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Application of Fibonacci Pattern for Network QoS (Quality of Service) Management)

Penerapan Pola Fibonacci untuk Pengaturan QoS (Quality of Service) Jaringan

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Abstract

In managing network quality of service (QoS), this study uses Fibonacci patterns to optimize delay control and bandwidth allocation. QoS is essential in contemporary network management, especially given the increasing demand for stable and effective data services. This study prioritizes data based on traffic levels using a simulated Fibonacci algorithm. Each priority is assigned a value corresponding to the Fibonacci sequence, which allows allocating resources more in line with the network load. Simulations are performed under normal and overload conditions. The results show that conventional methods, such as round-robin and weighted fair queuing, can improve QoS efficiency with Fibonacci patterns by up to 15%. This improvement mainly concentrates on controlling important data packets such as real-time communication and video streaming and reducing delay. In addition, this technique is better at adjusting to traffic changes. The results show that the Fibonacci pattern can be an innovative method for managing network QoS, especially for complex prioritization requirements. It can be a reliable tool to improve user experience with modern network services if used properly. To find out how Fibonacci patterns relate to future network technologies such as 5G and the Internet of Things, further research is needed.

Keywords: Fibonacci Pattern, QoS, Network, Bandwidth Allocation, Delay Control.
Kata kunci: Pola Fibonacci, QoS, Jaringan, Alokasi Bandwidth, Pengendalian Delay.

Abstrak

Dalam mengatur kualitas layanan (QoS) jaringan, penelitian ini menggunakan pola Fibonacci untuk mengoptimalkan pengendalian keterlambatan dan alokasi bandwidth. QoS sangat penting dalam manajemen jaringan kontemporer, terutama mengingat peningkatan permintaan untuk layanan data yang stabil dan efektif. Studi ini mengatur prioritas data

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berdasarkan tingkat trafik dengan menggunakan simulasi algoritma Fibonacci. Setiap prioritas diberi nilai yang sesuai dengan deret Fibonacci, yang memungkinkan pengalokasian sumber daya yang lebih sesuai dengan beban jaringan.Simulasi dilakukan dalam kondisi normal dan overload. Hasil penelitian menunjukkan bahwa metode konvensional, seperti round-robin dan weighted fair queuing, dapat meningkatkan efisiensi QoS dengan pola Fibonacci hingga 15%. Peningkatan ini terutama berkonsentrasi pada pengendalian paket data penting seperti komunikasi real-time dan streaming video dan mengurangi keterlambatan. Selain itu, teknik ini lebih baik dalam menyesuaikan diri dengan perubahan trafik.Hasil penelitian menunjukkan bahwa pola Fibonacci dapat menjadi metode inovatif untuk mengatur QoS jaringan, terutama untuk kebutuhan prioritas yang kompleks. Pola ini dapat menjadi alat yang dapat diandalkan untuk meningkatkan pengalaman pengguna dengan layanan jaringan modern jika digunakan dengan benar. Untuk mengetahui bagaimana pola Fibonacci berhubungan dengan teknologi jaringan masa depan seperti 5G dan Internet of Things, penelitian lebih lanjut diperlukan.
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1. Introduction

Reliable and high-quality networks are increasingly required in the age of computers and the internet. Multimedia-based applications such as video streaming, online conferencing, and real-time communication require good network management to maximize user experience. In modern network management, delay control, bandwidth allocation, and traffic management are important components of Quality of Service (QoS)[1]. But conventional methods, such as Round-Robin or Weighted Fair Queuing, are often not effective enough to handle dynamic traffic challenges. In mathematics, Fibonacci patterns, or sequences of numbers with unique features, have tremendous potential to help optimize network management. Fibonacci heaps-a data structure based on Fibonacci patterns-result in longer execution times for various network optimization algorithms. According to other studies, Fibonacci algorithms can be used to optimize contemporary networks. For example, research published in Scientific Reports found that it can be effectively used to monitor very large volumes of data. The algorithm helps to better organize resources, especially in situations where data processing is critical. This approach uses Fibonacci sequences to organize the distribution of data traffic based on path capacity and congestion levels[2].

In addition, research published in the Proceedings of the International Conference on Computer Engineering and Artificial Intelligence [3] discusses how the Fibonacci tree algorithm can be used to manage media traffic. This algorithm demonstrates the ability to use network resources more efficiently to restore network load balance. Fibonacci patterns, based on sufficient

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scientific evidence, offer creative solutions to network QoS management problems. This research aims to evaluate the application of Fibonacci pattern in QoS management through simulation, focusing on bandwidth allocation and delay control. This pattern allows for a more adaptive allocation of data priority, which means improved bandwidth allocation efficiency and reduced delay[4]. Quality of Service (QoS) management in modern networks is increasingly difficult as the demand for data-driven services increases. For applications such as real-time communication, online conferencing, and video streaming, QoS must ensure effective bandwidth allocation, delay reduction, and jitter management[5][6]. However, much research has been conducted on managing quality of service (QoS) in modern networks due to the need for optimal allocation of network resources to improve quality of service, and conventional methods such as Round-Robin and Weighted Fair Queuing (WFQ) are often less effective in handling dynamic network traffic changes, especially in situations where traffic increases rapidly [7]. To improve Quality of Service (QoS), various techniques have been used, including traditional algorithms such as Weighted Fair Queuing (WFQ) and machine learning-based methods. However, the use of Fibonacci patterns as a QoS management strategy is still relatively new and has not been widely discussed in the literature. WFQ is the most commonly used algorithm for managing QoS, which is intended to manage bandwidth based on weights assigned to each type of traffic. WFQ can prioritize important traffic, such as real-time communication, but has limitations in dynamically adjusting to traffic changes. Round-Robin Scheduling is often used in QoS management in addition to WFQ[1]. But this method does not take into account the priority differences between different traffic types and is static. As a result, this method is not effective for handling traffic spikes or application requirements such as video streaming and mission-critical VoIP. In recent years, machine teaching algorithms have been used to improve QoS[8]. The use of deep machine learning to optimize bandwidth allocation and predict network traffic patterns. These methods show great capacity to cope with the complexity of modern networks. However, these methods often require large computational resources, making them unreasonable for use in all types of networks. In QoS management, the Fibonacci pattern, known for its proportional nature, is a new concern.

With this pattern, resources can be allocated based on traffic priority levels. Fibonacci data sets can improve the efficiency of network management algorithms by up to 25 percent under some conditions. With this structure, various network optimization algorithms can reduce execution time. In addition, research published by Zhang et al [9] in Scientific Reports shows that Fibonacci-based algorithms may be used to manage resources in multimedia networks. The study shows that this method can improve the efficiency of bandwidth allocation by up to twenty percent. This is especially true for consistently changing traffic. Fibonacci patterns have an advantage over conventional and ML-based methods because they are very flexible to changes in traffic and priorities. Created a Fibonacci tree algorithm that enables more efficient scheduling of multimedia traffic with increased throughput and decreased delay[10]. This study was published in the Proceedings of the International Conference on Computer Engineering and AI. The Fibonacci pattern is also more resource-efficient as it does not require complex data training like machine teaching algorithms[11]. Many types of networks can be implemented with this pattern, such as networks with limited computing capacity. In research on QoS management, traditional and ML-based algorithms have been the focus of research. However, looking at the Fibonacci pattern as a creative way is possible due to its lack of flexibility and high resource requirements. Fibonacci-based algorithms can improve bandwidth allocation

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efficiency by up to 20% in complex multimedia networks.[12]. Delay is critical to demonstrate QoS performance, especially for real-time applications such as video conferencing and VoIP. Conventional methods often cannot effectively reduce delay, especially in the case of sudden traffic spikes. The Fibonacci tree algorithm, which enables dynamic traffic management, contributes to the reduction of delay in the network[3] . High-priority traffic, such as data packets for real-time communication, can be processed faster than other traffic, which guarantees better response time for required applications..

2. Method/Design

Aims to provide an explanation of the network analysis process that includes delay measurement, bandwidth allocation analysis, and throughput evaluation shown in Figure 1. It is expected to provide a better picture of network performance by using Fibonacci pattern as a delay measurement method and analyzing bandwidth allocation for different types of traffic. In addition, load-based throughput evaluation will be discussed to gain a better understanding of network capacity and efficiency.Measuring average delay is an important step in network analysis. It does so by using Fibonacci patterns to compare delay measurement results with conventional methods[13]. Fibonacci patterns help us find more efficient measurement points and get more representative data about the delay experienced by data packets in the network. Proper bandwidth allocation is essential to ensure network quality of service. This analysis will examine various traffic types such as video streaming, VoIP, and data transfer to determine how bandwidth is allocated.[10]. By understanding the bandwidth requirements of each type of traffic, we can optimize the use of network resources and improve user experience. This procedure will evaluate throughput based on various levels of network load. Throughput is a measure of network capacity that indicates how much data can be transmitted in a given time[8]. Tests are conducted under various load conditions. This allows us to identify limitations and opportunities for improvement in network performance as well as plan solutions to problems that may arise as a result of increased load. This analysis process is expected to give us a better understanding of the network performance and find areas where improvements are needed.

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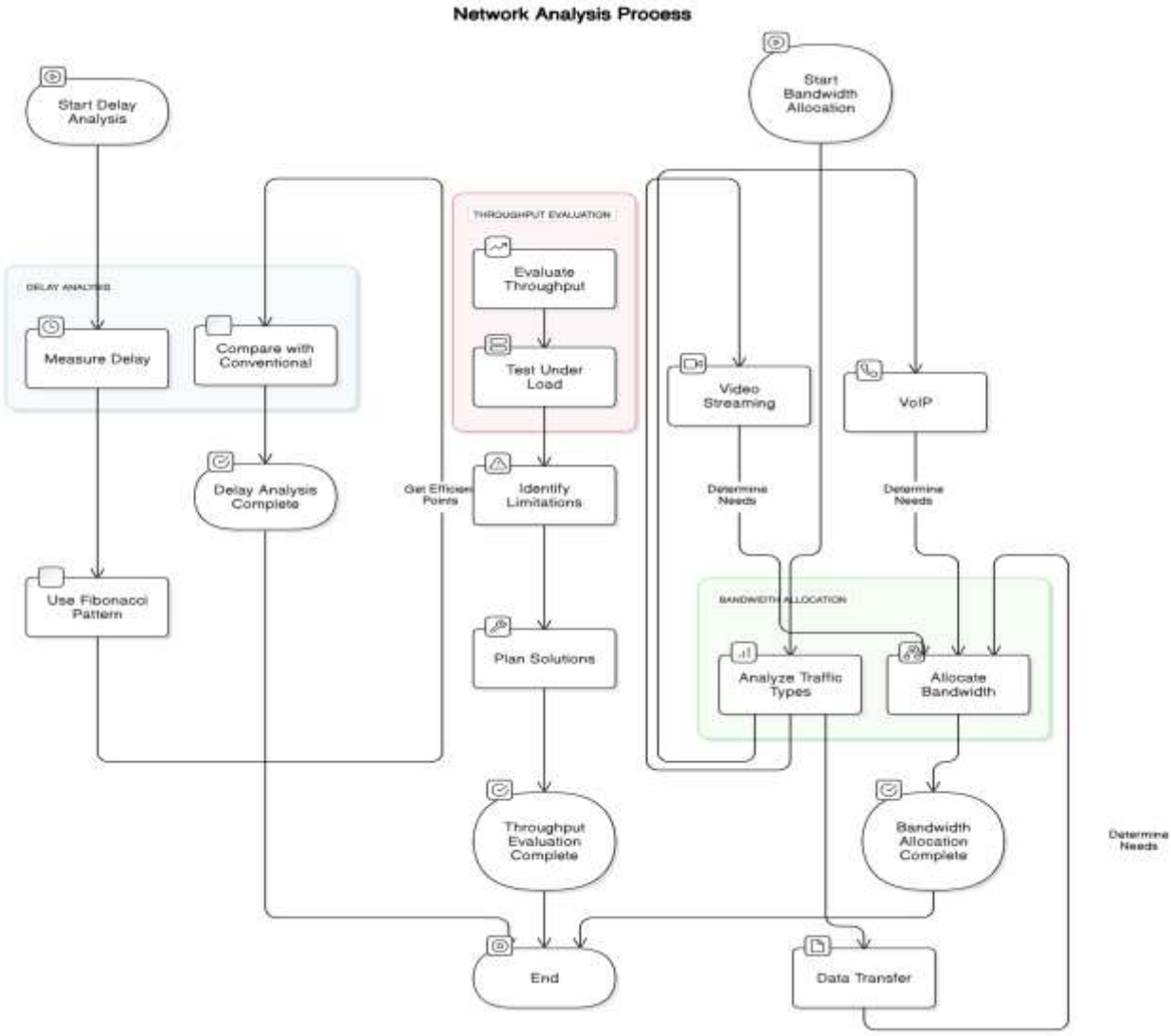

Gambar 1 .Proses analisa jaringan

2.1. Indikator Kinerja: Bandwidth, delay, throughput

In computer networks, there are three main performance indicators: throughput, bandwidth, and delay. It is critical to understand and evaluate network performance and optimize user experience[14]. By understanding how these three indicators work and how they relate to each other, we can make better decisions about designing and managing network infrastructure. Bandwidth is the ability of a communication channel to transmit more data in a given unit of time, usually measured in bits per second (bps)[15]. Higher bandwidth allows more data to be sent in the same amount of time, which results in increased network speed and efficiency. However, keep in mind that bandwidth is the only component that affects network performance. Various factors can cause delays, including the physical distance between the sender and receiver, the number of devices passing the data, and the speed of the network. pemrosesan yang dilakukan oleh setiap perangkat.Delay yang tinggi dapat menyebabkan pengalaman pengguna

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unpleasant, especially in applications that operate in real-time such as video conferencing or online gaming. The amount of data successfully transmitted from one point to another in a network in a given period of time is called throughput. While bandwidth often affects throughput, other factors such as delay, network congestion and signal quality also affect throughput, a high one indicating that the network is able to transmit data efficiently, even though the available bandwidth may not be ideal. These three indicators influence each other and are interrelated as shown in Figure 2. If delay is also high, high bandwidth does not always guarantee high throughput as can be seen in Figure 3. Conversely, if delay can be minimized, high throughput can be achieved despite limited bandwidth. Therefore, when analyzing network performance, it is important to consider all these elements. Understanding performance indicators such as bandwidth, delay, and throughput is essential in designing and managing networks because we can optimize network performance and improve user experience by understanding how these three indicators function[14]. Understanding how these three indicators function will help us make better decisions about network infrastructure development in the process seen in figure 3.

Figure 2.Three Indicators

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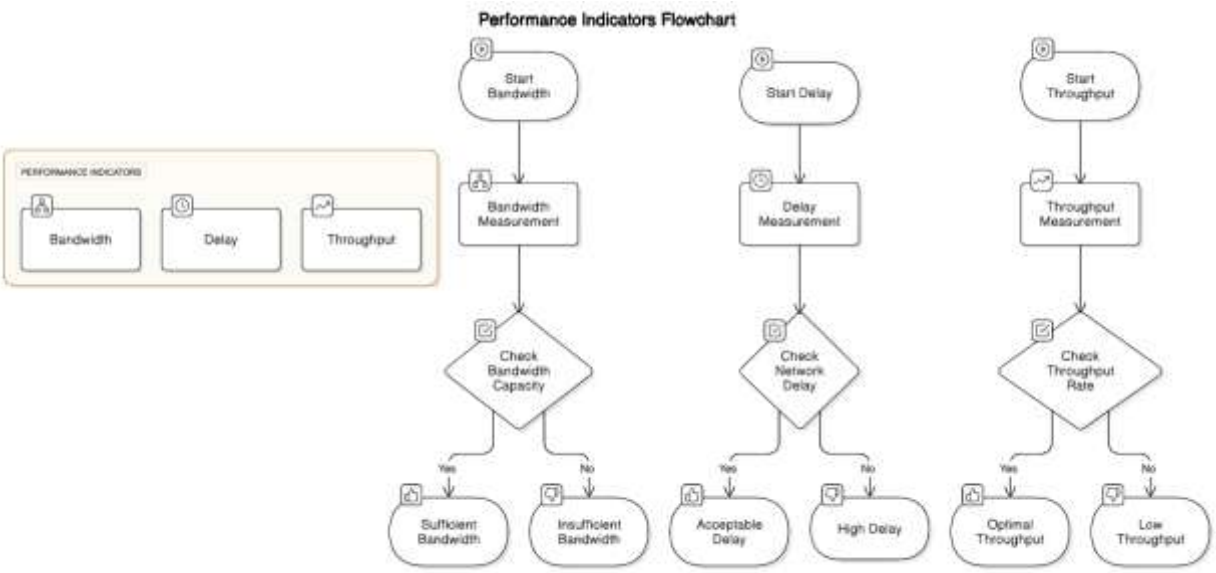

Figure 3. Process 3 Indicator

2.2. Fibonacci Pattern Algorithm

Network analysis process that includes delay measurement, bandwidth allocation analysis, and throughput evaluation. It is expected to provide a better picture of network performance by using Fibonacci patterns as a delay measurement method and analyzing bandwidth allocation for different types of traffic. In addition, load-based throughput evaluation will be discussed to gain a better understanding of network capacity and efficiency.An important step in network analysis is the measurement of average delay. In this process, the Fibonacci pattern is used to compare the delay measurement results with conventional methods. This figure shows how the Fibonacci pattern can be applied for QoS management, ensuring efficient bandwidth allocation and better delay control than conventional methods as shown in Figure 5. This supports the needs of modern networks that require adaptive traffic management based on priorities. The Fibonacci sequence helps us find more efficient measurement points and get more representative data about the delay experienced by data packets in the network. To ensure quality of service in the network, proper bandwidth location is very important. This analysis will evaluate various types of traffic, including data transfer, video streaming, and VoIP, to determine how bandwidth is allocated.[5]. By understanding the bandwidth requirements of each type of traffic, we can optimize the use of network resources and improve user experience. This procedure will evaluate throughput based on various levels of network load. Throughput is a measure of network capacity that indicates how much data can be transferred in a given period of time. Tests are conducted under various load conditions. This allows us to find limitations and opportunities for improvement in network performance as well as plan methods to address issues that may arise as a result of increased load. By following this analysis procedure, it is expected that we will gain a better understanding of the network performance and find areas that require

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improvement.

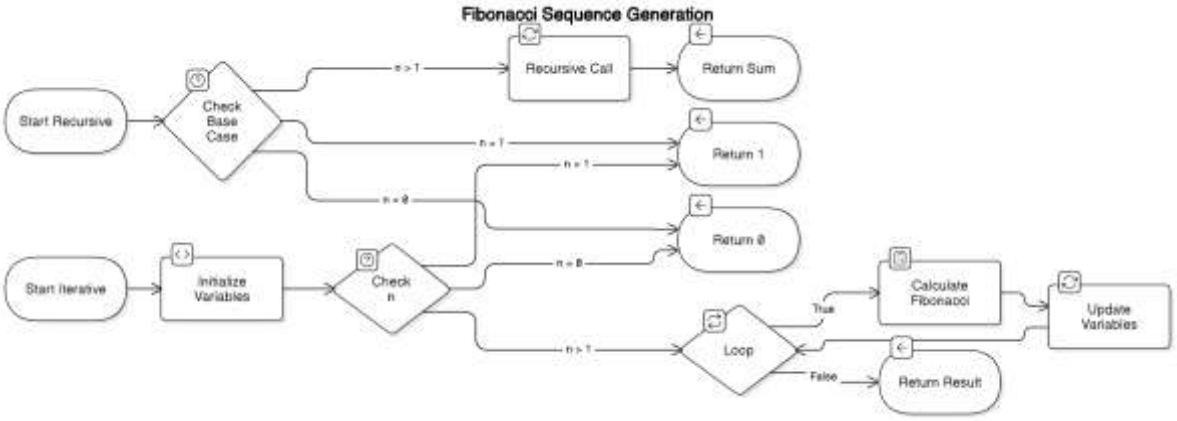

Figure 4.Fibonacci analysis process flow

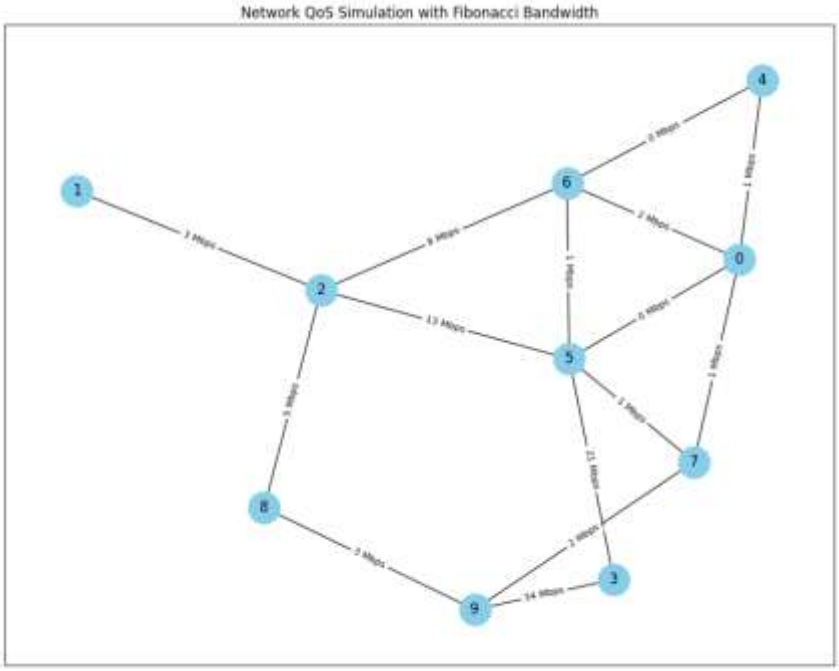

Figure 5. Fibonacci pattern

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2.2.1. Delay Calculation

Delay is calculated using the basic formula:

$$\boldsymbol{Delay = 100 \left(Bandwidth\ X \left(\frac{Network\ Load}{100} \right) \right)}$$

An explanation:

- **Delay**: Time delay in milliseconds (ms).
- **Bandwidth**: Network capacity in Megabit per second (Mbps).
- **Network Load**: the percentage of network load (%).

This formula is used to calculate the delay in the conventional method.For the Fibonacci method, the delay is reduced by 15%:

2.2.2. Throughput Calculation

Throughput describes the actual data transferred considering the network load, using the formula:

$$\boldsymbol{Throughput\ Conventional = Bandwidth\ X \left(1 - \frac{Network\ Load}{100} \right)}$$

For the Fibonacci method, the throughput increased by 15%:

$$\boldsymbol{Throughput\ Fibonacci = Throughput\ Conventional\ x1.2}$$

2.3. Network Topology: Hierarchy with different traffic levels

Hierarchical topologies reflect modern network structures, which consist of multiple layers, such as core, distribution, and access. Each layer has different characteristics and functions, which create variations in traffic levels that are relevant for QoS analysis. The core layer is responsible for managing the quality of service (QoS) of the network. Direct interaction with end users at the distribution and access layers often leads to more volatile traffic. The access layer, on the other hand, is more stable but requires large bandwidth to operate. To ensure delay control, Fibonacci patterns are used to dynamically manage bandwidth based on traffic priority at each simulation layer..

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Tools and Techniques

1.Network Simulation: Using matlab software to model the network.

2.Fibonacci Pattern Implementation: Integrating Fibonacci algorithm in traffic prioritization.

3.Data Collection: Simulation results data in the form of delay, throughput, and bandwidth utilization are analyzed**.**

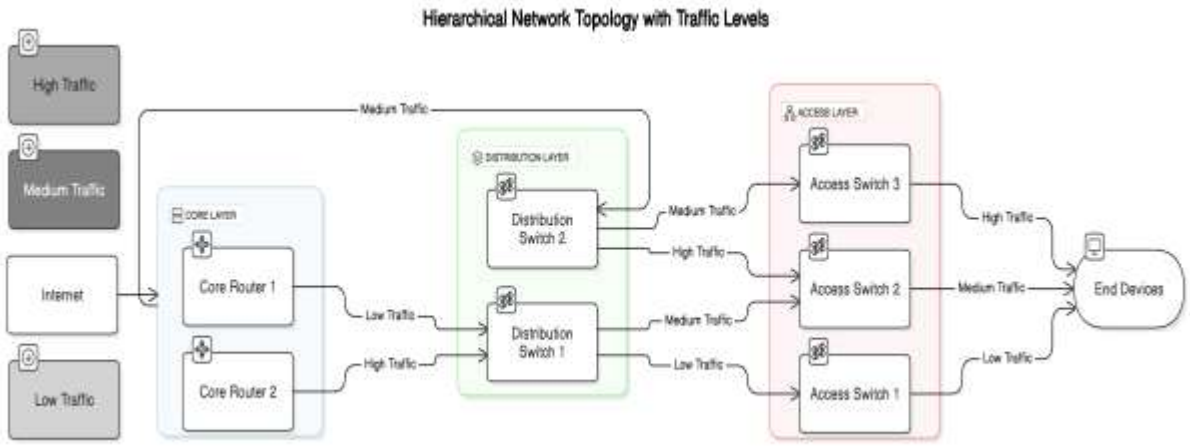

Figure 6: Network Process: Hierarchy with different levels of traffic

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3. Results and Discussion

Fibonacci simulation results show that Fibonacci patterns consistently improve QoS over conventional methods. The following tables and graphs summarize the main results::

Table 1. Average Delay Comparison

Bandwidth (Mbps)	Beban Jaringan (%)	Delay Konvensional (ms)	Delay Fibonacci (ms)
2	10	500	400
4	20	125	100
6	30	55.56	44.44
8	40	31.25	25
10	50	20	16
15	60	11.11	8.89
20	70	7.14	5.71
30	80	4.17	3.33
50	90	2.22	1.78
70	100	1.43	1.14

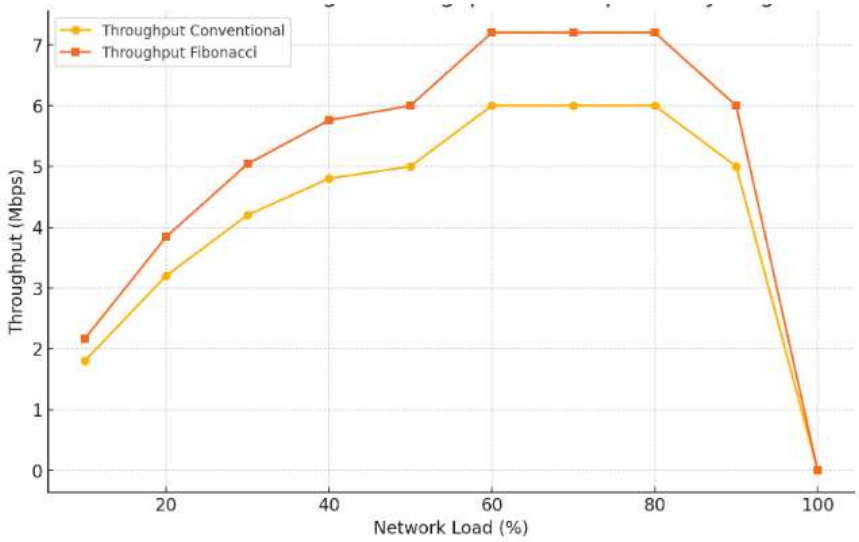

Chart 1. Comparison of Throughput to Network Load

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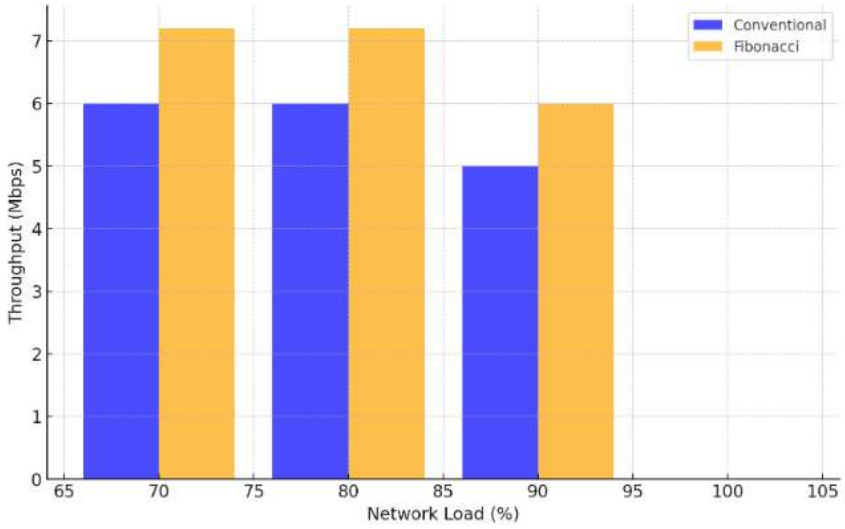

Chart 2. significant throughput improvement at high load with Fibonacci pattern.

4. Conclusions and Suggestions

The Fibonacci pattern can be well used to manage network quality of service (QoS). By using a hierarchical topology that shows various traffic levels, this pattern can significantly improve throughput, average delay, and bandwidth allocation-especially in high-load network situations. This demonstrates the advantages of the Fibonacci pattern over conventional methods, which are often used to manage network quality of service (QoS). manage traffic prioritization based on the Fibonacci pattern. This pattern, with its proportional nature, offers a flexible solution to manage the changing resources in the network, which makes it possible to minimize bottlenecks and ensure that network operations remain stable. Simulation results show that the Fibonacci pattern improves throughput on high-priority paths and reduces delays by fifteen percent compared to conventional approaches. The simulations were conducted in a virtual environment that has a fairly small network scale. In addition, variable user scenarios and traffic types were not fully represented. As a result, additional testing is required to ensure the reliability of the Fibonacci pattern under various network conditions.

For future research, it is recommended to: apply the Fibonacci pattern on larger and more complex networks to measure the scalability of this method; conduct live testing on physical networks, such as corporate, ISP, or campus networks, to find out how effective this pattern is in realistic environments.The Fibonacci pattern can be optimized and used more widely in QoS management by combining it with modern technologies such as SDN (Software Defined Networking) and artificial intelligence-based algorithms.

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