classroom B	69,593 ms	3	Good
4	16 May 2024	Classroom C	62,83 ms	3	Good

## B. Discussion

Based on the measurement results of network performance parameters before and after the implementation of the HTB method at Sekolah Tinggi Ilmu Ekonomi Indonesia Makassar (STIKI), testing was carried out over a period of eight days. The pre-implementation measurements were taken on May 8, 14, 15, and 16, 2024, while post-implementation measurements were taken on May 20, 21, 22, and 23, 2024. The results were evaluated based on the THIPON standard as follows:

## 1) Throughput Analysis

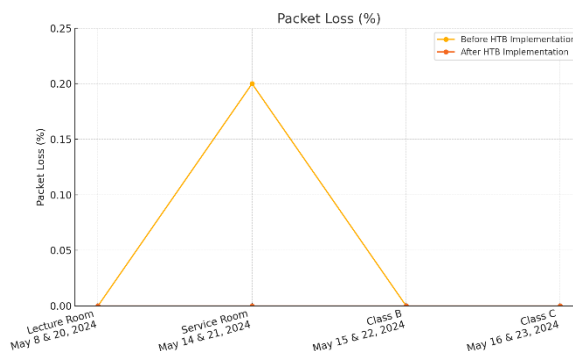
**Figure 3.** Throughput Before and After HTB Implementation

Based on **Figure 3**, it can be observed from eight days of measurement that the average throughput before the implementation of the HTB method ranged from 479 Kbps to 1055 Kbps, while after HTB implementation, it ranged from 1149 Kbps to 1753 Kbps. The highest throughput before HTB was recorded on the fourth day (Thursday, May 16, 2024) at 1055 Kbps, while the lowest was on the second day (Tuesday, May 14, 2024) at 479 Kbps.

After the implementation of HTB, the highest throughput was observed on the sixth day (Tuesday, May 21, 2024) at 1753 Kbps, and the lowest was on the seventh day (Wednesday, May 22, 2024) at 1149 Kbps.

Overall, the average throughput before HTB was 688 Kbps, and after HTB it increased to 1453 Kbps. However, it is recommended to improve both the bandwidth capacity and the devices used to access the internet, in order to achieve even better network performance. Based on the average throughput values recorded before and after HTB implementation, there was a significant improvement—from 688 Kbps to 1149 Kbps..

## 2) Packet Loss Analysis



**Figure 4.** Packet Loss Before and After HTB Implementation

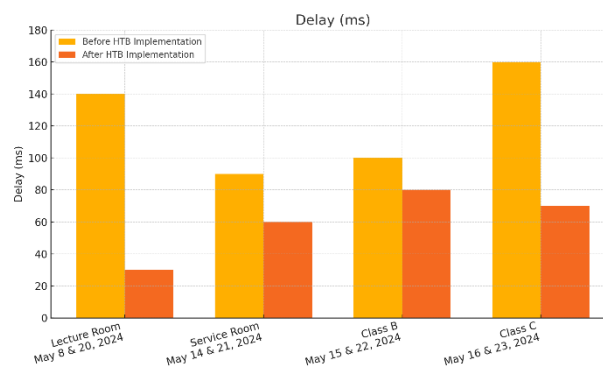
Based on **Figure 4**, it can be observed from eight measurements that the average packet loss before the implementation of HTB ranged from 0.0% to 0.2%. The highest packet loss occurred on Day 2 (Tuesday, May 14, 2024) at 0.2%, while the lowest was recorded on Days 1, 3, and 4, at 0.0%. The overall average packet loss before HTB was 0.05%, which, according to the THIPON standard, falls within the "very good" category.

After the HTB method was implemented, packet loss remained consistently at 0.0% from Day 5 to Day 8, resulting in an overall average packet loss of 0.00%, which also meets the "very good" classification according to THIPON standards.

The smaller the packet loss value recorded by network monitoring software like Wireshark, the better the network quality. Conversely, higher packet loss values indicate worse performance, as more data packets are either lost or fail to reach their destination.

Therefore, based on the average values measured before and after HTB implementation, packet loss improved from 0.05% to 0.00%, indicating a more stable and reliable network performance after applying the HTB method..

## 3) Delay Analysis



**Figure 5.** Delay Before and After HTB Implementation

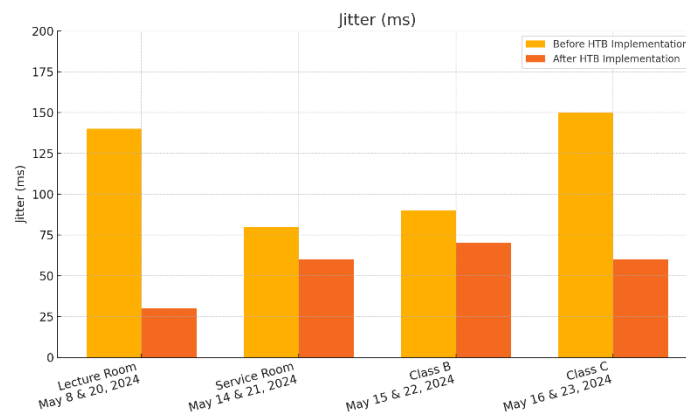
Based on **Figure 5**, it can be observed from eight days of measurement that the average delay before HTB implementation ranged from 88.597 ms to 151.838 ms. The highest average delay was recorded on Day 4 (Thursday, May 16, 2024) at 151.838 ms, while the lowest occurred on Day 2 (Tuesday, May 14, 2024) at 88.597 ms. The overall average delay before HTB was 118.676 ms.

After implementing the HTB method, the delay values ranged from 31.9178 ms to 69.456 ms, with the highest delay recorded on Day 7 (Wednesday, May 22, 2024) at 69.456 ms, and the lowest on Day 5 (Monday, May 20, 2024) at 31.9178 ms. The overall average delay after HTB was 56.197 ms.

According to the THIPON standard, these delay values fall under the “very good” category. The smaller the delay recorded by monitoring tools such as Wireshark, the better the network performance. Conversely, the higher the delay, the poorer the quality of the network, as increased delay results in longer times for data packets to be received—ultimately degrading network responsiveness and efficiency.

Therefore, based on the average delay values before and after HTB implementation, there was a significant improvement—from 118.676 ms to 56.197 ms—indicating enhanced network performance after applying the HTB method..

#### 4) Jitter Analysis



**Figure 6.** Jitter Before and After HTB Implementation

Based **Figure 6**, it can be observed from seven days of measurement that the average jitter before the implementation of HTB ranged from 88.562 ms to 151.827 ms. The highest average jitter was recorded on Day 4 (Thursday, May 15, 2024) at 151.827 ms, while the lowest was recorded on Day 2 (Tuesday, May 14, 2024) at 88.562 ms. The overall average jitter before HTB was 119.08 ms.

After the implementation of HTB, jitter values ranged from 31.017 ms to 69.593 ms. The highest jitter was recorded on Day 7 (Wednesday, May 22, 2024) at 69.593 ms, while the lowest was on Day 5 (Monday, May 20, 2024) at 31.017 ms. The overall average jitter after HTB was 56.04 ms.

According to the THIPON standard, the average jitter value after HTB implementation falls into the "good to very good" category. The lower the jitter value recorded by network monitoring software such as Wireshark, the better the quality of the network. Conversely, the higher the jitter value, the poorer the network performance, as it indicates greater variability in packet arrival times which can negatively affect real-time applications.

Therefore, based on the average jitter values recorded before and after the implementation of HTB, network performance improved significantly—from 119.08 ms before HTB to 56.04 ms after HTB.

## IV. Conclusion

Based on the results of computer network performance checks before and after the implementation of bandwidth management using the HTB method at Sekolah Tinggi Ilmu Ekonomi Indonesia Makassar (STIKI), the following conclusions can be drawn: (1) Before the implementation of the HTB method, the highest throughput was 1055 Kbps and the lowest was 479 Kbps. After HTB was applied, the highest throughput increased to 1753 Kbps and the lowest to 1149 Kbps. Thus, the average throughput improved from 688 Kbps

to 1149 Kbps. (2) For packet loss, the highest value before HTB was 0.2% and the lowest was 0.0%. After implementing HTB, both the highest and lowest packet loss values were 0.0%, resulting in an average improvement from 0.05% to 0.0%. (3) Regarding delay, the maximum delay before HTB was 151.838 ms and the minimum was 88.597 ms, while after HTB, the maximum delay decreased to 69.456 ms and the minimum to 31.9178 ms. This means the average delay improved from 118.676 ms to 56.197 ms. (4) Lastly, for jitter, the highest jitter before HTB was 151.827 ms and the lowest was 88.562 ms, while after HTB implementation, the highest jitter was 69.593 ms and the lowest was 31.017 ms. Therefore, the average jitter value improved from 119.08 ms to 56.04 ms. These results demonstrate that the implementation of the Hierarchical Token Bucket (HTB) method led to significant improvements in all measured network performance parameters.

### References

- [1] C. Prihantoro, A. K. Hidayah, and S. Fernandez, "Analisis Manajemen Bandwidth Menggunakan Metode Queue Tree pada Jaringan Internet Universitas Muhammadiyah Bengkulu," *Just TI (Jurnal Sains Terap. Teknol. Informasi)*, vol. 13, no. 2, p. 81, 2021, doi: 10.46964/justti.v13i2.750.
- [2] I. P. Sari and S. Sukri, "Analisis Penerapan Metode Antrian Hierarchical Token Bucket untuk Management Bandwidth Jaringan Internet," *J. RESTI (Rekayasa Sist. dan Teknol. Informasi)*, vol. 2, no. 2, pp. 522–529, 2018, doi:
- [3] M. I. Ichwan, L. Sugiyanta, and P. W. Yunanto, "Analisis Manajemen Bandwidth Hierarchical Token Bucket ( HTB ) dengan Mikrotik pada Jaringan SMK Negeri 22 Avalaiaable at : Avalaiaable at :," *J. Pinter*, vol. 3, no. 2, pp. 122–126, 2019.
- [4] Andi Wijaya, L. Handoko "Management Bandwidth dengan Motode HTB ( Hierarchical Token Bucket) Pada Sekolah Menengah Pertama Negeri 5 Semarang" *J. Teknik Informatika.Udinus 1 (1), 5 – 7 , 2015*
- [5] S. Wardoyo, T. Ryadi, and R. Fahrizal, "Analisis Performa File Transport Protocol Pada Perbandingan Metode IPv4 Murni, IPv6 Murni dan Tunneling 6to4 Berbasis Router Mikrotik," *J. Nas. Tek. Elektro*, vol. 3, no. 2, p. 106, 2014, doi: 10.25077/jnte.v3n2.74.2014.
- [6] M. Iqbal, "Perancangan Sistem Optimalisasi Manajemen Bandwidth dengan HTB ( Hierarchical Token Bucket) menggunakan dalam Optimalisasi Bandwidth ada beberapa komponen yang harus diketahui : Manajemen bandwidth Quality of Service," *Jar. Sist. Inf. Robot.*, vol. 1, no.01, pp. 25– 29, 2017.
- [7] J. Sinaga, "Practice Managing Internet Connection Campus Area Network ( Can ) With Firewall and Address Listmikrotik Router Os," *Techno Nusa Mandiri*, vol. 10, no. 1, pp. 132–142, 2013, [Online]. Available: <https://www.neliti.com/id/publications/227335/>
- [8] S. Ahdan, O. Firmanto, and S. Ramadona, "Rancang Bangun dan Analisis QoS (Quality of Service) Menggunakan Metode HTB (Hierarchical Token Bucket) pada RT/RW Net Perumahan Prasanti 2," *J. Teknoinfo*, vol. 12, no. 2, p. 49, 2018, doi: 10.33365/jti.v12i2.89.
- [9] I. Riadi, "Keamanan Jaringan Menggunakan Pemfilteran Aplikasi Berbasis Mikrotik, Optimalisasi," *Jusi*, vol. 1, no. 1, pp. 71–80, 2011.
- [10] D. Mamu, M., Pelleng, F. A., & Kelles, "No Title Implementasi Quality of Service Dengan Metode HTB(hierarchical Token Bucket) Pada PT.Komunika Lima Dua Belas," *JELIKU*, vol. 1, no. August, p. 32, 2012.
- [11] P. Oktivasari and R. Sanjaya, "Implementasi Sistem Load Balancing Dua ISP Menggunakan Mikrotik dengan Metode Per Connection Classifier," *Multinetics*, vol. 1, no. 2, p. 33, 2015, doi: 10.32722/vol1.no2.2015.pp33-37.
- [12] Erick Irawadi Alwi dan Lutfi Budi Ilmawan, "Analisis Kinerja QoS (Quality of Service) Jaringan WLAN Ukhuwahnet Pada Universitas Muslim Indonesia"
- [13] Fatwahadi Ilham Pamungkas,Ramdan Satra,Erick Irawadi Alwi, " Perbandingan Manajemen Bandwidth Menggunakan Metode Per Connection Queue (PCQ) dan Hirarchical Token Bucket (HTB)".