



Implementation of Computer Network System Engineering Methods in Smk Negeri 5 Tanimbar Islands Regency

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ABSTRACT

This study aims to improve the stability and performance of computer networks at SMK Negeri 5, Tanimbar Islands Regency through the application of the Computer Network System Engineering method. The main problems faced are slow, unstable internet connections, and limited signal coverage, which hamper the implementation of the Computer-Based National Assessment (ANBK) and digital learning activities. This study uses a quasi-experimental method with One-Group Pretest-Posttest Design. The test results show a significant increase in download speed, upload speed and decreased latency

INTRODUCTION

The development of information and communication technology currently plays an important role in the world of education (Roza et al., 2023). One of the technologies that supports the advancement of education is computer networks. Computer networks allow efficient data transfer and communication between devices, which supports teaching and learning activities and school administration. However, there are still many obstacles faced by educational institutions due to lack of knowledge about computer networks, therefore a good understanding and development of computer networks is needed (Buana et al., 2023).

Computer network and internet technology has become a strategic part of educational institutions. Therefore, the availability of computer network infrastructure and its technology that can provide quality services and solutions in various activities in the world of education is very important (Akhir et al., 2024). With the development of this technology, schools, especially in remote areas, really need computer networks as a tool to assist in learning in these schools (Risanto Amala et al., 2023). Optimizing internet speed is one strategy that can be used to improve network performance. By optimizing internet speed, it is expected to accelerate access to information, increase productivity, and expand the reach of network services (Winata et al., 2023).

Wireless communication infrastructure facilities and infrastructure in remote, frontier and outermost areas are still a problem for the Indonesian government amidst technological developments. There are still several areas that have not enjoyed wireless communication services. (Fadli, 2022). SMK Negeri 5, Tanimbar Islands Regency, faces problems in terms of network handling and inadequate infrastructure limitations. Based on the results of interviews with the Head of the Laboratory, it is known that the school does not yet have good standards or planning in building network infrastructure.

This has an impact on the smooth operation of the school, especially when facing a large data load. There are often delays in sending data, even data cannot be sent at all. This condition is very disruptive, especially during the implementation of the Computer-Based National Assessment (ANBK), where poor internet connectivity is the main obstacle. As a result, the school must manually send data to the city of Saumlaki as the capital of the regency, which of course takes time. Based on the problems above, this study was conducted with the aim of providing solutions to the network problems that exist in the school.

LITERATURE REVIEW

Computer Networks

A computer network is a system that connects two or more computer devices to share resources, such as data or hardware, and enables efficient communication between devices. According to (Buana et al., 2023), computer networks enable fast and efficient data transfer within organizations, including in the education sector, where these networks play a key role in supporting teaching and learning activities.

The development of reliable network infrastructure is very important, especially in schools located in remote areas, such as SMK Negeri 5, Tanimbar Islands Regency. Inadequate infrastructure is often the cause of problems such as slow data transfer speeds and limitations in supporting technology-based learning activities, including the Computer-Based National Assessment (ANBK). (Wijaya & Purwanto, 2019) highlighted that computer network system engineering methods can help overcome the problem of slow and unstable network performance.

Computer Network Systems Engineering Methods

The computer network system engineering method is a network development process consisting of several stages, namely gathering needs, design, implementation, and evaluation. In a study conducted by Mahmud & Aprizal, (2022), this method was applied to design a more optimal network architecture that can meet user needs. This method involves selecting the right hardware, network configuration, and appropriate security techniques to ensure optimal network performance. The computer network system engineering process runs in a structured cycle involving gathering needs, design, testing, implementation, and maintenance. Each stage ensures that the system developed is in accordance with user needs and is able to support activities optimally.

Several supporting technologies that can be applied in network development at SMK Negeri 5, Tanimbar Islands Regency. Network Segmentation with Wireless: Its flexibility and mobility, which allows users to stay connected without being limited by cables. Wi-Fi Access Points: The use of access points with the latest Wi-Fi standards (eg, 802.11ac or 802.11ax) will increase the range and speed of the wireless network in schools. Network security is an important aspect that must be considered in the development of a computer network system in schools.

Firewalls, intrusion detection systems (IDS), and user access rights management are elements that need to be implemented to protect the network from external threats. According to research (Papaceda et al., 2023), the development of a structured network security system can increase reliability and protect data from cyberattacks.

Yagi Antenna

Yagi Antenna, or better known by its full name Yagi-Uda Antenna, is a type of directional antenna that is widely used for long-distance communication, especially in wireless and television network systems. This antenna was first developed by Shintaro Uda and Hidetsugu Yagi in 1926, and until now it remains

an efficient solution to improve signal reception in areas with weak signal coverage (Kaikatui & Corputty, 2019).

The Yagi antenna structure consists of several main components, namely: Driven

- a. **Element:** The main element that is directly connected to the transmitter or receiver.
- b. **Reflector:** The element behind the driven element to reflect the signal in the desired direction.
- c. **Director(s):** One or more elements in front of the driven element that direct and focus the signal in a certain direction.

The main function of the Yagi antenna in the context of strengthening the internet network is to capture signals from the Base Transceiver Station (BTS) or distant access point and direct them efficiently to the receiving modem or router. With high gain capabilities (generally between 10–14 dBi), this antenna is able to increase signal strength and reduce noise levels and interference.

Yagi antennas also have narrow beamwidth characteristics that make them very effective in focusing signal direction. However, the weakness is that they cannot capture signals from various directions at once (unlike omnidirectional antennas). Therefore, the position and direction of the antenna installation must be very precise and point directly at the signal source. In remote areas, such as the location of SMK Negeri 5, Tanimbar Islands Regency, the use of Yagi antennas is an important solution because it can expand the coverage and stability of previously limited wireless networks.

Network Topology

Network topology is the logical and physical arrangement of computer network elements, including computers, switches, routers, access points, and other devices. Choosing the right topology greatly affects the efficiency of data transfer, security, and ease of network maintenance Octaviana & Soewito, (2023). Commonly used topologies include: Bus topology: All devices are connected to one main cable. This topology is simple and inexpensive, but is not resistant to single points of failure. Star topology: Each device is connected to one control center (hub or switch). This is the most widely used topology because it is easy to troubleshoot and has high scalability. Ring topology: Devices are connected in a circle. Data moves in one direction or two directions. If one connection is lost, the network can be disrupted unless it has a redundancy mechanism. Mesh topology: Each device has a direct path to other devices. This topology provides high redundancy, is very resistant to failure, but is expensive and complex. Tree and hybrid topologies: A combination of two or more basic topologies to meet complex needs. In the case of SMK Negeri 5 Tanimbar Islands Reency, the topology used is a combination of star and point-to-point topology, where the access point becomes the distribution center and each client is directly connected using a cable or Wi-Fi connection. The selection of this topology is adjusted to the physical condition of the school building and connectivity needs.

IP Address (Internet Protocol Address) is a unique numeric address assigned to each device in a computer network so that the devices can communicate with each other. IP Address functions as an identity and guide for data sent and received in the network (Rehan et al., 2020). There are two versions of IP Address: IPv4: 32-bit format consisting of 4 blocks of decimal numbers (eg

192.168.1.1). IPv4 is the most commonly used version in local networks (LAN). IPv6: 128-bit format that can provide more addresses to overcome the limitations of IPv4, but has not been widely implemented in local environments. IP Addresses are also classified by class: Class A (1.0.0.0 – 126.255.255.255): For large networks. Class B (128.0.0.0 – 191.255.255.255): For medium networks. Class C (192.0.0.0 – 223.255.255.255): For small to medium networks, typically used in schools and offices. Class D and E: For multicast and experimental.

At SMK Negeri 5 in Tanimbar Islands Regency, class C IP Addresses such as 192.168.1.10 – 192.168.1.16 are used. This address is included in the Private IP category which is used for local networks and cannot be accessed directly from the internet without NAT (Network Address Translation). Setting the IP Address statically (manually) also helps avoid IP conflicts and simplifies the network troubleshooting process.

Experiment Method

The experimental method is a scientific approach used to observe and analyze the effects of a treatment on the variables being studied. In the context of computer network research, this method is very suitable for determining the effectiveness of implementing new technology on the performance of existing systems (Christidamayani & Kristanto, 2020). Types of Experimental Methods: True Experiment: Randomization and full control of variables. Quasi Experiment: No randomization, but there is still manipulation of variables. Field Experiment: Conducted in a real environment, not in a laboratory. This study uses a quasi-experimental approach with a One-Group Pretest-Posttest design, which is a design in which only one group is tested twice: before and after the treatment is carried out.

This design is suitable for use in educational environments where the formation of a control group is difficult due to population limitations. The main steps of this method include: Pretest: Measuring the initial conditions of network performance (download speed, upload speed, latency, etc.). Treatment: Implementation of network system engineering methods (e.g. installation of Yagi antennas, network reconfiguration, etc.). Posttest: Re-measuring network performance after implementation to see if there is any improvement or change. The advantage of this method is its ability to compare data directly and concretely, while the disadvantage is the absence of a control group which makes the results more susceptible to the influence of external variables. However, with strict environmental control and a systematic approach, the results can still be trusted as a basis for an evaluation system.

METHODOLOGY

Research Approach

This study uses a quantitative descriptive approach, where the collected data will be analyzed to describe the impact of the application of the Quasi Experiment method on the performance of computer networks at SMK Negeri 5, Tanimbar Islands Regency. The purpose of establishing a quasi experiment in computer network design is to provide a systematic and structured framework for planning, designing, implementing, operating and optimizing computer networks at SMK Negeri 5, Tanimbar Islands Regency.

Data Collection Technique

1. Observation

The observation method was carried out by directly observing the condition of computer network services at SMK Negeri 5 Tanimbar Islands Regency. This observation aims to see directly the obstacles faced in network infrastructure, such as the hardware used, connectivity conditions, and network use in teaching and learning activities.

2. Interview

The interview process is carried out with related individuals, such as school network operators, teachers and other education personnel. The purpose of the interview is to dig up deeper information regarding the problems faced in using computer networks, the need for improved services, as well as proposed solutions that are expected.

3. Documentation

Documentation is carried out by collecting various technical and administrative data that supports research. This data includes network device specifications, network topologies that have been implemented, as well as reports regarding problems that have occurred.

Network Development Methods

This study uses a quasi-experiment method with a One-Group Pretest-Posttest Design as shown in Figure 1. The aim is to measure the effect of implementing computer network system engineering methods on network performance and stability at SMK Negeri 5 Tanimbar Islands Regency. Researchers can compare the condition of the computer network before and after treatment (implementation of a new system) without using a control group. The treatments given in this study include: redesigning the computer network topology, installing Yagi antennas to strengthen internet signals, installing coaxial cables and pig tail connectors on modems, setting IP addresses and configuring network devices.

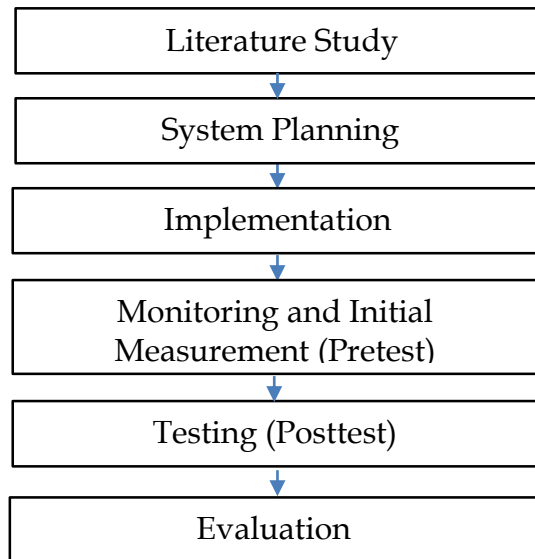


Figure 1. Quasi-Experiment Method

RESULTS AND DISCUSSION

Network Needs Analysis

At this stage, the researcher will conduct a computer network needs analysis at SMK Negeri 5, Tanimbar Islands Regency. This involves interviews with the school, direct observation, and analysis of existing infrastructure. The goal is to understand the specific needs of the school, the challenges faced, and expectations for the system to be developed.

From the results of data collection carried out by the researcher, there are physical conditions and layout of the school environment. The school plan is an important reference in determining the position of network devices, Wi-Fi access points and antenna placement points, which can be seen in Figure 2.

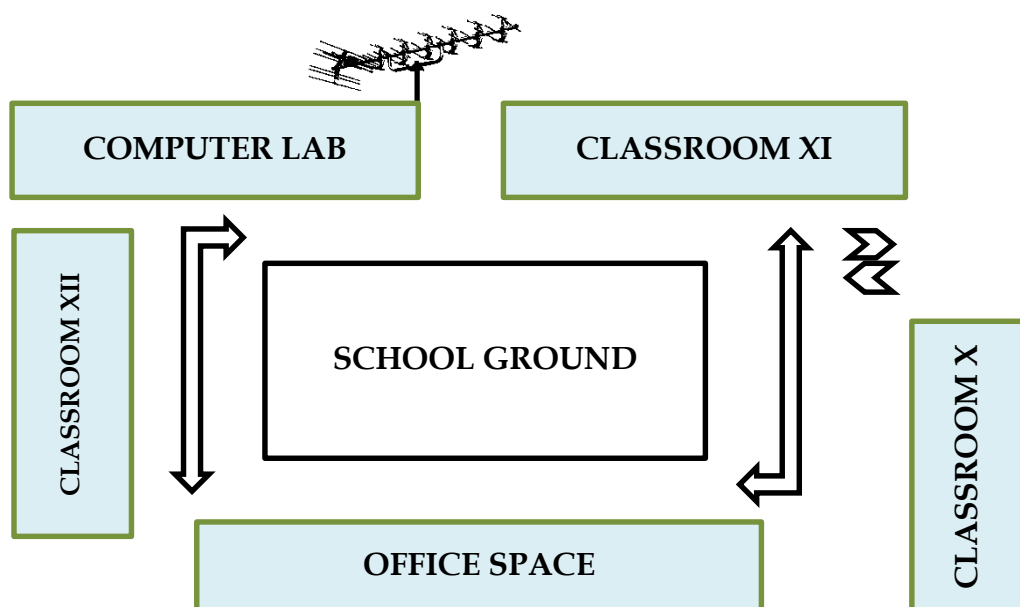


Figure 2. School Layout

From the results of initial observations and interviews with ICT teachers and the Head of the Laboratory, it is known that SMK Negeri 5, Tanimbar Islands Regency already has a computer laboratory containing 7 personal computers, one Orbit as an internet center and one Access point as a network introduction, where the school still has limitations in terms of internet connection and wireless network coverage.

Hardware, software, and data collection tools. The hardware consists of: Yagi Antenna, 15 meter Coaxial Cable, SMA Single Modem Pigtail Connector, Huawei B320-923 Modem (Orbit), TP-Link 8 Port Access Point, and Lenovo Client Laptop with 8 GB RAM. The software consists of: CBN Speedtest Application, Signal measuring tools such as NetMonitor.

Pretest: Initial Conditions of Infrastructure and Network Performance

This study uses a One-Group Pretest-Posttest Design, where measurements are taken before (pretest) and after (posttest) the implementation of a computer network system. There is no control group in this design, but changes that occur after treatment are compared with initial conditions as a reference for effectiveness.

Before the treatment was given, initial observations and measurements were made on the computer network at SMK Negeri 5, Tanimbar Islands Regency: Initial Infrastructure: 1 Huawei B320-923 Modem (Orbit), 1 TP-Link 8 Port Access Point and 7 PC Client units without signal amplifiers. Main constraints: Unstable internet connection, Limited Wi-Fi signal range, Low internet speed and High latency. Initial Measurement Results (Pretest): Download Speed: 1.21 Mbps, Upload Speed: 1.85 Mbps, and Latency: 791 ms. This test was carried out using the Speedtest CBN application, which can be seen in Figure 3.

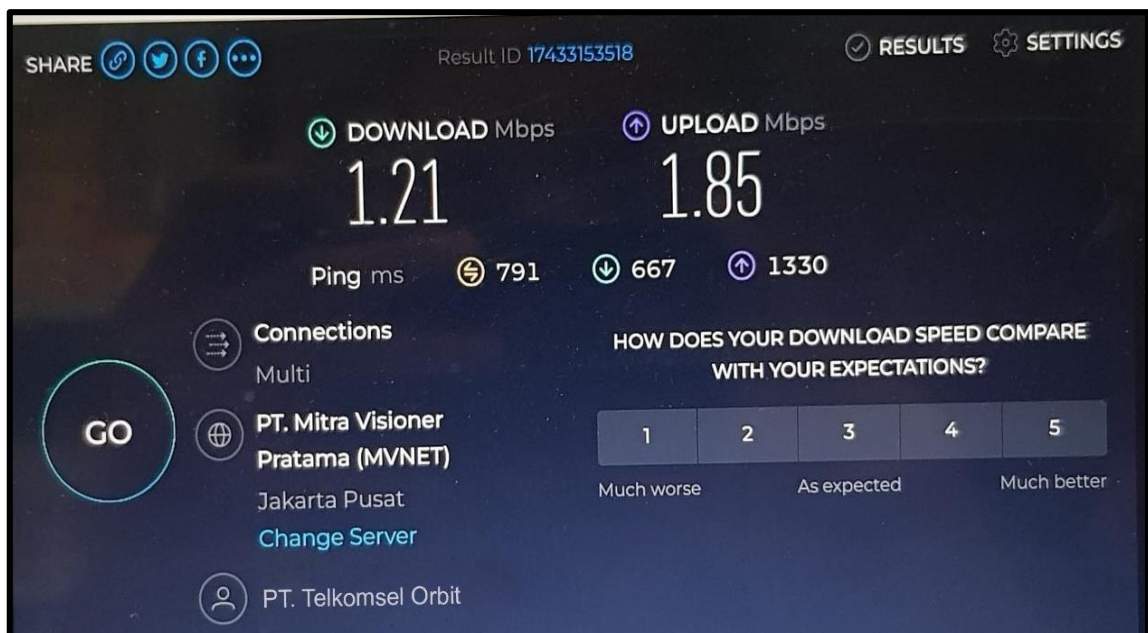


Figure 3. Speedtest Results Before Implementation

Treatment: System Implementation

Implementation steps are: Installing a Yagi antenna to capture external signals, pulling a coaxial cable to connect the antenna to the modem, resetting the network topology and IP Address, testing the connectivity Additional Devices Installed: 1 unit Yagi Antenna, 15 meter Coaxial Cable and 1 SMA Single Modem Pigtail Connector.

For the installation steps, it should be noted that the installation of the Yagi antenna functions to capture external signals, such as cellular or Wi-Fi signals, can significantly improve signal reception, especially in areas with weak signals. The treatment itself is carried out by paying attention to the following: Yagi antenna (adjusted for the target frequency, for example 900 MHz, 1800 MHz, or 2.4 GHz), support pole (iron or PVC pipe), bracket and bolts to attach the antenna to the pole, coaxial cable for example RG6 or LMR400, N-type connector or according to the device, receiving device namely modem - router - booster, grounding for safety from lightning, compass or BTS direction indicator application.

The installation of the Yagi antenna begins by determining the direction of the nearest BTS using an application such as NetMonitor. Install the antenna in a high place without obstructions and point it at the BTS. Connect the coaxial cable to the receiving device with the shortest possible cable to reduce signal loss. Test and adjust the direction of the antenna until the signal is optimal, then complete the installation with grounding for safety from lightning as shown in Figure 4.



Figure 4. Antenna Installation Process

Coaxial cable installation is done using quality cables and as long as possible to minimize signal loss. The cable is pulled through a safe path, not pinched, and protected from the weather, for example with a protective pipe. Avoid sharp bends and make sure the connectors are tightly installed and waterproof, especially in outdoor areas such as figure 5.



Gambar 5. Coaxial Cable Installation Process - Antenna - Modem

Network topology and IP Address Resetting

Network topology is an important element in the design and implementation of a computer network system, because it determines how devices in the network are connected and communicate with each other. The following is a picture of the network topology and IP addresses that were reset at SMK Negeri 5, Tanimbar Islands Regency, can be seen in Figure 6 and Table 1. dapat di lihat pada gambar 6 dan tabel 1.

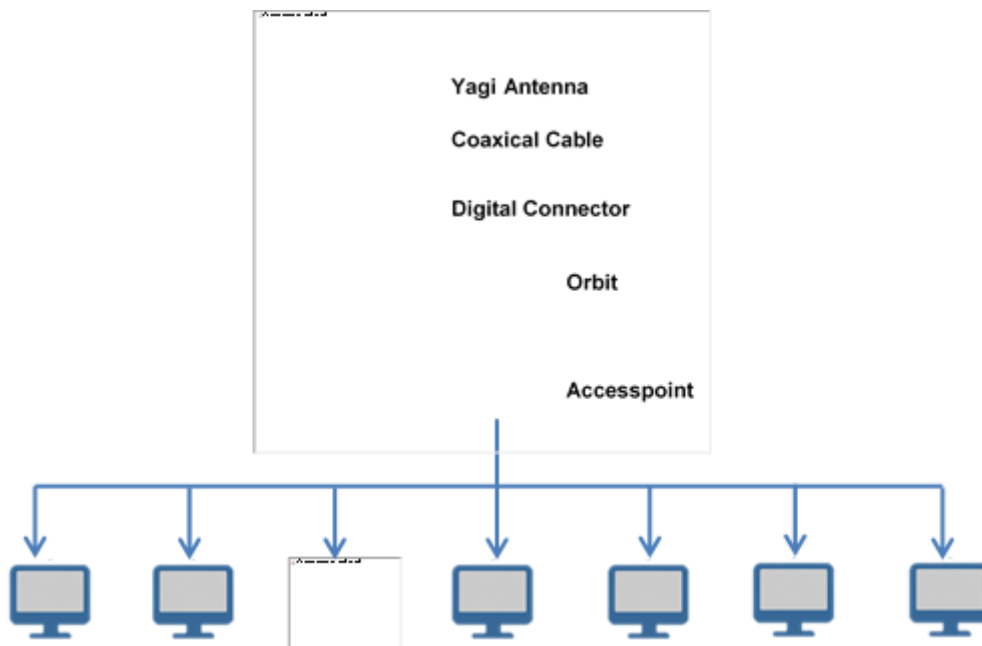


Figure 6. Network Topology at SMK Negeri 5, Tanimbar Islands Regency

The following is the Class C IP address in the computer laboratory at SMK Negeri 5, Tanimbar Islands Regency:

Table 2. Class C IP Addresses

No.	PC Name	IP Address
1	PC-1	192.168.1.10
2	PC-2	192.168.1.11
3	PC-3	192.168.1.12
4	PC-4	192.168.1.13
5	PC-5	192.168.1.14
6	PC-6	192.168.1.15
7	PC-7	192.168.1.16

Post-test: Condition After Implementation

After the installation and configuration process is complete, testing is carried out again using the same parameters as the pretest. The measurement results after implementation (posttest): download speed: 3.90 Mbps, upload speed: 5.58 Mbps, latency: 43 ms. These results show a significant increase in terms of network speed and stability, as shown in Figure 7.

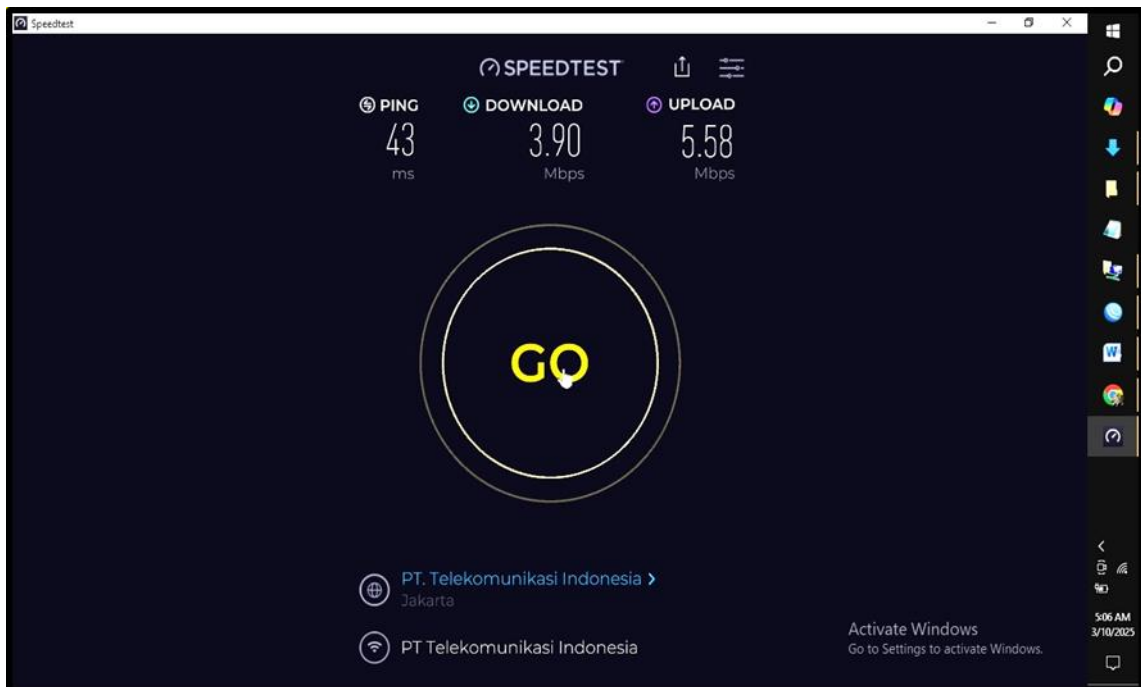


Figure 7. Speedtest results after implementation

Analysis of Results

After the implementation of the computer network system engineering method, there was a significant increase in network speed and stability. Based on internet speed testing, the results before and after implementation are as follows:

Table 3. Speedtest results after implementation

Parameter	Pretest	Posttest	Change
Download Speed	1.21 Mbps	3.90 Mbps	+2.69 Mbps
Upload Speed	1.85 Mbps	5.58 Mbps	+3.73 Mbps
Latency	791 ms	43 ms	-748 ms

There was an increase in internet speed of more than 200%, Network latency was drastically reduced, indicating increased connection stability and the signal coverage was also wider and more stable, reaching the entire laboratory.

Based on internet speed testing, the pretest results showed that the network at SMK Negeri 5, Tanimbar Islands Regency had inadequate performance, with a download speed of only 1.21 Mbps, an upload speed of 1.85 Mbps, and a high latency of 791 ms. After implementing the computer network system engineering method, there was a significant increase in performance at the posttest stage: the download speed increased to 3.90 Mbps, the upload to 5.58 Mbps, and the latency dropped drastically to 43 ms.

In addition to technical testing, evaluations were also conducted through interviews with IT teachers and several students in the computer laboratory. Based on their feedback, the network now feels much more stable and faster. The process of downloading and uploading files runs smoothly, and there are no longer connection disruptions when accessing the online learning platform. This has a positive impact on the school's readiness to carry out the Computer-Based National Assessment (ANBK) independently without significant technical constraints.

The evaluation also showed that the use of Yagi antennas as signal amplifiers is very effective in reaching cellular signals from outdoors. Proper antenna placement, use of appropriate coaxial cables, and complete reconfiguration of network topology and IP Addresses are factors in the success of implementing this system.

Overall, the application of computer network system engineering methods can be considered very successful in overcoming infrastructure limitations in underdeveloped areas, as well as supporting digital transformation in educational environments.

CONCLUSION AND RECOMMENDATION

The main problems of computer networks in SMK Negeri 5, Tanimbar Islands Regency are slow, unstable internet connections, and limited signal coverage, thus hampering the implementation of digital learning activities and the Computer-Based National Assessment (ANBK). The application of computer network system engineering methods carried out through a quasi-experimental approach with a One-Group Pretest-Posttest design has proven effective in improving network performance. The steps implemented include: installation of

Yagi antennas, installation of coaxial cables, IP Address configuration, and resetting network topology.

The test results showed a significant improvement in network quality, where download speed increased from 1.21 Mbps to 3.90 Mbps, upload speed from 1.85 Mbps to 5.58 Mbps, and latency decreased from 791 ms to 43 ms. This shows an increase in internet connection stability of more than 200%.

Yagi antennas play an important role as a technical solution in strengthening signals in remote areas. The combination of hardware use and proper network system settings provides real results in supporting the needs of educational technology in schools. Overall, this study proves that computer network system engineering methods can be applied practically and effectively to improve school network infrastructure, especially in disadvantaged, frontier, and outermost areas, and provide direct benefits in supporting the implementation of ANBK and digital learning.

FUTHER STUDY

Further research is recommended to develop more complex network systems, such as the use of VLAN technology, firewalls, or bandwidth management systems to increase network efficiency and security according to the development of school needs.

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