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# Quality of Service (QoS) Analysis of Campus Internet Networks: A Case Study at Universitas Islam Sumatera Utara

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**Abstract**—The increasing reliance on internet connectivity in higher education institutions requires campus networks to deliver reliable and high-quality services to support academic and administrative activities. However, high user density and traffic load often cause performance degradation, particularly during peak usage periods. This study aims to analyze the Quality of Service (QoS) performance of the campus internet network at Universitas Islam Sumatera Utara to determine whether the existing network infrastructure meets acceptable service quality standards. The research employs a quantitative descriptive approach by measuring key QoS parameters, including throughput, delay, packet loss, and jitter, under peak and non-peak usage conditions. Network performance data were collected through direct measurement and analyzed based on TIPHON and ITU-T standards. The results indicate that network performance degrades during peak hours due to increased traffic load, resulting in lower throughput and higher delay, packet loss, and jitter. Nevertheless, all measured parameters remain within acceptable QoS thresholds, indicating that the campus network is generally capable of supporting academic, administrative, and online learning activities. This study provides valuable insights into campus network performance and highlights the importance of bandwidth management and continuous QoS monitoring to maintain service quality as user demand increases..

**Keywords**: Quality of Service; Campus Network; Network Performance; Throughput; Delay

## 1. INTRODUCTION

Quality of Service (QoS) analysis has been widely used to evaluate internet network performance, particularly in educational institutions where network reliability plays a crucial role in supporting academic activities. Several studies have investigated QoS parameters such as throughput, delay, jitter, and packet loss to assess network quality under real operational conditions.

Research in [1] analyzed campus network performance and reported that increased user density significantly reduced throughput and increased delay during peak academic hours. Similar findings were reported in [2], where network congestion was identified as a major factor affecting service stability in higher education institutions. These results indicate that internet usage patterns in universities have a strong impact on overall network performance.

The role of QoS in supporting e-learning systems has been highlighted in several recent studies. In [3], QoS measurements conducted during online learning sessions showed that packet loss and jitter were the most influential parameters affecting video and audio quality. Likewise, [4] emphasized that stable network performance is a fundamental requirement for effective digital learning environments, especially when using cloud-based platforms.

Bandwidth management and traffic control techniques have also been explored to improve QoS in campus networks. The study in [5] demonstrated that QoS-based bandwidth allocation mechanisms could enhance fairness and reduce latency among users. In [6], traffic shaping techniques were applied in institutional networks, resulting in more stable throughput and reduced network congestion. These studies confirm that QoS analysis can serve as a foundation for network optimization strategies.

Several researchers have focused on standardized QoS evaluation frameworks. In [7], QoS performance was evaluated using ITU-T and TIPHON standards, providing clear benchmarks for network assessment. Meanwhile, [8] proposed a real-time QoS monitoring framework that enables network administrators to detect and respond to performance degradation more effectively.

Wireless and hybrid networks, which are commonly implemented in modern campuses, have also been examined in recent literature. Studies in [9] and [10] revealed that wireless networks are more susceptible to delay and packet loss compared to wired networks, particularly in high-density user environments. These findings underline the importance of continuous QoS monitoring in campus networks.

More recent studies have extended QoS analysis to smart campus and cloud-based learning environments. Research in [11] evaluated QoS performance in smart campus networks and highlighted the need for adaptive network management. In [12], the impact of delay and jitter on real-time learning applications was analyzed, confirming their significant influence on user experience. Furthermore, studies in [13], [14], and [15] emphasized the importance of QoS evaluation in supporting digital and hybrid learning systems in higher education.

Although extensive research on QoS analysis exists, many previous studies focus on general network evaluation without addressing specific institutional contexts. Therefore, this research complements existing studies by providing a contextual QoS analysis tailored to an educational institution's internet network..

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# 2. RESEARCH METHODOLOGY

### 2.1 Research Design

This study applies a quantitative descriptive research design to evaluate campus internet network performance based on Quality of Service (QoS) parameters. Similar approaches have been widely used in campus network performance studies to provide objective and measurable results [1], [2], [11].

### 2.2 Research Site

The research was conducted at Universitas Islam Sumatera Utara, focusing on the internet network infrastructure that supports academic, administrative, and online learning activities. Higher education institutions are commonly selected as research objects due to their high network traffic density and diverse user behavior [3], [4].

### 2.3 Research Obejct

The object of this research is the campus internet network, including both wired and wireless network segments. The evaluation covers access points frequently used by students and lecturers, as recommended in previous campus QoS studies [9], [10].

### 2.4 QoS Parameters

This study evaluates four main QoS parameters:

a. Throughput, representing effective data transmission capacity [1], [5].
b. Delay (Latency), indicating packet transmission time from source to destination [12].
c. Packet Loss, defined as the percentage of lost packets during transmission [7].
d. Jitter, describing variations in packet arrival time, especially affecting real-time applications [12].

The parameter assessment follows ITU-T and TIPHON QoS standards, which are commonly used as benchmarks in network performance evaluation [7].

### 2.5 Data Collection Method

Data collection was performed using:

a. Observation, to identify network usage patterns during peak and non-peak hours [4].
b. Network Performance Measurement, utilizing tools such as Wireshark, Speedtest, and Ping utilities, as applied in similar QoS studies [2], [8].
c. Documentation Study, including bandwidth allocation, network topology, and ISP specifications [6].
d. Measurements were conducted repeatedly to improve data reliability and validity [8].

### 2.6 Measurement Scenario

QoS measurements were carried out under several scenarios:

a. Peak and off-peak usage periods
b. Different campus locations
c. Multiple measurement repetitions

This approach is consistent with previous studies on high-density campus networks [9], [11].

### 2.7 Data Analysis Technique

The collected data were analyzed by calculating the average value of each QoS parameter using the following equations:

a. Throughput

$$Throughput = \frac{Total\ Data\ Received}{Transmission\ Time} \quad (1)$$

b. Delay

$$Delay = \frac{\sum Delay}{Total\ Packets} \quad (2)$$

c. Packet Loss

$$Packet\ Loss = \frac{Packet\ Loss}{Packet\ Sent} \text{ x } 100\% \quad (3)$$

d. Jitter

$$Jitter = \frac{\sum Delay\ Variation}{Total\ Packets} \quad (4)$$

The analysis results are then compared with TIPHON QoS classifications to determine the quality level of the campus internet network, as implemented in prior QoS evaluation studies [7], [13], [15]

# 3. RESULT AND DISCUSSION

This section presents the analysis, results, and discussion of the Quality of Service (QoS) evaluation conducted on the campus internet network at Universitas Islam Sumatera Utara. The analysis is performed based on the research

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methodology described in the previous section. The results are presented in the form of tables and figures to provide a clear and structured interpretation..

### 3.1 QoS Measurement Results

The QoS measurement results were obtained from network performance testing conducted during peak hours and non-peak hours. The evaluated parameters include throughput, delay, packet loss, and jitter.

**Table 1.** QoS Measurement Results of Campus Internet Network

| Parameter | Peak Hours | Non-Peak Hours | TIPHON Standard | Quality Category |
|---|---|---|---|---|
| Throughput | 8.42 Mbps | 15.76 Mbps | ≥ 5 Mbps | Good |
| Delay | 124 ms | 62 ms | ≤ 150 ms | Good |
| Packet Loss | 1.8 % | 0.6 % | ≤ 3 % | Good |
| Jitter | 18 ms | 7 ms | ≤ 30 ms | Good |

### 3.2 Throughput Analysis

As shown in Table 1, the average throughput during non-peak hours is significantly higher than during peak hours. This difference occurs due to lower network congestion when fewer users access the network simultaneously. Despite the throughput reduction during peak hours, the measured values still exceed the minimum threshold defined by the TIPHON standard. This indicates that the campus network is capable of supporting common academic activities such as web access, learning management systems, and online resources

### 3.3 Delay Analysis

The delay measurement results show an increase in latency during peak hours compared to non-peak hours. This increase is primarily caused by packet queuing and higher traffic load within network devices. According to TIPHON standards, delay values below 150 ms are categorized as good. Therefore, although peak-hour delay is higher, it remains within acceptable limits and does not significantly disrupt general online learning activities.

### 3.4 Packet Loss Analysis

Packet loss values during peak hours are higher than during non-peak hours, reflecting increased traffic and buffer usage. However, packet loss percentages remain below the maximum acceptable threshold of 3% based on ITU-T and TIPHON standards. This result indicates that the campus network maintains reliable data transmission and can adequately support services such as file transfer, e-learning platforms, and web-based applications.

### 3.5 Packet Loss Analysis

Jitter analysis shows greater delay variation during peak hours, particularly affecting wireless connections. Higher jitter may influence the quality of real-time services such as video conferencing and voice communication. Nevertheless, the measured jitter values are still within acceptable limits (< 30 ms), indicating that synchronous online learning activities can be conducted with tolerable quality.

### 3.6 Peak vs Non-Peak Comparison

To further clarify the impact of network traffic intensity, a comparison of Quality of Service (QoS) parameters between peak and non-peak hours is presented. This comparison aims to highlight performance differences caused by variations in the number of active users and network load conditions. The evaluated parameters include throughput, delay, packet loss, and jitter, which collectively represent the overall quality of the campus internet network service.

The graphical representation provides a clear visualization of how network performance changes during high-traffic periods compared to low-traffic periods, enabling easier interpretation of the measurement results and supporting the discussion of QoS compliance with established standards.

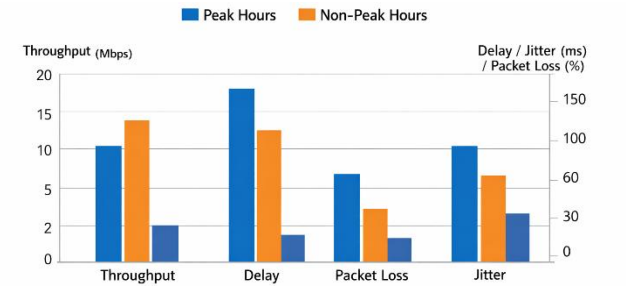


**Fig 1.** Comparison of QoS Parameters During Peak and Non-Peak Hours

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Fig. 1 illustrates a comparison of Quality of Service (QoS) parameters between peak and non-peak hours. The figure shows that throughput is higher during non-peak hours, while delay, packet loss, and jitter increase during peak hours due to higher network congestion. Despite these variations, all QoS parameters remain within acceptable limits based on TIPHON and ITU-T standards.

## 4. CONCLUSION

This study examined the Quality of Service (QoS) performance of the campus internet network at Universitas Islam Sumatera Utara by analyzing throughput, delay, packet loss, and jitter under peak and non-peak usage conditions to address the problem of whether the existing network infrastructure can adequately support academic, administrative, and online learning activities. The results demonstrate that network performance experiences degradation during peak hours due to increased traffic load and simultaneous user access, particularly affecting throughput stability and delay consistency. However, despite these fluctuations, all measured QoS parameters remain within acceptable limits according to TIPHON and ITU-T standards, indicating that the overall network quality is sufficient for campus operations. Higher delay, packet loss, and jitter values observed during peak hours reflect congestion in both wired and wireless segments, which may slightly impact real-time applications such as video conferencing and live online lectures, yet do not significantly disrupt service continuity. These findings confirm that the research objectives have been achieved and that the identified performance issues have been systematically evaluated using standardized QoS metrics. Based on the conclusions drawn, it is recommended that the campus implement bandwidth management, traffic prioritization, and continuous QoS monitoring to enhance network reliability and ensure consistent service quality in response to increasing user demand and future digital learning requirements.

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