



Implementation of Simple Queue and Content Filtering for Bandwidth Management on WLAN and LAN Networks

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Abstract

SMK Negeri 1 Sungai Raya is a vocational high school located on Sultan Agung Street, Kuala Dua, Sungai Raya District, Kubu Raya Regency, West Kalimantan, which offers programs such as Visual Communication Design (DKV) and Broadcasting that utilize the internet to support learning activities including completing assignments, accessing educational resources, and submitting schoolwork; however, problems frequently occur in the laboratory network such as buffering, network downtime, and bandwidth congestion due to simultaneous usage, therefore bandwidth management using the simple queue method was implemented along with content filtering to block access to social media and online gaming websites in order to prevent disruptions to the learning process, and the results showed improvements in network performance where on the LAN network throughput decreased by 0.5735%, packet loss decreased by 0.0969%, delay decreased by 0.5942%, and jitter decreased by 0.9182%, indicating better stability and efficiency, while the WLAN network in the laboratory was also successfully installed, providing improved connectivity and supporting a more effective and focused learning environment.

Keywords: Management bandwidth, Simple Queue, Filtering Content, LAN

1. Introduction

In the current digital era, the internet has become one of the most widely used media, not only as a communication tool but also as a major support for learning activities in educational environments, where its implementation continues to grow significantly, thus requiring an optimal, stable, and efficient network to prevent disruptions during the teaching and learning process; therefore, proper bandwidth management is essential, as bandwidth represents the amount of data capacity available in a telecommunications network measured in bits per second and is provided by Internet Service Providers (ISP) according to user subscriptions [1].

SMK Negeri 1 Sungai Raya, a vocational high school, utilizes internet networks to support learning, particularly in the Visual Communication Design (DKV) and Broadcasting departments, with approximately 90 students using the laboratory alternately across grades 10, 11, and 12, each consisting of around 15 students per session; although the school has implemented a Local Area Network (LAN) with an internet capacity of 100 Mbps, several issues still occur such as buffering, network downtime, unstable connections, and bandwidth contention among users, which indicates the need for effective bandwidth management. One method used is Simple Queue, a technique that applies the FIFO (First In First Out) concept to regulate bandwidth allocation sequentially so that each user receives a fair share of network resources [2], while Content Filtering is implemented to restrict or block access to certain websites, such as social media and online games, in order to maintain network performance and ensure that internet usage remains focused on educational purposes [3].

This study is supported by previous research entitled "Implementation of Bandwidth Management Using Simple Queue and Content Filtering at the East Jakarta Industrial Development Training Center," which explains that the application of these methods allows each user to have controlled bandwidth allocation while also creating a filtering system that prevents access to inappropriate websites [4]. In this research, both WLAN and LAN networks are configured with bandwidth limits using Simple Queue and access restrictions using Content Filtering, and their performance is evaluated using Quality of Service (QoS) parameters including Throughput, Packet Loss, Delay, and Jitter, with the results showing improved network stability, efficiency, and overall internet performance in the computer laboratory of SMK Negeri 1 Sungai Raya, thereby supporting a more effective and uninterrupted learning environment.

2. Theoretical Basis

2.1. Previous Research

Previous research refers to studies conducted by other researchers and published as scientific papers, serving as references to avoid similarities with current research. Several related studies are used in this literature review. The first study at SMK Darul Mu'in Pakuhaji showed that the absence of bandwidth management caused unstable internet access, which was improved using Simple Queue and Content Filtering with limits of 68 kbps upload and 256 kbps download [5]. The second study at the East Jakarta Industrial Development Training Center (PPKPI) applied Simple Queue and Content Filtering to achieve stable and secure internet usage, with limits of 256 kbps upload and 2 Mbps download [6]. The third study at SMP Negeri 1 Waingapu improved unstable connections using Simple Queue with 3 Mbps limits for both upload and download [7]. The fourth study in Dusun Krajan, Jember, addressed network congestion using Simple Queue with 5 Mbps for admin and 3 Mbps for clients [8]. The fifth study at SMK Negeri 5 Bandar Lampung analyzed WLAN performance using QoS parameters such as throughput, packet loss, delay, and jitter based on TIPHON standards [9]. Based on these studies, the implementation of Simple Queue and Content Filtering for bandwidth management on WLAN and LAN with QoS testing at SMK Negeri 1 Sungai Raya has not been conducted, and this research is expected to improve network performance and support learning activities.

2.2. Computer Network

A computer network is a telecommunications infrastructure that connects computers to enable communication and data exchange between them. The purpose of a computer network is to ensure that each component has equal capability in requesting and providing services from the server to the client [10].

2.3. Bandwidth Management

Bandwidth management is a technique used in wireless networks to distribute internet speed effectively among users, aiming to optimize network performance, ensure fair usage, and satisfy user needs; it ensures that available bandwidth can handle data traffic, information flow, and competition between applications, making it essential in modern multi-service networks where multiple applications share the same link and must meet user demands efficiently [12].

2.4. Simple Queue Method

Simple Queue is a method used in MikroTik routers to manage bandwidth by organizing traffic into queues based on the FIFO (First In First Out) principle, where data is processed in the order it arrives; it applies simple rate-based limiting to control upload and download bandwidth for each user, making it suitable for small to medium-scale networks. As a feature of MikroTik RouterOS, Simple Queue helps limit bandwidth, prioritize traffic, and control network resource usage. It operates at the Transport Layer (Layer 4) of the OSI model, which is responsible for managing data transmission, including packet handling and retransmission of lost or damaged data [13].

2.5. Content Filtering Method

Content Filtering is a method used to block access to unwanted content such as websites, and it is a feature available in MikroTik with various techniques including static DNS, web proxy, Layer 7 firewall, route policy, and IP blocking [14]. It operates at the Application Layer (Layer 7) of the OSI model, which manages data exchange and provides an interface for user applications and network services.

2.6. Wireless Local Area Network (WLAN)

Wireless Local Area Network (WLAN) is a network technology that does not use cables, commonly referred to as wireless, meaning without cables (wireless). WLAN is a radio data communication system that can connect two or more computers to a Local Area Network (LAN) or vice versa. WLAN is more efficient than LAN because it does not require extensive cable space, enabling resource sharing without the use of network cables [15].

2.7. Local Area Network (LAN)

Local Area Network (LAN) is a network consisting of one or more computers and other devices within a small area that enables them to connect and communicate. Multiple LANs can be connected using devices such as hubs or switches, forming larger networks made up of several LAN segments [16].

2.8. Quality of Service (QoS)

Quality of Service (QoS) refers to network quality used to measure and ensure optimal network performance, minimizing packet loss and delay in data delivery. QoS follows the TIPHON (Telecommunication and Internet Protocol Harmonization Over Networks) standard, which classifies performance into four levels: best (optimal), high, medium, and best effort. The following are four QoS parameters based on the TIPHON network quality standard [17].

a. Throughput

Throughput is the total data sent from sender to receiver, measured as the average for each site access. It can be calculated using the following equation

Table 1: Throughput Quality Parameters

Kategori <i>Throughput</i>	<i>Throughput (Kbps)</i>	Indeks
Sangat Bagus	>1200	4
Bagus	700-1200	3
Sedang	388-700	2
Buruk	<388	1

b. Packet Loss

Packet Loss is a parameter that indicates the number of lost packets, usually caused by collisions or network congestion. It occurs when one or more data packets fail to reach their destination.

Table 2: Packet Loss Quality Parameters

Kategori <i>Packet Loss</i>	<i>Packet Loss (%)</i>	Indeks
Sangat Bagus	0	4
Bagus	3	3
Sedang	15	2
Buruk	<25	1

c. Delay

Delay is the time required for data to travel from source to destination. It is affected by distance, physical media, and processing time, and influences network management decisions

Table 3: Delay Quality Parameters

Kategori <i>Delay</i>	<i>Delay (ms)</i>	Indeks
Sangat Bagus	<150	4
Bagus	150-300ms	3
Sedang	300-450ms	2
Buruk	>450ms	1

d. Jitter

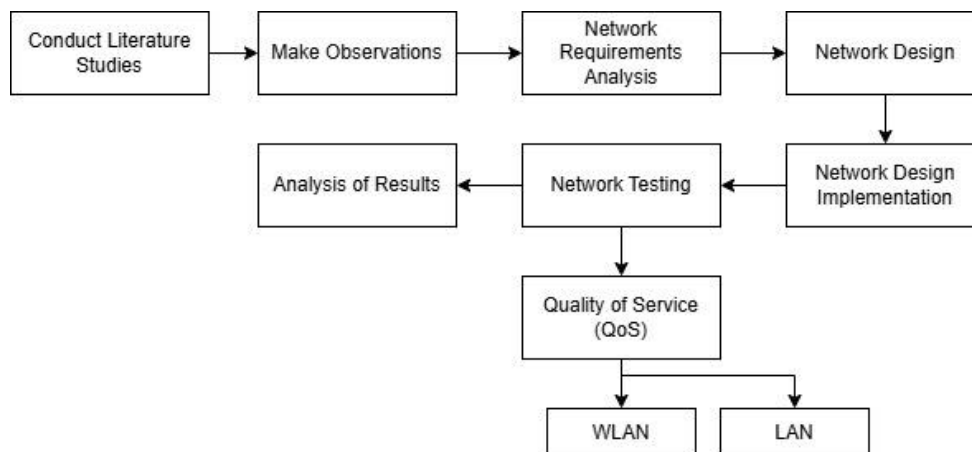
Jitter is the variation in packet arrival time, usually caused by long queues and delays in packet reassembly at the destination

Table 4: Jitter Quality Parameters

Kategori <i>Jitter</i>	<i>Peak Jitter (ms)</i>	Indeks
Sangat Bagus	0	4
Bagus	0-75	3
Sedang	75-125	2
Buruk	125-225	1

3. Research Methods

The research method is presented in a flowchart Figure 1 below to ensure a systematic process and achieve the expected results.

**Fig. 1:** Research Flow Chart

3.1. Network Design Implementation

At the implementation stage, MikroTik is configured via Winbox to connect to the internet, manage bandwidth using the Simple Queue

method, and control website access through Firewall with Content Filtering.

3.2. Network Testing

Network testing is conducted using QoS with Wireshark by applying bandwidth limits via Simple Queue and website access control through Content Filtering on WLAN and LAN, then evaluating throughput, packet loss, delay, and jitter based on TIPHON standards to determine overall network performance.

3.3. Network Performance Results Analysis

The analysis uses Wireshark data evaluated with QoS based on TIPHON standards (throughput, packet loss, delay, and jitter) to conclude that the bandwidth management is effective and meets expectations for SMK Negeri 1 Sungai Raya.

4. System Analysis and Design

4.1. System/Network Analysis

System/Network analysis is conducted to identify the requirements of the network during the research process. This section describes the implementation of the Simple Queue and Content Filtering methods for bandwidth management in WLAN and LAN networks. The network aims to optimize internet usage and will be evaluated using Quality of Service (QoS) to achieve effective and satisfactory performance in the WLAN and LAN of the SMK Negeri 1 Sungai Raya laboratory.

4.2. System/Network Implementation Design Process

The implementation phase uses hardware with Simple Queue and Content Filtering methods on a MikroTik router to manage bandwidth in the WLAN and LAN of the SMK Negeri 1 Sungai Raya laboratory aiming to prevent buffering, network downtime, and bandwidth contention by designing a new topology, configuring internet access, applying Simple Queue and Filtering Content, and evaluating performance using Quality of Service (QoS) parameters: throughput, packet loss, delay, and jitter.

4.3. Data Analysis Design

Bandwidth limits were set using Simple Queue and website access was restricted through Content Filtering on both WLAN (laptops and smartphones) and LAN (14 PCs), then analyzed with Wireshark and tested using QoS (throughput, packet loss, delay, and jitter) to evaluate overall network performance.

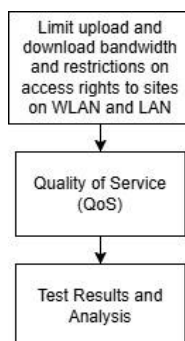


Fig. 2: Network Testing Stage with Quality of Service

4.4. Research Preparation

The study analyzes network issues by implementing Simple Queue and Content Filtering for bandwidth management—allocating bandwidth based on active devices and restricting website access—followed by Quality of Service (QoS) evaluation to compare performance before and after implementation in the WLAN and LAN of the SMK Negeri 1 Sungai Raya laboratory, conducted on January 7 (12:00–16:30) during peak and off-peak hours using devices such as a MikroTik router, manageable switch, and access point, with results presented in the next section.

5. Results and Discussion

5.1. First WLAN Network Performance Test Results

Network performance testing was conducted using Wireshark on a WLAN (Wi-Fi) network in the SMK Negeri 1 Sungai laboratory, which had been configured with Simple Queue and Content Filtering and connected to a PC. The testing applied the Quality of Service (QoS) method based on the TIPHON standard, using four parameters: throughput, packet loss, delay, and jitter. The first test was performed by streaming a video on YouTube, and the results are as follows:

- a. Throughput

The WLAN throughput measured during YouTube video streaming at SMK Negeri 1 Sungai Raya laboratory was 6187 kbps, which is classified as very good based on QoS throughput standards.

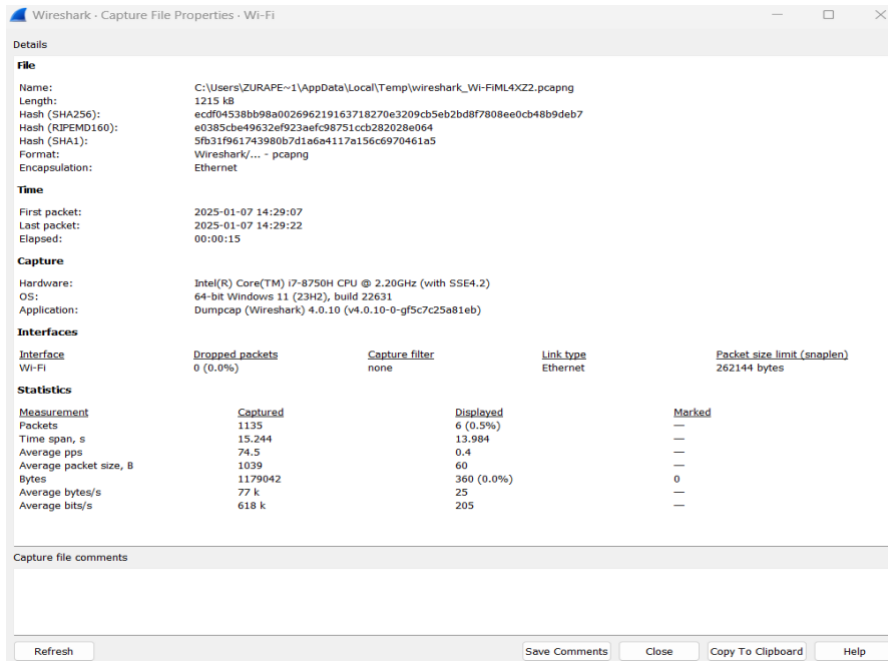


Fig. 3: Data Details WLAN throughput on first test

b. PacketLoss

The WLAN packet loss measured during YouTube video streaming at SMK Negeri 1 Sungai Raya laboratory was 0.528%, which is classified as very good based on QoS packet loss standards.

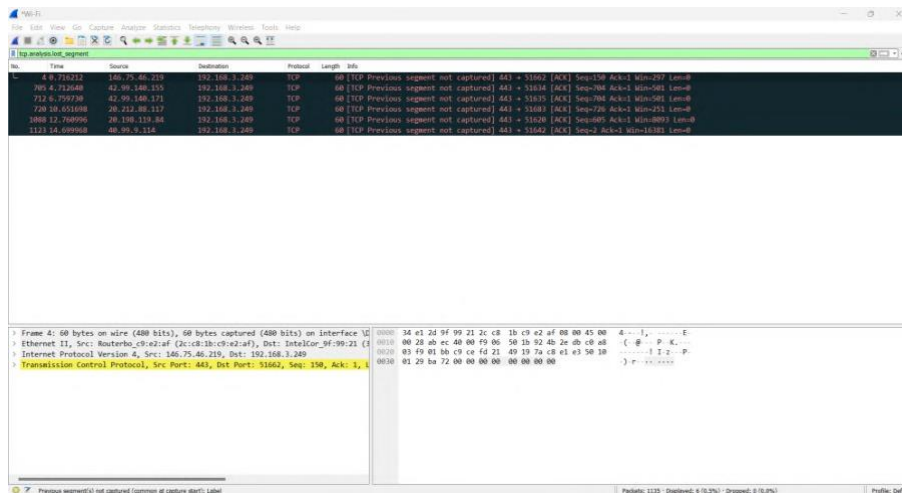


Fig. 4: Data Details WLAN packet loss on first test

c. Delay

The delay measured during YouTube video streaming at SMK Negeri 1 Sungai Raya laboratory was 0.1344 ms, which is classified as very good based on QoS delay standards.

1119	14,548171	14,556709	14,548171	0,008538
1120	14,556709	14,579608	14,556709	0,022899
1121	14,579608	14,675553	14,579608	0,095945
1122	14,675553	14,699968	14,675553	0,024415
1123	14,699968	14,947161	14,699968	0,247193
1124	14,947161	14,947161	14,947161	0
1125	14,947161	14,947245	14,947161	8,4E-05
1126	14,947245	14,974248	14,947245	0,027003
1127	14,974248	15,02852	14,974248	0,054272
1128	15,02852	15,070502	15,02852	0,041982
1129	15,070502	15,09196	15,070502	0,021458
1130	15,09196	15,09196	15,09196	0
1131	15,09196	15,096171	15,09196	0,004211
1132	15,096171	15,111868	15,096171	0,015697
1133	15,111868	15,243551	15,111868	0,131683
1134	15,243551	15,243551	15,243551	
1135	15,243551			
Total Delay				15,243551
Rata-rata Delay				0,013442285

Fig. 5: Data Details WLAN Delay on first test

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