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Performance Analysis of Mesh Networking Implementation on Mikrotik Router Board 941

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Abstract: The increasingly rapid development of computer network technology demands a network system that is reliable, flexible, and able to adapt to dynamic environmental conditions. One of the network technologies that is currently developing is mesh networking. Mesh networking is a network topology where each node can be connected to each other directly or indirectly through other nodes. This research aims to analyze the application of the mesh networking method using the Mikrotik RouterBoard 941 device. The research method used is experimental by configuring, implementing, and testing mesh networking on the Mikrotik RouterBoard 941. The results of the research show that mesh networking can be applied to the Mikrotik RouterBoard 941 by utilizing available features, such as OLSR (Optimized Link State Routing) and WDS (Wireless Distribution System). Mesh networking is able to increase redundancy and network availability, and can adapt to changes in network topology. However, mesh networking also has several disadvantages, such as configuration complexity, routing overhead, and the possibility of bottlenecks at certain nodes.

Keywords: Mesh Networking; Mikrotik RouterBoard 941; OLSR Routing Protocol; Wireless Distribution System (WDS); Network Availability

INTRODUCTION

In the advancement of information and communication technology, a high-quality internet network has become a fundamental requirement for users. Wi-Fi technology, which is widely implemented in both work and educational environments, provides flexibility for users to access the internet anytime and anywhere. Wi-Fi operates on two frequency bands, namely 2.4 GHz and 5 GHz. However, the 2.4 GHz frequency is more prone to interference due to its shared usage with other devices, such as Bluetooth. The IEEE 802.11b standard, for instance, utilizes the 2.4 GHz frequency band as a transmission medium for communication between electronic devices (Faizar, 2020).

Wireless networks enable communication between devices using radio waves, allowing data transmission from sender to receiver without requiring physical cables. This process involves several layers based on the Open Systems Interconnection (OSI) model, particularly the Physical Layer and Data Link Layer (Arman & Kasran, 2023). As a result, wireless networking has become a promising solution for next-generation communication systems due to its flexibility and scalability.

Wireless networks offer various advantages, including tolerance to network failures, ease of installation, cost efficiency, and simplified maintenance. One of the most widely developed technologies is the Wireless Mesh Network (WMN), which is self-organizing and self-configuring. In this system, nodes automatically form an ad-hoc network and maintain connectivity in a mesh topology. Each node can function as a mesh router or mesh client, enabling wider coverage and improved network resilience (Iqbal & Tambunan, 2021).

A Mobile Ad-hoc Network (MANET) is a type of wireless network formed by mobile devices such as laptops without relying on fixed infrastructure. One of the main challenges in MANET is the absence of a Base Service Set (BSS), which complicates network management and connectivity (Hariyanto & Rahayu, 2021). Unlike infrastructure-based networks, mesh networking utilizes ad-hoc routing mechanisms, eliminating the need for wired connections between access points. This makes it highly suitable for dynamic and flexible network environments (Siswanto, 2021).

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Wireless Mesh Networks play a significant role in the development of future communication technologies due to their self-healing capability and ease of implementation. These networks provide benefits such as reduced deployment costs, increased coverage, improved bandwidth, and flexible implementation. Furthermore, mesh networks can be integrated with advanced wireless standards and are suitable for various applications, including home networking, enterprise systems, and community-based networks (Siddik et al., 2023).

Mikrotik Router is a Linux-based operating system designed to function as a network router. It is widely used for network management, ranging from small-scale to large-scale systems. Mikrotik is available in two forms, namely RouterOS (software) and RouterBoard (hardware), which are specifically designed to operate efficiently without requiring additional computer systems (Bahtiar et al., 2021). One of the commonly used devices is the Mikrotik RouterBoard 941, which supports dual-band wireless communication and dynamic routing protocols.

Previous studies have generally focused on the implementation and basic performance evaluation of wireless mesh networks using Mikrotik devices (Octafiandi, 2021; Siswanto, 2021). However, there are still limitations in exploring aspects such as energy efficiency, advanced network security, and the use of alternative routing protocols beyond the commonly applied Hybrid Wireless Mesh Protocol (HWMP). In addition, research on the optimization of mesh networks in specific scenarios such as Internet of Things (IoT), disaster recovery, and remote area connectivity remains limited.

Therefore, this study aims to analyze the performance of mesh networking using the Mikrotik RouterBoard 941 by considering various optimization approaches and alternative routing protocols such as OSPF and BATMAN. The novelty of this research lies in its comprehensive evaluation of performance, scalability, and flexibility, as well as its focus on potential applications in IoT and emergency network scenarios. The results of this study are expected to provide valuable insights for the development and implementation of efficient wireless network solutions in various environments.

LITERATURE REVIEW

1.Mesh Networking

Analysis is a systematic process aimed at decomposing a complex problem into smaller, more manageable components in order to understand relationships, patterns, and underlying meanings. Conceptually, analysis involves observing, classifying, and interpreting phenomena through structured reasoning so that problems can be understood more clearly and comprehensively (Kurniasih & Rusfiana, 2021; Simanjuntak, 2021). In the context of network research, analysis is not limited to descriptive evaluation but also includes performance measurement, comparative assessment, and identification of optimization opportunities. Previous studies have primarily utilized analysis to measure network performance indicators such as throughput, delay, jitter, and packet loss (Tarigan, 2020). However, such approaches often remain technical and lack integration with contextual factors such as environmental conditions, scalability demands, and protocol efficiency. Therefore, this study adopts a more comprehensive analytical approach by not only evaluating performance metrics but also examining the interaction between routing protocols, hardware limitations, and real-world implementation scenarios. The novelty of this research lies in its integrative analytical framework, which combines performance evaluation with adaptive configuration analysis. This approach enables a deeper understanding of how mesh networking can be optimized under varying conditions, particularly when implemented using resource-constrained devices such as Mikrotik RouterBoard 941.

Mesh networking represents a decentralized network topology in which each node can act as both a transmitter and receiver, allowing for dynamic and flexible communication paths (Aisyah, 2022). One of the defining characteristics of this topology is its self-healing capability, where the network can automatically reconfigure itself when a node fails, ensuring continuous connectivity. From a theoretical perspective, mesh networking offers significant advantages in terms of reliability, scalability, and coverage. The existence of multiple routing paths enhances fault tolerance and reduces the risk of total network failure (June, 2025). Consequently, this technology has been widely applied in wireless communication systems, including Internet of Things (IoT), smart city infrastructure, and disaster recovery networks. However, despite its advantages, previous research often focuses on the general implementation of mesh networking without deeply analyzing the efficiency of routing protocols or the impact of node limitations on network performance. Many studies rely heavily on standard protocols such as Hybrid Wireless Mesh Protocol (HWMP), which may not always provide optimal performance in all scenarios. This study addresses these limitations by exploring alternative routing protocols such as OSPF and BATMAN within a mesh networking environment. The novelty lies in evaluating how these protocols perform in a decentralized topology using Mikrotik devices, particularly in terms of adaptability, efficiency, and scalability. This contributes to a more nuanced understanding of mesh networking beyond conventional implementations.

2. Mikrotik RouterBoard 941

Mikrotik RouterBoard 941 is a compact wireless router designed for small-scale network deployments, including homes, educational institutions, and small offices (Toyib et al., 2024). Powered by MikroTik RouterOS, this device provides a wide range of network management features such as routing, firewall, bandwidth control, VPN, DHCP, hotspot, and Quality of Service (QoS) (Ardhitya, 2021). Previous studies highlight Mikrotik devices as cost-effective and flexible solutions for network implementation (Putra et al., 2025). However, these studies often emphasize basic configuration and general performance without critically examining the device's limitations, particularly in mesh networking environments. Given its relatively limited hardware specifications, the RouterBoard 941 may experience performance degradation when handling complex routing or high network loads.

This research critically evaluates the capability of Mikrotik RouterBoard 941 in supporting mesh networking by considering both its strengths and limitations. Unlike prior studies, this research not only assesses performance outcomes but also investigates optimization strategies to enhance device efficiency. The novelty lies in the exploration of how low-cost hardware can be effectively utilized in advanced network topologies through proper configuration and protocol selection.

3. Router

A router is a fundamental networking device responsible for connecting multiple networks and directing data packets based on routing decisions (Rahman & Nurwarsito, 2020). It operates by analyzing destination IP addresses, referencing routing tables, and forwarding packets through the most efficient path (Yastianto, 2021). In modern networking, routers play a critical role in ensuring data transmission efficiency, security, and reliability. In addition to basic routing functions, routers provide advanced features such as Dynamic Host Configuration Protocol (DHCP), firewall protection, Virtual Private Network (VPN), and traffic management. These features are essential for maintaining network stability and security in increasingly complex digital environments (Fahriani, 2024). Previous research tends to treat routers as static infrastructure components, particularly in traditional network architectures. However, in mesh networking, routers assume a more dynamic role as nodes that participate in decentralized communication and routing processes. This shift requires routers to handle more complex tasks, including dynamic routing updates and adaptive traffic distribution. The novelty of this study lies in examining the role of routers—specifically Mikrotik RouterBoard devices—within a mesh networking framework. This research highlights how routing functionality evolves in decentralized environments and how router performance can be optimized to support self-organizing networks. By integrating routing analysis with mesh topology evaluation, this study provides a more comprehensive perspective on modern network design.

METHOD

This research uses a quantitative approach with experimental methods. The quantitative approach was chosen because this research focuses on measuring network performance using parameters that can be measured numerically, such as throughput, delay, jitter, and packet loss. Meanwhile, the experimental method was used because the research involved the design, implementation, and direct testing of a mesh network system built using a Mikrotik RouterBoard 941 device. Furthermore, this research also has the characteristics of a case study, because the network implementation was carried out in a specific environment, allowing the research results to represent the real-world conditions of mesh networking implementation on a limited scale. The research stages are as follows:

1. Research Stages

The research methods used in this study are as follows:

a. Literature Studies
The author conducts a review of relevant literature, including scientific journals, books, and official documentation. The goal is to get theoretical foundations and information related to mesh networking and the use of the Mikrotik Router Board 941.

b. Experiments
The author carried out an experiment by building a mesh network using the Mikrotik Router Board 941 in a laboratory environment. This experiment aims to test the configuration, connectivity, and performance of the mesh network.

c. Data Analysis
Data obtained from Experiments, such as throughput, latency, and network availability, was analyzed to evaluate network performance in Mesh and compare it to traditional networks (Nugroho et al., 2023).

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2. Planning Stages

The construction of a mesh network using Mikrotik RouterBoard 941 will be based on the results of the analysis that has been carried out, and then applied gradually to achieve the desired results. Here are the stages of planning:

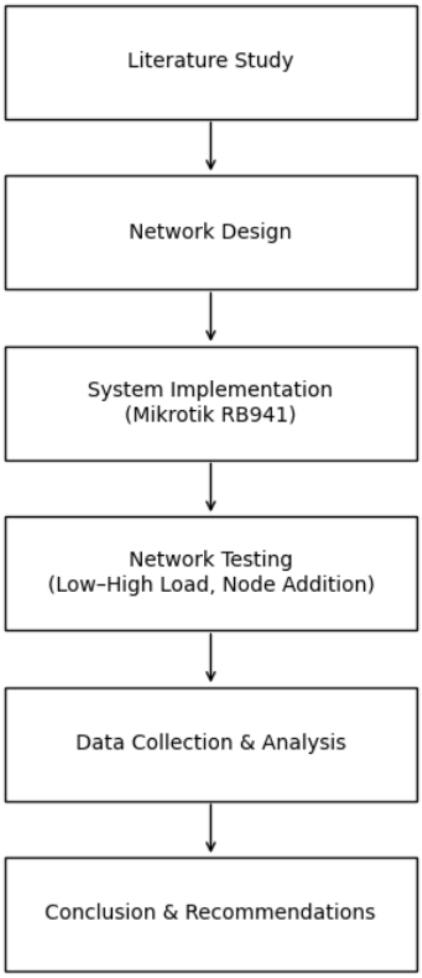

Fig 1. Planning Pictures

a. Preparation of Tools and Materials

The tools needed in network design consist of hardware and software. The hardware needed in this network is:

1. Mikrotik Router Board 941.
2. Additional Access Points.
3. Switch.
4. Client Devices: Laptops, Smartphones.
5. Monitoring Device.

b. Topology Planning

The most appropriate topology for this implementation is the full mesh topology. In this topology, each device (node) is directly connected to all other devices. That way, each device has several alternative paths to send data, which can improve network reliability and resiliency.

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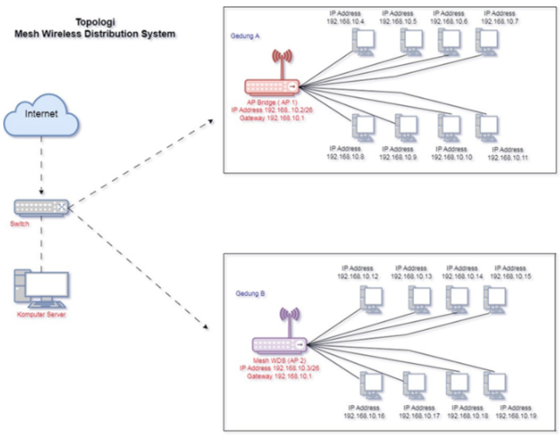

Fig 2. WDS mesh topology

Pictured above is the Mesh Wireless Distribution System Topology, which connects two buildings (Building A and Building B) to the internet network via a Switch and Server Computer. The explanation:

1) Internet: The Internet is at the topological end, connected to the internal network via a Switch.
2) Switch: Switches serve as the primary link between the internet, Server Computers, and other devices connected to the network.
3) Server Computers: These servers may be used for network management or to provide services to devices on the network.

Building A:

1) Using the AP Bridge (AP 1) as the network access point.
2) AP IP Address 1: 192.168.10.2/26, with Gateway 192.168.10.1.
3) There are multiple computers or devices connected to AP 1, each with a different IP address (192.168.10.4 to 192.168.10.11).

Building B:

1) It uses Mesh WDS (AP 2), which is a Wireless Distribution System (WDS) technology that expands network coverage wirelessly.
2) AP IP Address 2: 192.168.10.3/26, with the same Gateway as Building A (192.168.10.1).
3) Just like in Building A, the devices in Building B are also connected to AP 2 with IP addresses from 192.168.10.12 to 192.168.10.19.

From the results of the configuration above, it can be interpreted that both buildings A and B are connected to each other through a wireless network using WDS Mesh technology, with the AP Bridge in Building A as the main access point. All devices in both buildings have the same gateway (192.168.10.1), which leads to the internet via switches and servers. The network is designed to provide internet access and communication between devices in two different locations.

c. Mikrotik Configuration

Configuration aims to organize and organize the network so that it can function properly and according to needs. The configuration stage starts with logging in to the Winbox application, then continues with the following configurations: wireless, WDS, mesh interfaces, HWMP (Hybrid Wireless Mesh Protocol), IP addresses, routing, DNS, NAT, firewall, and DHCP.

d. Installation and Implementation

Installation and implementation of mesh networking with Mikrotik Router Board 941. The installation and implementation of the Mesh Networking method using the Mikrotik Router Board 941 is a process to build a wireless network based on mesh technology, where each node in the network can communicate with each other without relying on a single central point.

e. Testing and Optimization

Testing is carried out to determine the success of the system. In this stage, the results of the pre-made configuration will be evaluated. If the test is successful, the network is ready to use. However, if it fails, a reanalysis will be performed and the configuration repaired. Some of the tests that will be carried out include a network speed test using speedtest.cbn.id, and a login test by entering the username and password that have been set at the configuration stage. In addition, the network will be monitored through the Winbox application, such as monitoring network traffic in the Interface menu, as well as network

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management by viewing the configuration backup list in the Files menu and activity logs in the Logs menu.

f. Documentation and Maintenance

Documentation and maintenance on the analysis of the Mesh Networking method using the Mikrotik Router Board 941 is an important step to ensure the network functions optimally.

RESULTS

The results of this study show how the implementation of mesh networking uses the Mikrotik Router Board 941. Mesh networking is a network topology where each node is interconnected, creating an integrated network. With the Mikrotik Router Board 941, the implementation of mesh networking becomes simpler because this device has various important features, such as wireless, routing, and network management.

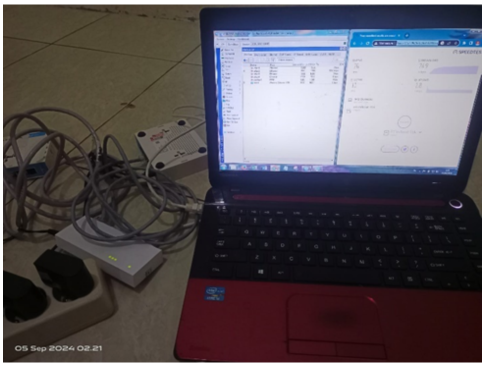

Fig 3. Result Image

In a mesh networking implementation with the Mikrotik Router Board 941, each node in the network will be connected to each other via a wireless connection. Each node also functions as a router, allowing data to be passed from one node to another. This keeps the network functioning even if there are nodes that are dead or disconnected, as data can be routed through the available alternative paths. In addition, mesh networking allows for a wider network coverage than traditional networks, as each node can serve as a repeater to amplify the signal. This is especially useful in situations where traditional grid infrastructure is difficult to build, such as in remote areas or during natural disasters.

After the configuration process on the Mikrotik Router Board 941 device is complete, the next step is to test the mesh network connectivity. This test aims to ensure that each node in the network can connect and communicate well with the others, as well as assess the overall performance of the network. One of the methods used in this test is to conduct a speed test through Google services. Through this test, it can be seen whether the network is functioning optimally, including measuring important parameters such as data transfer speed, latency, and the rate of packet loss that occurs. In addition, testing can also be done by sending large amounts of data to evaluate the performance of the mesh network in handling high data traffic. This is important to ensure that the network is able to operate properly, even under heavy loads.

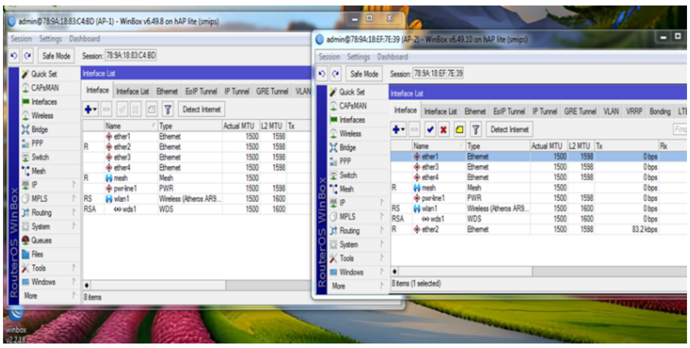

Fig 4. Configuration Result Image

On the WinBox view above, each is connected to two different devices. Here's the explanation:

1) Left Window (AP-1):

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a. connect to a device with a MAC address 78:9A:18:83:C4:BD (referred to as AP-1).
b. The table shows the various interfaces available on the device.
c. Ether2, Ether3, Ether4 are Ethernet ports.
d. Mesh is a mesh network interface.
e. PWR-LINE1 is a PWR network interface used for communication over power cables.
f. WDS1 is a Wireless Distribution System (WDS) interface that connects devices over a wireless network.
g. There is also a wireless interface (wlan1) using the Atheros AR9 chipset.

2) Right Window (AP-2):
a. connect to another device with a MAC address 78:9A:18:EF:7E:39 (referred to as AP-2).
b. ether1, ether2, ether3, ether4 as ethernet ports.
c. mesh, PWR-line1, and WDS1, which indicates that these devices are also connected via mesh and WDS networks.
d. wlan1 uses the Atheros chipset for the wireless interface.

In both windows, all interfaces have the same MTU (Maximum Transmission Unit), which is 1500 for the physical MTU and 1598 for the layer 2 MTU. In addition, the right window shows data activity on the ether2 interface (83.2 kbps for RX), indicating data transfer through that port.

Conclusion:
a. Both devices are connected in a network using Ethernet, Mesh, Power Line, and Wireless (WDS).
b. The network is working fine, and one of the devices is sending/receiving data over ether2.

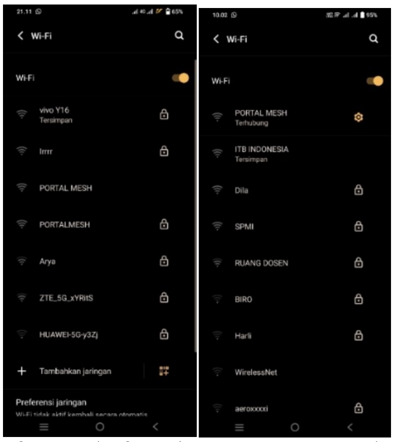

Fig 5.. Before and after views are connected

First Image:
a. Displays a list of Wi-Fi networks detected by the device.
b. Some of the detected Wi-Fi networks have SSIDs such as "MESH PORTAL", " MESH PORTAL ", "Arya", "ZTE_5G_xYRiS", and others.
c. From the list of related "MESH PORTALS" and "MESH PORTALS" use mesh network technology, which is marked with the word "MESH" in the name.

Second Image:
a. In the image, it can be seen that it is connected to a Wi-Fi network with the name "MESH PORTAL".
b. Other Wi-Fi networks detected include "ITB INDONESIA", "Dila", "SPMI", "RUANG LECTURER", and others.
c. The status indicates that the device is currently actively connected to the "MESH PORTAL" network, confirming the active network that is currently in use.

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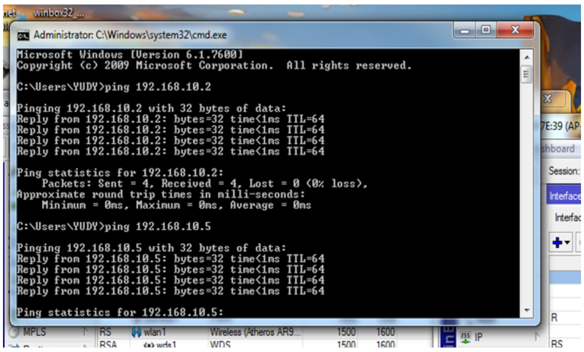

Fig 6. Configure IP

checks the network connection to two IP addresses, namely 192.168.10.2 and 192.168.10.5.

1. Pinged to 192.168.10.2:
   a. Command: ping 192.168.10.2
   b. The system received 4 replies from IPs with a reply time of less than 1ms, and a TTL (Time To Live) of 64.
   c. The ping statistics show no packets lost (0% loss) with the minimum, maximum, and average reply times all being 0ms, indicating a very fast and stable connection.
2. Pinged to 192.168.10.5:
   a. Command: ping 192.168.10.5
   b. Just like before, there were 4 replies with a response time of less than 1ms and a TTL of 64.
   c. The ping statistics are not fully displayed in the image, but from the reply results, it can be seen that the connection to this IP is also working fine with no packets lost.

In conclusion, both IPs (192.168.10.2 and 192.168.10.5) connect well without any packets being lost, and the connection has a very fast response time.

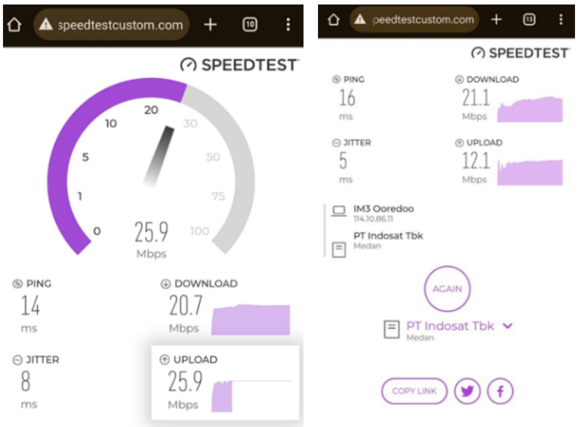

Fig 7. Display of Download and Upload Test Results via Speed Test

a. Ping: 16 ms — Latency indicates the time it takes to send and receive data packets from the server. A value of 16 ms is relatively fast, indicating a responsive connection.
b. Jitter: 5 ms — Variation in data transmission time. This value is quite low, indicating a stable connection.
c. Download Speed: 21.1 Mbps — The speed at which data is downloaded from the internet to your device. This figure is good enough for video streaming, browsing, and other internet activities.
d. Upload Speed: 12.1 Mbps — Speed to upload data from the device to the internet. This speed is also good enough for activities like uploading files or video calls.
e. Server: IM3 Ooredoo with PT Indosat Tbk server in Medan — This shows the server used for testing, providing location information, and the providers we are connected to.

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DISCUSSIONS

The research results show that the implementation of mesh networking using the Mikrotik RouterBoard 941 is capable of producing stable, efficient, and adaptive network performance to various data load conditions. Conceptually, mesh networking is a decentralized network topology in which each node is directly or indirectly connected to each other, enabling flexible and continuous communication. This characteristic provides a key advantage in the form of self-healing, namely the network's ability to automatically adjust communication paths when disruptions occur at one of the nodes.

In terms of performance, the results of this study indicate that the constructed mesh network is able to maintain connection stability despite increased traffic loads. This aligns with previous findings that mesh networking has a high level of reliability due to the availability of numerous alternative paths for data transmission (June, 2025). Furthermore, the network's ability to distribute data efficiently demonstrates that the routing mechanism used is capable of performing optimally in a dynamic network environment.

Compared to previous studies, which focused more on the basic implementation of mesh networking and the advantages of its topology, this study provides further contributions by emphasizing network performance in real-world conditions and the device's ability to handle high traffic loads. Previous studies have tended to under-explore how devices with limited specifications can be optimized to effectively support mesh topologies.

The use of the Mikrotik RouterBoard 941 as the primary device in this study is also a key aspect that differentiates it from previous research. Mikrotik is known as a flexible and economical networking solution with comprehensive feature support, such as routing, bandwidth management, firewalls, and RouterOS-based configuration. However, hardware limitations such as processor capacity and memory often hinder complex network implementations. The results of this study demonstrate that, with the right configuration, the device can still deliver optimal performance in mesh networking implementations.

Furthermore, this research also shows that mesh topology is highly suitable for implementation in environments requiring flexible and easily expandable networks, such as educational institutions or offices. The network's ability to remain stable despite the addition of nodes indicates that the system has good scalability. This confirms the results of previous research, which stated that mesh networking is highly effective for developing large-scale networks without the need for additional cabling infrastructure.

This research has several advantages compared to previous studies. First, it focuses not only on implementation but also conducts a comprehensive network performance analysis under varying data load conditions. Second, this research emphasizes optimizing the use of devices with limited specifications, namely the Mikrotik RouterBoard 941, thus providing a practical and economical solution for mesh network implementation. Third, this research examines in more depth the aspects of stability, data distribution efficiency, and network scalability within a single, integrated analytical framework.

Therefore, this research makes a significant contribution to the development of mesh networking technology, particularly in utilizing Mikrotik devices to create stable, efficient, and flexible networks. The results of this research are expected to be a reference for the development of wireless networks in various sectors, especially in environments with limited infrastructure but requiring reliable connectivity.

CONCLUSION

This study demonstrates that the implementation of mesh networking using the Mikrotik RouterBoard 941 provides satisfactory performance in terms of data distribution efficiency, network stability, and scalability. The developed mesh network is capable of maintaining stable connectivity while minimizing interference, ensuring consistent network performance. Furthermore, the system supports node expansion without significantly degrading connection quality, indicating good scalability. Despite its hardware limitations, the Mikrotik RouterBoard 941 proves to be a viable solution for implementing flexible and adaptive wireless networks when properly configured. The findings highlight that network performance is not solely dependent on hardware specifications but is also significantly influenced by configuration strategies and network topology design.

To enhance the effectiveness of mesh networking implementation, it is recommended to expand network coverage in areas with weak or no signal by adding additional mesh nodes. Increasing the number of Mikrotik devices and bandwidth capacity is also necessary to support a growing number of users. Furthermore, improving network security through advanced configurations such as firewall rules and access control mechanisms is essential. Continuous monitoring and management by network administrators are also required to ensure optimal performance and secure network operations.

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