International Journal Scientific and Profesional (IJ-ChiProf)
Vol 4 Issue 2 March-May 2025, pp: 541-547
ISSN: 2829-2618 (Online)
DOI: https://doi.org/10.56988/chiprof.v4i2.88

Implementation of the Backtracking Algorithm for Bandwidth Management in the Network of SMA Negeri 1 Belitang

M. Fachri Hafizena[1], Tata Sutabri[2],
[1,2]Magister of Informatics Engineering, Universitas Bina Darma, Indonesia
Email: hafizzfahri@gmail.com[1], tata.sutabri@gmail.com[2]

Article Info
Article history:
Received April 10, 2025
Revised April 14, 2025
Accepted April 22, 2025

Keywords:
Bandwidth Management
Backtracking Algorithm
Quality of Service (QoS)

ABSTRACT
Internet has become an essential necessity in the field of education, particularly in supporting the teaching and learning processes in schools. Effective bandwidth management ensures efficient and equitable network usage for all users. This study implements the Backtracking algorithm as a solution for bandwidth management at SMA Negeri 1 Belitang. The algorithm is utilized to optimize bandwidth allocation based on usage priority and the dynamic number of users. The results indicate that this method can enhance bandwidth utilization efficiency, reduce delays, and improve the quality of service (QoS). Therefore, the Backtracking algorithm can serve as an alternative solution for achieving optimal network management in schools.

Corresponding Author:
Tata Sutabri,
Magister of Informatics Engineering,
Universitas Bina Darma, Indonesia
Email: tata.sutabri@gmail.com

1. INTRODUCTION

The world of information today appears to be closely interconnected with technology. The technical landscape has become increasingly complex due to society's widespread use of technology. With technological advancements, communication has accelerated to the point of becoming instantaneous. The saying "The world is not as small as a moringa leaf" should now be revised to "The world is as small as a moringa leaf," considering the rapid pace of technological development [1]. The advancement of information technology and the internet has had a significant impact on the field of education. The internet has become a vital medium for supporting the teaching and learning process in schools [2], [3]. However, the high number of users and the growing demand for access often lead to issues such as delays, packet loss, and a decline in network service quality [4], [5].

Bandwidth is inseparable from the concept of the internet, as it enables access to online content for both information and entertainment purposes, including live video streaming and live television, which require a substantial amount of bandwidth [6]. Bandwidth management plays a critical role in maintaining network efficiency and quality. Several approaches have been employed to manage bandwidth allocation, including conventional routing algorithms and artificial intelligence-based algorithms [7]. One of the algorithms with potential for application is the backtracking algorithm, which systematically searches for solutions through a Depth-First Search (DFS) approach and performs backtracking when a solution fails to meet the specified criteria [8].

Unlike greedy algorithms, which tend to ignore the preferences of heterogeneous users for the sake of quicker solutions, or genetic algorithms, which rely heavily on random processes, the backtracking algorithm ensures that each iteration remains precise and measured [9]. Internet facilities enable all educational devices to interact with each other. Information, represented by computers connected through the internet as the primary medium, has contributed significantly to educational processes. This study aims to implement the backtracking algorithm for bandwidth management in the network of SMA Negeri 1 Belitang to improve the efficiency and quality of the school's network services.

Vol 4 Issue 2 2025, pp: 541-547
ISSN: 2829-2618 (Online)

2. RESEARCH METHOD

2.1. Research Design

This study adopts a quantitative experimental approach through simulation. The initial steps include identifying network issues, collecting data on bandwidth requirements, and testing the backtracking algorithm within a virtual environment. Backtracking is utilized to find the optimal solution for bandwidth allocation based on user priority and network traffic load levels. Using the Depth-First Search (DFS) mechanism, all possible bandwidth allocations are explored, and infeasible solutions are discarded through pruning [8], [10].

2.1.1. Research Flowchart

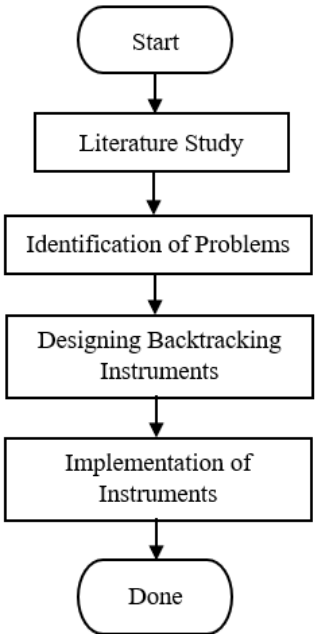

Figure 1. Research Stages Diagram

2.1.2. Mathematical Formula

The main mathematical formula used in this study to measure the efficiency of bandwidth allocation is:

$$\text{Efficiency } (\%) = \frac{(\text{Realized Bandwidth})}{(\text{Maximum Bandwidth})}\ x\ 100$$

Example of table application:

a. Maximum Bandwidth: 100 Mbps
b. Realized Bandwidth (e.g.): 85 Mbps
c. Therefore:

$$\text{Efficiency} = \frac{(85)}{(100)}\ x\ 100 = 85\%$$

2.2. Data Collection Techniques

Data were collected through direct observation and interviews with IT staff and school representatives. Additionally, network monitoring tools were utilized to record parameters such as access speed, delay, jitter, and packet loss [11], [12].

2.3. Data Processing and Analysis

The data obtained from network monitoring were processed using analysis software to identify bandwidth usage patterns. The backtracking algorithm was applied to this data to test the effectiveness of bandwidth distribution on service quality (QoS) parameters, namely delay, jitter, and packet loss [13], [14].

International Journal Scientific and Profesional (IJ-ChiProf)
Vol 4 Issue 2 March-May 2025, pp: 541-547
ISSN: 2829-2618 (Online)
DOI: https://doi.org/10.56988/chiprof.v4i2.88

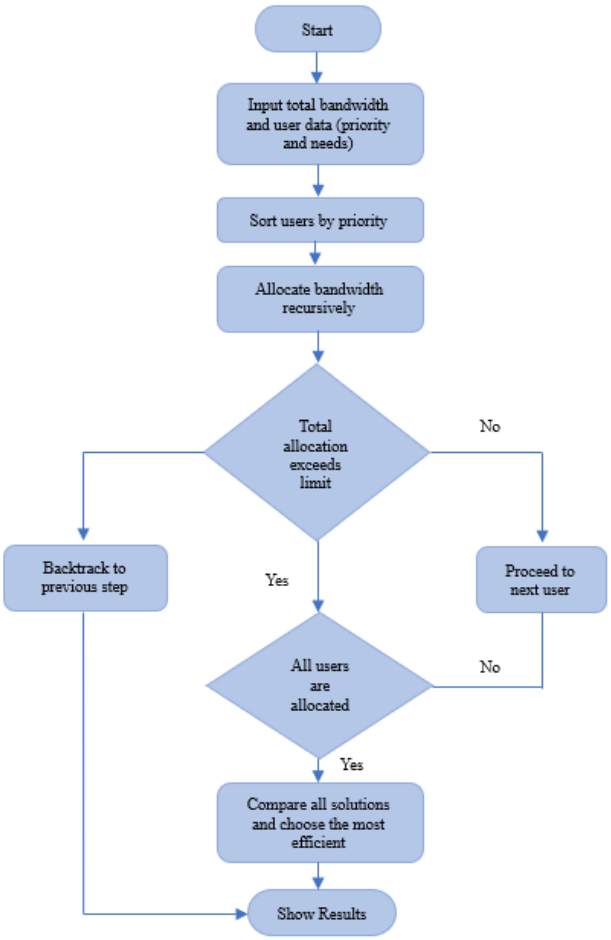

Figure 2. The working mechanism of the backtracking algorithm for bandwidth management.

2.4. Simulation and Testing

Simulations were conducted to evaluate the performance of the backtracking algorithm in bandwidth management at SMA Negeri 1 Belitang's network before actual implementation. The simulation environment was built using network simulation software (such as NS-3 or GNS3) to represent various traffic scenarios in a realistic network. The tested scenarios include normal traffic, high traffic, and extreme conditions that may occur during peak network usage periods. The simulation environment was designed to represent a range of traffic scenarios, from normal to extreme. The parameters tested include delay, jitter, packet loss, throughput, and user satisfaction [15].

2.4.1. Tested Traffic Scenarios:

a. Normal Traffic

1) The number of users on the network is at a normal level (e.g., 100-150 users) with a relatively even distribution of bandwidth.
2) Latency and jitter remain within acceptable limits for educational activities such as browsing, video streaming for learning, and cloud-based application usage.

b. High Traffic

1) The number of users increases significantly (e.g., 200-300 users), with bandwidth-intensive applications such as video conferences and simultaneous online learning.
2) Bandwidth allocation must be optimized to avoid a decline in service quality (QoS).

c. Extreme Conditions:

1) Users reach the network's maximum capacity, with extremely bandwidth-intensive applications such as HD video streaming and simultaneous online conference sessions.
2) The backtracking algorithm is tested to mitigate adverse effects such as packet loss and high delay.

International Journal Scientific and Profesional (IJ-ChiProf)
Vol 4 Issue 2 2025, pp: 541-547
ISSN: 2829-2618 (Online)

2.4.2. Tested Parameters:

a. Delay
The time required for a data packet to reach its destination. Tested under both normal and extreme conditions to observe how the backtracking algorithm minimizes delay in bandwidth management.

b. Jitter
The variation in delay between packets. High jitter can affect service quality, especially for real-time applications like video calls.

c. Packet Loss
The loss of packets during transmission. This simulation tests whether the backtracking algorithm can reduce or manage packet loss, particularly under heavy traffic.

d. Throughput
The amount of data successfully transmitted within a specific period. This test measures how well the algorithm can maintain optimal throughput even under high traffic conditions.

e. User Satisfaction
A user satisfaction survey was conducted to measure perceptions of service quality after the implementation of the backtracking algorithm. Users were asked to provide feedback on network stability, access speed, and the smoothness of educational services.

2.4.3. Simulation Procedure:

a. Build the network topology using relevant hardware and software simulation tools.
b. Apply the backtracking algorithm for bandwidth allocation in each scenario.
c. Conduct performance tests for each of the parameters mentioned above across various traffic scenarios.
d. Analyze the simulation results by comparing them with the network conditions without the backtracking algorithm.

The results from this simulation are expected to provide a clear overview of the effectiveness of the algorithm in managing bandwidth under various network conditions, as well as offer recommendations for implementing a bandwidth management system at SMA Negeri 1 Belitang.

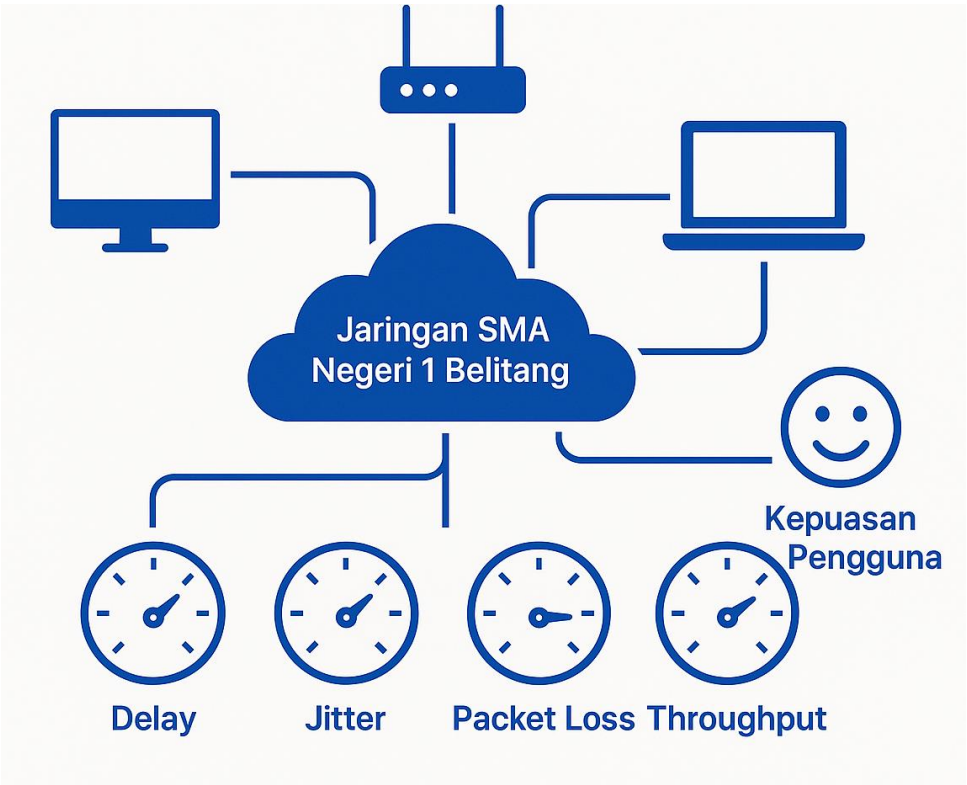

Figure 3. Simulation Testing

International Journal Scientific and Profesional (IJ-ChiProf)
Vol 4 Issue 2 March-May 2025, pp: 541-547
ISSN: 2829-2618 (Online)
DOI: https://doi.org/10.56988/chiprof.v4i2.88

3. RESULTS AND ANALYSIS

3.1. Test Result

The simulation results show that the implementation of the backtracking algorithm successfully improved network performance compared to the default routing method.

Table 1. Network Performance Comparison

Parameter	Default Routing	Backtracking
Delay (ms)	180	75
Jitter (ms)	30	10
Packet Loss (%)	4.5	1.2
User Satisfaction (%)	60	88

Achieved Solutions:

a. Delay decreased by 58.3%
b. Jitter decreased by 66.6%
c. Packet loss decreased by 73.3%
d. User satisfaction increased by 28%

3.2. Bandwidth Efficiency Analysis

Table 2. Bandwidth Efficiency Before and After Backtracking

Time (Hour)	Maximum Bandwidth (Mbps)	Realized Bandwidth (Mbps)	Efficiency (%)
08:00 - 10:00	100	85	85
10:00 - 12:00	100	90	90
12:00 - 14:00	100	70	70
14:00 - 16:00	100	80	80

Efficiency Solutions:

a. Average efficiency: 81.25%
b. No significant bandwidth wastage.
c. Bandwidth allocation is flexible, following peak load times

3.3. Quality of Service (QoS) Analysis

The Quality of Service (QoS) analysis was performed to evaluate how well the network can meet user needs in terms of response time (delay), stability (jitter), and packet loss. With the use of the backtracking algorithm, it is expected that the QoS can be significantly improved.

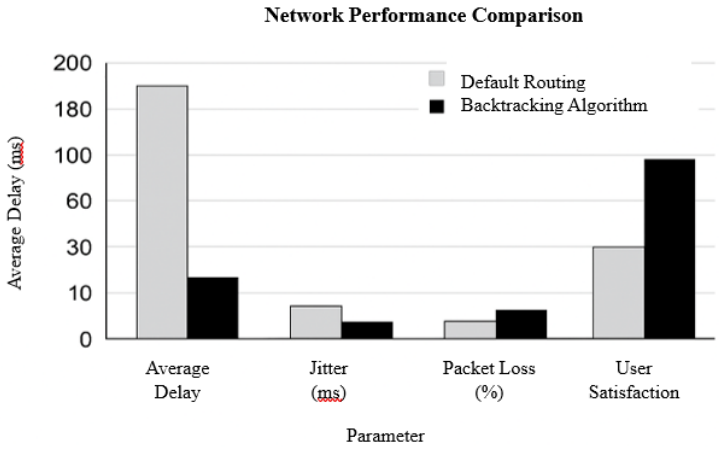

Figure 4. Comparison Graph of Delay, Jitter, and Packet Loss Before and After Implementing the Backtracking Algorithm

3.4 User Satisfaction

Table 3. User Satisfaction Level

Category	Before Implementation (%)	After Implementation (%)
Overall Satisfaction	60	88
Access Speed	55	85
Network Stability	65	90
Smooth Usage	58	84

User Solution Conclusion:

a. Users experienced significant improvements after the algorithm's implementation.
b. Network stability and comfort have noticeably increased.

3.5 Discussion

The simulation and testing results show that the backtracking algorithm significantly improved network performance in the school environment. Compared to the default routing method, the implementation of this algorithm successfully reduced delay by 58.3%, decreased jitter by 66.7%, and lowered packet loss by 73.3%. These reductions demonstrate that the backtracking algorithm is effective in distributing bandwidth more precisely according to user needs, especially during traffic spikes.

Furthermore, the improved bandwidth efficiency achieved during various operational periods of the school indicates that backtracking optimizes network capacity without overloading the system. The highest efficiency, recorded during busy operational hours, reached 90%, indicating that the algorithm can adaptively allocate bandwidth based on application priorities and traffic load.

Additionally, the significant increase in user satisfaction from 60% to 88% after the backtracking algorithm's implementation provides clear evidence that this approach directly impacts the quality of the user experience. This also strengthens the argument that the backtracking algorithm is not only technically superior but also meets user expectations for network stability and speed.

Overall, this discussion reaffirms that the backtracking algorithm is a potential and applicable solution for bandwidth management in school networks. Considering the improvement in all Quality of Service (QoS) parameters and the positive response from end users, this algorithm is worth considering for real-world implementation as part of a modern network management system in educational settings.

Moreover, the implementation of the backtracking algorithm not only enhances network quality but also improves user satisfaction, with noticeable differences in the overall experience of using the internet at school. This demonstrates that the backtracking algorithm is a highly promising solution for bandwidth management in school networks. [8], [13], [14]. Information systems not only assist in processing technical data but also provide a solid foundation for data-driven decision-making [16], [17].

4. CONCLUSION

Based on the simulation and analysis results, it can be concluded that the backtracking algorithm performs exceptionally well in efficiently and adaptively managing bandwidth allocation in the school network environment. This algorithm successfully reduced delay, jitter, and packet loss significantly, and improved bandwidth usage efficiency to 90% during peak hours. Another positive impact is the increase in user satisfaction, which indicates that the overall quality of the network service has undergone a significant improvement.

The application of the backtracking algorithm enables bandwidth allocation decisions based on dynamic traffic load and priority, making it a relevant solution to address challenges in networks with fluctuating traffic. The results obtained through simulations show that this method is not only effective from a technical perspective but also provides added value from the user experience side.

Therefore, the backtracking algorithm can be recommended as an alternative solution for efficient bandwidth management, particularly in educational environments such as SMA Negeri 1 Belitang. The implementation of this algorithm in real-world networks is expected to improve internet service quality comprehensively and support the growing digital learning activities.

ACKNOWLEDGEMENTS

The authors would like to thank the Editorial Team of Teknika Journal, Politeknik Negeri Sriwijaya, for giving the opportunity to publish this scientific article.

REFERENCES

[1] D. Sisco, D. Sangaji, and T. Sutabri, "Management and Real-Time Monitoring of Internet Healthy Access Users in Prabumulih City," *bit-Tech*, vol. 7, pp. 474–483, Dec. 2024, doi: 10.32877/bt.v7i2.1854.
[2] A. Rahman, "Analysis and Optimization of Multi-Point Wireless Access Points on Mikrotik hAP LITE Router," *Sains dan Teknologi*, 2019.
[3] K. D. Amponsah, G. K. Aboagye, M. Narh-Kert, P. Commey-Mintah, and F. K. Boateng, "The Impact of Internet Usage on Students' Success in Selected Senior High Schools in Cape Coast Metropolis, Ghana," *European Journal of Education Studies*, vol. 9, no. 2, pp. 1–18, 2022, doi: 10.19044/ejes.v9no2a1.
[4] T. A. Harmawan and L. S. Istiyowati, "Big Data and Understanding Supporting Factors for Students' Academic Performance to Improve Learning Effectiveness," *Journal of Educational Technology Studies*, vol. 7, no. 1, p. 035, 2024, doi: 10.17977/um038v7i12024p035.
[5] N. Rosadi, "Improving the Performance of Biology Teachers in Conducting Learning Through Academic Supervision," *Journal of Evaluation and Learning*, vol. 4, no. 1, pp. 32–39, 2022, doi: 10.52647/jep.v4i1.42.
[6] N. Nandi, T. Sutabri, and M. Ridwan, "Analysis of Bandwidth Distribution on Video Streaming Using Unicast and Multicast Methods on Gigabit Passive Optical Network Technology," 2019. [Online]. Available: https://scholar.google.com/citations?view_op=view_citation&hl=id&user=o8XmqXQAAAAJ&cstart=200&pagesize=100&citation_for_view=o8XmqXQAAAAJ:hC7cP41nSMkC
[7] R. A. Azizah, F. Bachtiar, and S. Adinugroho, "Classification of Student Academic Performance Using Neighbor Weighted K-Nearest Neighbor with Information Gain Feature Selection," *Journal of Information Technology and Computer Science*, vol. 9, no. 3, pp. 605–614, 2022, doi: 10.25126/jtiik.2022935751.
[8] D. Edi, "Study of Routing Algorithms in Computer Networks," 2006. [Online]. Available: https://www.neliti.com/publications/219206/kajian-algoritma-routing-dalam-jaringan-komputer
[9] G. Linden, B. Smith, and J. York, "Amazon.com Recommendations: Item-to-Item Collaborative Filtering," *IEEE Internet Computing*, vol. 7, no. 1, pp. 76–80, 2003, doi: 10.1109/MIC.2003.1167344.
[10] M. Hudaya, "Application of Backtracking Algorithm as a Routing Algorithm in Computer Networks," pp. 1–3.
[11] T. T. Nguyen, "Optimal Distribution Network Configuration Using Improved Backtracking Search Algorithm," *TELKOMNIKA (Telecommunication, Computing, Electronics and Control)*, vol. 19, pp. 301–309, Feb. 2021, doi: 10.12928/TELKOMNIKA.V19I1.16773.
[12] E. Torres, R. Reale, L. Sampaio, and J. Martins, "A SDN/OpenFlow Framework for Dynamic Resource Allocation Based on Bandwidth Allocation Model," *IEEE Latin America Transactions*, vol. 18, no. 5, pp. 853–860, 2020, doi: 10.1109/TLA.2020.9082913.
[13] S. R. Pokhrel and A. Walid, "Learning to Harness Bandwidth with Multipath Congestion Control and Scheduling," *IEEE Transactions on Mobile Computing*, vol. 22, no. 2, pp. 996–1009, 2023, doi: 10.1109/TMC.2021.3085598.
[14] F. Yang, Q. Wu, Z. Li, Y. Liu, G. Pau, and G. Xie, "BBRv2+: Towards Balancing Aggressiveness and Fairness with Delay-Based Bandwidth Probing," *Computer Networks*, vol. 206, 2022, doi: 10.1016/j.comnet.2022.108789.
[15] I. M. A. B. Saputra, P. D. Indrajaya, R. A. N. Diaz, I. K. A. A. Aryanto, and N. L. P. Srinadi, "Analysis of Quality of Service Bandwidth Management on Computer Networks Using Mikrotik RB951Ui-2HnD," *Jurnal Techno Nusa Mandiri*, vol. 18, no. 1, pp. 8–16, 2021, doi: 10.33480/techno.v18i1.2164.
[16] T. Sutabri and D. Natipulu, *Business Information Systems*, Yogyakarta: Andi, 2019.
[17] T. Sutabri, *Information System Concepts*, Yogyakarta: Andi, 2012.