aREKA ELKOMIKA: Jurnal Pengabdian kepada Masyarakat
ISSN(p): 2723-3235 | ISSN(e): 2723-3243 | Vol. 6 | No. 3 | Pages 207 - 216
DOI : 10.26760/rekaelkomika.v6i3.207-216 November 2025

Quality of Service (QoS) Analysis of the Internet Network at Diskominfo Bengkayang Regency

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Received 08 August 2025 **|** Revised 19 November 2025 **|** Accepted 21 November 2025

ABSTRACT

The rapid growth in internet usage in recent years has placed significant demands on network service quality. Technological developments and increasingly complex communication needs have made it important to improve the Quality of Service (QoS) of internet networks at Diskominfo Bengkayang Regency. Optimal Quality of Service is essential to support critical applicationssuch as video conferencing, streaming, and other real-time applications. Obstacles such as high latency, low throughput, and lack of prioritization in traffic management can hinder the user experience and reduce service effectiveness. By optimizing QoS, not only does it ensure that critical services receive the appropriate priority, but it also improves the overall efficiency of network resource usage. The involvement of this prioritization scheme in the network infrastructure provides a holistic solution, combining a deep understanding of latency, throughput, and prioritization needs. All of this is done in an effort to optimize QoS so that users can enjoy a good experience when using internet access.

Keywords*: QoS, Internet, Bandwidth, Network, Topology*

1. INTRODUCTION

The rapid growth in internet usage in recent years has placed significant demands on network service quality. Technological developments and increasingly complex communication needs have made it important to improve the Quality of Service (QoS) of internet networks (**Darmawan et al., 2020)**, (**Ahmadi & Winata, 2021**), (**Lesmana Siahaan et al., 2021**). Optimal Quality of Service is very important to support critical applications such as video conferencing, streaming, and other real-time applications. Internet access speed is currently a focus for internet service providers or providers. QoS is designed to help end servers become more productive by ensuring that users get reliable performance from network applications. With Quality of Service (QoS), bandwidth can be used optimally to improve the quality of internet service received by users. Improvements in QoS cover various aspects that are important for providing a better user experience and support modern applications **(Prayoga et al., 2024**), (**Sari & Nurcahyo, n.d.**). The approach to measuring network latency by considering network topology and more advanced software configuration allows this research to provide deeper insights into network latency performance (**Mikola & Sari, 2022**). This enables more accurate identification of bottlenecks and allows for more effective optimization.

Furthermore, integrated throughput analysis provides an additional dimension to this research. By comprehensively understanding effective capacity and bandwidth availability, this research can detail the factors that influence throughput, paving the way for more specific optimization strategies. Optimal service quality is essential to support critical applications such as video conferencing, streaming, and other real-time applications (**Ahmadi & Winata, 2021**), **(Sari & Nurcahyo, n.d.**), (**Darsono et al., 2020**).

In the ever-evolving digital era, the availability and quality of internet service have a significant impact on productivity and user satisfaction (**Sundara et al., 2022**),. Although efforts have been made to improve service quality, new challenges continue to arise with technological developments technology. With a deeper understanding of the factors influencing service quality, it is hoped that the results of this research can provide valuable insights for network service providers, organizations, and end users. The implementation of an effective prioritization scheme is also expected to enhance the user experience and support applications that require high availability and reliability (**Ahmadi & Winata, 2021**), **(Mikola & Sari, 2022**), (**Sari et al., 2025**). This research is expected to contribute positively to the development of network infrastructure that is more efficient and responsive to the evolving needs of today's digital environment. Obstacles such as high latency, low throughput, and lack of prioritization in traffic management can hinder the user experience and reduce the effectiveness of services (**Rahmatika et al., 2020**), (**Nurul et al., 2024**), **(Pamungkas & Sutanto, 2024**). Therefore, careful research is needed to optimize the QoS of the internet network at the Bengkayang Communication and Information Agency in order to provide a better experience for users.

Based on previous research on Quality of Service, Quality of Service is a set of techniques and mechanisms that guarantee the performance of computer networks (especially on the internet) in providing services to applications within computer networks. Quality of Service is viewed and measured from the perspective of service providers (**Ahmadi & Winata, 2021**). Parameters include: bandwidth, throughput, delay, jitter, and packet loss. This needs analysis and design uses and applies the HTB (Hierarchical Token Bucket) method **(Nurcahyo et al., 2021**). HTB is a queuing technique designed for link sharing. In the concept of connection sharing, if a class requests less service than allocated, the remaining bandwidth is shared with other classes requesting that service. HTB uses TBF (Token Bucket Filter) as an estimator that is very easy to implement. This estimator only uses rate, so administrators only need to set the rate for that class (**Rico & Dkk, 2022**). HTB enables more structured queuing by implementing multi-level grouping. The implementation of HTB in queuing allows for some parameters that do not function as intended. Parameters that do not function include priority and dual restrictions (CIR/MIR). CIR (Committed Information Rate) is the baseline or minimum traffic (Limit-at) that a queue can achieve. Limit-at limits the minimum traffic for a queue, regardless of the conditions under which the queue will not accept traffic below that limit. MIR (Maximum Information Rate) is the upper limit or maximum traffic (max-limit) that a queue can achieve. Max-Limit limits the optimal traffic for a queue, and each queue reaches this limit if the parent queue still has bandwidth reserves (**Bakhtiar Rifai, 2020**).

The objectives of community service activities are QoS produced by the HTB method in managing bandwidth management, thereby improving internet services at Diskominfo Bengkayang Regency. The benefit of scientific development is that network quality using the HTB queuing method is more optimal, as all buildings will receive bandwidth according to the rules applied in bandwidth management. This research focuses on analyzing the quality of internet network services in the current network topology and not on system implementation.

2. METHODS

The stages in the method of carrying out activities as a solution offered to overcome partner problems in Diskominfo, Bengkayang Regency, consist of :

2.1 Research Stages

In this study, the running system observation method was used, while the method used for QoS optimization was the HTB method (**Darmawan et al., 2020**). The research flow is explained in Figure 1 below.

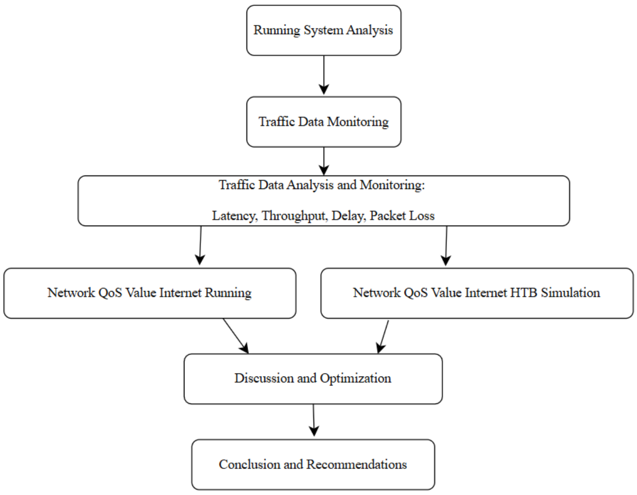

Figure 1. Research Stages

2.2 Running System Analysis

Referring to the stages that researchers conducted with standard QoS measurements in accordance with TIPHON standards. QoS analysis uses the parameters of Delay, Jitter, Packet Loss, and Throughput. QoS helps users to be more capable of obtaining faster performance from network-based applications **(Ahmadi & Winata, 2021**). Table 1 shows the values of Quality of Service according to the network quality standard from TIPHON (Telecommunications and Internet Protocol Harmonization Over Network) (**Prayoga et al., 2024**).

Table 1. Index Quality of Service

Value	**Persentase**	**Index**
3,84-4	95-100%	Very Good
3-3,79	75-94,75%	Good
2-2,99	50-74,75%	Currently
1-1,99	25-49,75%	Badly

2.2.1 Delay

This is the time it takes for data to travel from its source to its destination. Delay can be influenced by distance, physical media, congestion, or long processing times , as explained in Table 2.

Table 2. Delay

Degradation	Significant Delay	Index
Very Good	< 150 m/s	4
Good	150 m/s – 300 m/s	3
Currently	300 m/s – 450 m/s	2
Badly	>450 m/s	1

2.2.2 Jitter

This is a variation or change in the delay time of packet arrival. Jitter is also defined as interference in digital or analog communication caused by signal changes. This is explained in Table 3.

Table 3. Jitter

Degradation	Peak Jitter	Index
Very Good	0 m/s	4
Good	0 m/s – 75 m/s	3
Currently	75 m/s – 125 m/s	2
Badly	125 m/s – 225 m/s	1

2.2.3 Packet Loss

Table 4 shows a parameter that describes a condition indicating the total number of packets that cannot reach their destination, which can be caused by collisions and congestion on the network.

Table 4. Packet Loss

Degradation	Packet Loss	Index
Very Good	0 - 2 %	4
Good	3 - 14 %	3
Currently	12 - 24 %	2
Badly	> 25 %	1

2.2.4 Throughput

Table 5 shows the actual bandwidth measured at a specific time of day using a specific internet route while downloading a file.

Table 5. Throughput

Degradation	Throughput	Index
Very Good	100%	4
Good	75%	3
Currently	50%	2
Badly	25%	1

2.3 Hierarchical Token Bucket

HTB is a bandwidth management method that enables hierarchical bandwidth allocation, so that each node or device in the network receives bandwidth allocation according to its needs. In this topology, HTB can be used on the main switch to ensure that each switch and connected device receives the required bandwidth without any over- or under-allocation **(Nurcahyo et al., 2021**). The HTB structure is described in Figure 2.

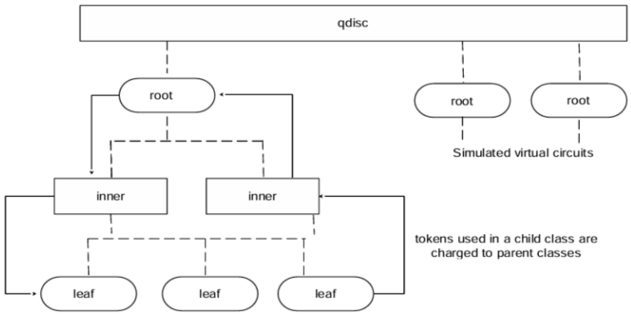

Figure 2. Hierarchical Token Bucket Structure (HTB)

The application of HTB in topology by configuring queues on the main switch and other switches. These queues can be used to set network traffic priorities based on data type or application. For example, VoIP and video conference traffic can be given higher priority than email or web browsing traffic, to ensure good quality of service (QoS). By using HTB, network administrators can monitor bandwidth usage and make adjustments as needed **(Christanto et al., 2021**). This is important for identifying bottlenecks or weak points in the network and optimizing bandwidth allocation to maintain maximum network performance. Overall, the implementation of HTB in this network topology will ensure that each device receives sufficient bandwidth according to its needs. This not only improves overall network performance but also ensures a better user experience by minimizing latency and jitter in time-sensitive applications such as VoIP and video conferencing.

2.4 Per Connection Queue (PCQ)

Peer Connection Queue (PCQ) is a method that can manage bandwidth quite easily where PCQ works with an algorithm that will divide bandwidth evenly among a number of active clients (**Finandi et al., 2023**). PCQ works by implementing a simple queue or queue tree where there is only one active client using bandwidth, while other clients are in idle mode, so that the active client can use the maximum available bandwidth, but if another client becomes active, the maximum bandwidth can be used by both clients (bandwidth or number of active clients) so that bandwidth is distributed fairly to all clients (**Nurcahyo et al., 2021**). The PCQ logic simulation can be seen in Figure 3 below.

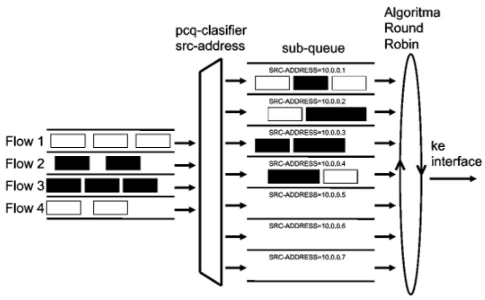

Figure 3. Peer Connection Queue (PCQ) Logic

3. RESULT AND DISCUSSION

3.1 Network Topology

Figure 4 below shows that the Internet is distributed throughout the campus area, which consists of 7 buildings, each with its own router. Traffic data analysis and monitoring can be performed by each building's routerwith bandwidth limitations set by the central router. Therefore, bandwidth utilization management for eachbuilding depends on the optimization of router configuration. Differences in router settings and management can affect network performance and functionality.

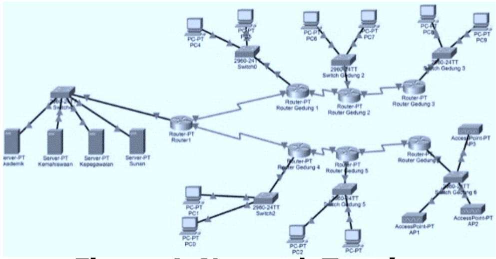

Figure 4. Network Topology

In this study, recommendations are provided for restructuring the topology with the placement of multilayer switches for QoS traffic network priority. QoS enables high priority for important data packets such as VOIP or video streaming compared to general data traffic. This is done by configuring queues and scheduling rules on multilayer switches to divide bandwidth according to the priority needs of each building or bandwidth management in an efficient network topology and minimize congestion.

The Hierarchical Token Bucket (HTB) method is used in the topology (figure 5), where a bandwidth of 700 Mbps is allocated to 7 buildings. The received bandwidth is then distributed from the main router in each building to configure the HTB method in the IP firewall mangle. Next, create connection marks and packet marks for packet filtering processes such as browsing, streaming, downloading, and online gaming. After that, the queue tree is divided based on the packet marks that have been created. This is very useful in environments that require fast and stable access to various server services. The HTB method can dynamically allocate bandwidth according to the network's current needs. The implementation of HTB will help avoid bottlenecks and ensure that each network segment receives the resources needed for optimal performance.

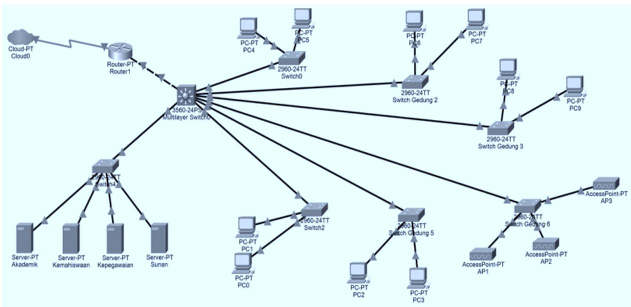

Figure 5. Topology Recommendations

The testing parameters used were QoS measurements, namely Delay, Jitter, Packet Loss, and Throughput. The testing was conducted during peak traffic hours, from 08:00 to 15:00 WIB. The testing data used the TIPHON version of the QoS standard. The following are the results of the QoS parameter testing of the internet network using a simulated topology and using the Hierarchical Token Bucket (HTB) method, where testing was conducted in each building.

Table 6. Average Delay

Testing Location	Delay (m/s)	Index	Result
Building A	90 m/s	4	Very Good
Building B	101 m/s	4	Very Good
Building C	105 m/s	4	Very Good
Building D	98 m/s	4	Very Good

Testing Location	Delay (m/s)	Index	Result
Building E	97 m/s	4	Very Good
Building F	107 m/s	4	Very Good
Building G	120 m/s	4	Very Good

Table 6 shows the average delay results for each building. The average delay (105 ms) across all buildings are exceptional. These results indicate a highly responsive and reliable network, which is critical for real-time applications like video conferencing and online government services.

Table 7. Avarage Throuhput

Testing Location	Throughput	Index	Result
Building A	98 m/s	4	Very Good
Building B	90 m/s	4	Very Good
Building C	94 m/s	4	Very Good
Building D	96 m/s	4	Very Good
Building E	97 m/s	4	Very Good
Building F	89 m/s	4	Very Good
Building G	70 m/s	3	Good

Table 7 shows the average throughput results for each building. While the average throughput is a strong 90.4%, the results for Building G (70%, categorized as "Good") are notably lower than the others. This suggests that the current bandwidth distribution model, while effective overall, may not be fully optimal for Building G. This could be due to its higher user load, distance from the core, or a conservative bandwidth cap set within the HTB rules. This identifies Building G as a point for potential adjustment in future optimization cycles.

Table 8. Avarage Jitter

Testing Location	Jitter (%)	Index	Result
Building A	25 %	3	Good
Building B	40 %	3	Good
Building C	45 %	3	Good
Building D	36 %	3	Good
Building E	47 %	3	Good
Building F	38 %	3	Good
Building G	56 %	3	Good

Table 8 shows the average jitter results for each building. All buildings recorded a "Good" score for jitter, with an average of 33 ms. While this is acceptable, it is the only parameter that did not achieve a "Very Good" rating across the board. Jitter, or the variation in latency, is crucial for voice and video quality. The consistent "Good" rating indicates that while the network is stable, there is still room to refine traffic shaping rules to make it even more consistent, potentially by prioritizing latency-sensitive protocols.

Table 9. Packet Loss

Testing Location	Packet Loss (%)	Index	Result
Building A	0 m/s	4	Very Good
Building B	0 m/s	4	Very Good
Building C	0 m/s	4	Very Good
Building D	0 m/s	4	Very Good
Building E	2 m/s	4	Very Good

Testing Location	Packet Loss (%)	Index	Result
Building F	3 m/s	4	Very Good
Building G	5 m/s	4	Very Good

Table 9 shows the average Packet Loss results for each building. packet loss (0%) across all buildings are exceptional. The zero packet loss in most buildings confirms the network's stability.

3.2 Community Service Outcomes and Sustainability

As concluded from the activity, the benefits of this community service initiative are a more stable internet connection, well-managed bandwidth, minimal lag, and a stable network during peak hours. The feedback from Diskominfo Bengkayang Regency, as shown in Table 10, confirms these outcomes, noting significant improvements in stability for official business, educational streaming, and online services.

Table 10. Feedback from Diskominfo Bengkayang Regency

No	Feedback
1	The internet is more stable for official business, educational streaming does not buffer, and government online services are more responsive.
2	Regular monitoring is necessary to ensure fair bandwidth distribution.

4. CONCLUSIONS

In conclusion, the successful implementation of the Hierarchical Token Bucket (HTB) method, as validated by a strong QoS score of 3.67, demonstrates its efficacy in managing network traffic for the Diskominfo Bengkayang Regency. Therefore, it is recommended that the organization proceed with the adoption of the HTB method. For optimal and sustainable performance, this implementation should be accompanied by a network topology that is specifically designed or adjusted to leverage HTB's bandwidth distribution capabilities, ensuring reliable and high-quality internet service across all buildings.

ACKNOWLEDGEMENT

We would like to convey our gratitude to Diskominfo Bengkayang for giving us the opportunity to be involved in Research and Community Service activities. Our gratitude also goes to the parties who supported this activity, including the Shanti Bhuana Institute of Bengkayang.

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