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Configuration and Visualization of Spanning Tree Protocol (STP) for VLAN-Based Using Packet Tracer

Misinem[1], Hardian Alfin Triarso [2]

[1] Computer Engineering, Vocational Faculty, Bina Darma University
[2] Computer Engineering, Vocational Faculty, Bina Darma University

[*]**Email:** [1]misinem@binadarma.ac.id, [2]hardianalfin@gmail.com

Abstract

In this era of globalization, scientific and technological progress is increasing, and so is the company we work with, the PT. Telkom Rivai. The company has discovered that computer networks are essential especially because they use and manage the kind of Local Area Network (LAN). Most LAN problems are the absence of a backup link and frequent looping in switch devices that make the internet network inactive or stop functioning. This problem can be resolved by breaking the cycle using the Spanning Tree Protocol (STP) approach. Since there are no restrictions on access between divisions, it allows unauthorized or unidentified people to access data at the company. As a solution, we propose configuring and visualizing a Virtual Local Area Network (VLAN) with access privileges for each division. The last problem is data leakage for every division, which can be fixed by restricting access to certain regions of the division by activating Access List Control on the router.

Keywords

Spanning Tree Protocol, Virtual Local Area Network, Access List Control

Introduction

A group of multiple computers connected by a communication protocol is called a computer network. A primary example is the importance of computer networks in large organizations like PT. Telekomunikasi Indonesia Rivai, has over fifty host or client PCs connected to a single Local Area Network (LAN) network spread across three floors of the building. The hardware and software of the office network system are more than sufficient to support employees' network access performance.

A conventional switch (default) is used to build the network issues at PT Telkom Rivai, resulting in a single network with a wide broadcast. Consequently, the development of Broadcast Storm, which is characterized by persistent packet duplication and looping, lowers network performance and causes it to collapse. Since every device on the local area network may view and interact with every other device, network security is likewise not guaranteed. Better network

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development in terms of performance and security necessitates study and design (Sutanto et al., 2018).

The invention of the Spanning Tree Protocol (STP) network system, which is a link layer network protocol that makes sure there are no loops in the topology of numerous bridges/switches in a LAN, was the solution to the issue that we put forth. Network architectures can include redundant links to provide automatic backup paths thanks to the Spanning Tree Protocol (STP) (Rahman et al., 2020). Security systems create solutions to security issues by applying Access List Control (ACL) and segmenting Virtual Local Area Networks (VLAN). ACL can decide which data packets are rejected and forwarded in the network to ensure smooth data traffic paths (Wijaya & Budiman, 2023).

Methodology

Several steps have been taken in this study to ensure the proposed solutions are practical and realistic to be implemented in the company. Those steps consist of configuring and visualizing the VLAN, adding ACL and STP with all the possible root, design, and backup bridges. This is followed by the network activation in the Packet Tracer application, diagnosing, and action planning. The details of each step are presented below.

Virtual Local Area Network (VLAN)

A Virtual Area Network (VLAN) is a collection of devices on a LAN network configured using management software to communicate if the devices are connected to the same cable and are located on a different number of LAN segments. VLANs work based on logical connections rather than physical connections, and VLANs are very flexible. VLANs can be considered to represent a broadcast domain. In this case, it means that the transmission generated by a station in the VLAN is received by a station not determined by specific criteria in the domain (Damanik & Hamdani, 2020).

According to Satryawati et al. (2021), a virtual trunk protocol (VTP) is a configuration that involves many switches. Configuration functions are like adding VLANs, deleting VLANs and changing VLAN names on a button. So, when there is a configuration change, it will automatically change according to the same VTP domain name.

Hamid et al. (2023) state that inter-VLAN routing forwards traffic from one VLAN to another using a router. On this network, the routing system can be centralized using only one router and one port interface to distribute IP addresses, which will be made virtual and trunked to other VLANs in the switches in the building.

Access List Control (ACL)

Access List Control (ACL) is one of the network security systems on Cisco routers that works by selecting data packets that enter/exit the router with a series of rules. ACL can determine which packages are allowed (permit) or denied (deny) (Satryawati et al., 2021).

Spanning Tree Protocol (STP)

Spanning Tree Protocol, often abbreviated as STP, is a link layer network protocol that ensures no loops in the topology of many bridges/switches in a LAN. STP is based on an algorithm discovered by Radia Perlman while working for Digital Equipment Corporation. In the OSI model for computer networking, STP is at layer 2 of the OSI. STP allows network designs to have redundant links to create automatic backup paths if an active link fails without the danger of bridge/switch loops (Damanik & Hamdani, 2020).

Subli et al. (2020) say the Spanning Tree Algorithm (Spanning Tree Protocol) automatically finds network topology. It forms an optimal single path through a network bridge by assigning the following functions to each bridge. The bridge function determines how the bridge functions concerning other bridges and whether the bridge forwards traffic to other networks.

Root Bridge

The root bridge is the master bridge or controlling bridge. The root bridge periodically broadcasts configuration messages (Zhang et al., 2022). This message is used to select routes and reconfigure the functions of other bridges if necessary. There is only one root bridge per network. The root bridge is chosen by the administrator when specifying the root bridge. Otherwise, the root bridge is physically closest to the centre of the network.

Design Bridge

The design bridge is the other bridge that participates in forwarding packets across the network. They are chosen automatically by exchanging bridge configuration packets (Rodeheffer et al., 2000). Each network segment has only one bridge design to avoid bridging loops.

Backup Bridge

All redundancy bridges are considered backup bridges. The backup bridge listens for network traffic and builds a bridge database. However, they do not forward packets. This backup bridge will take over the function if the root and design bridges are not working (Elmeleegy et al., 2009).

Packet Tracer

Packet tracer is a network simulation software made by Cisco. The packet tracer is suitable for beginners and is available for Windows and Linux Ubuntu operations. Before carrying out the actual network configuration (activating the function of each hardware device), it must first be reconfigured using this software. This simulation is helpful if you create a limited physical network (Kumar & Ed, 2022).

Diagnosing

Based on observations during the internship, the researcher conducted a joint diagnosis with the IT Support division as a network admin related to existing problems and problems to be solved at the PT. Telkom Rival. The problem is the occurrence of a Broadcast Storm, which causes looping and duplicate packets to be sent continuously because it has one domain path on each switch connected directly to the router. There are no restrictions on access rights between divisions. It allows users who are not known or not permitted to access data in PT. Telkom Rivai, and the last problem is that data leaks occur for each division.

The form of the topology used at this time uses a tree topology that is implemented in the PT. Telkom Rivai building. The PT Telkom Rivai building has three (3) floors: the 1st floor of the AMO division, the 2nd floor of the Telkom Access division, and the 3rd floor of the IT Support division. The topology consists of an ISP as a medium for internet access, a server as a data and file centre (database), a router device for internet and server communication, four (4) switch devices as a link between client and server, and three (3) access point devices connecting wireless devices such as smartphones and laptops.

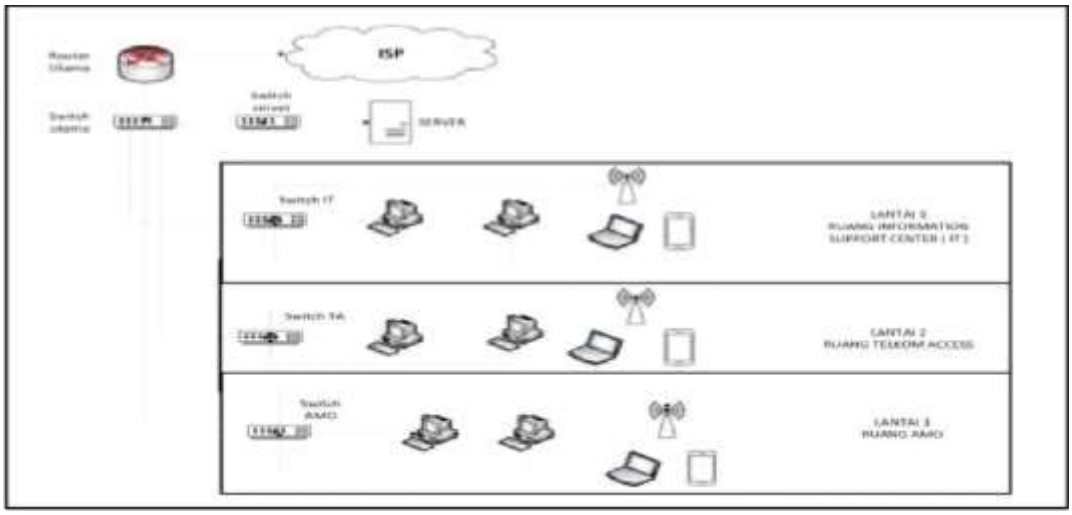

Figure 1. Network Topology at PT. Telkom Rivai

Action Planning

At this stage, the researcher first studied and understood, together with the IT Support division, the problems in the PT's Local Area Network (LAN) network. Telkom Rivai building. The action plan that will be carried out at this stage includes:

- Create a new network topology according to the topology used by PT. Telkom Rivai using Cisco Packet Tracer software. As well as in the new topology, the researchers added an alternative cable to connect each switch in the building.
- Determine the IP address address according to the connected device at PT. Telkom Rivai Palembang.
- Configure each device, including routers, switches, servers, access points and clients (PCs, laptops, smartphones).
- I am implementing a ping test between clients on the network at PT. Telkom Rivai Palembang.
- Implement Spanning Tree Protocol (STP) by connecting between clients on the PT. Telkom Rivai Palembang network.

Results and Discussion

Results

The results of the design of the VLAN-based Spanning Tree Protocol (STP) network system that has been carried out are shown. With these results, you can see the performance of the spanning tree protocol to prevent Broadcast Storms from occurring on the PT. Telkom Rivai network. As well as VLANs help STP work to break down smaller broadcast domains and divide devices into groups based on their location. At the same time, the Access List Control (ACL) method improves the security system, which is more guaranteed because it limits the access rights of each division.

Discussion

Spanning Tree Protocol (STP) Network System Design Simulation

The new network topology design is a tree topology following the network topology design of PT. Telkom Rivai. Below is a unique network topology at PT. Telkom Rivai designed using Cisco Packet Tracer software.

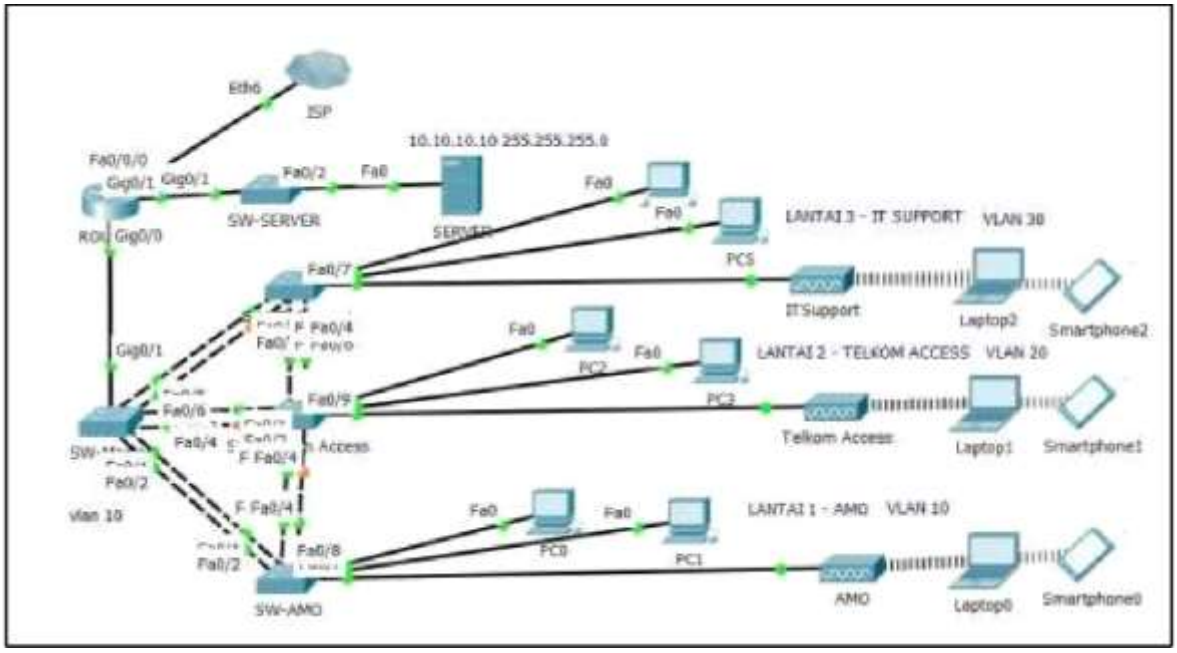

Figure 2. PT. Telkom Network Topology with VLAN-based STP

IP Address Scheme of Spanning Tree Protocol (STP) Network System Design

The following is a scheme of IP address addressing applied to designing a VLAN-based Spanning Tree Protocol (STP) network system at PT. Telkom Rivai.

Table 1. VLAN-based Spanning Tree Protocol network IP address

IP ADDRESS	SUBNET	DEVICE	INTERFACE
10.218.99.3	255.255.252.0	AMO-Device	VLAN-99
10.218.99.4	255.255.252.0	TA-Device	VLAN-99
10.218.99.5	255.255.252.0	IT-Device	VLAN-99

10.218.10.2	255.255.252.0	MASTER-Device	VLAN-10
10.218.20.2	255.255.252.0	MASTER-Device	VLAN-20
10.218.30.2	255.255.252.0	MASTER-Device	VLAN-30
10.218.99.2	255.255.252.0	MASTER-Device	VLAN-99
10.218.10.1	255.255.252.0	ROUTER-Device	VLAN-10
10.218.20.1	255.255.252.0	ROUTER-Device	VLAN-20
10.218.30.1	255.255.252.0	ROUTER-Device	VLAN-30
10.10.10.10	255.255.252.0	SERVER	

Conclusion

The following findings are concluded from the simulation and visualization results, based on our research at PT. Telkom Rivai: the availability of the Spanning Tree Protocol (STP) will reduce the repetitive transmission of data packets with the same package across the same switch on a different port and forwarded by broadcast, which is how it has been demonstrated to defeat Broadcast Storm. Redundant links, also known as backup pathways, back up the trail and function properly if the primary link's network is unavailable or offline. If this main line is still operational or difficulties do not exist, the Spanning Tree Protocol (STP) can identify which path is chosen as the main line and close other available lines. A firm or agency needs to group or organize its divisions using a Virtual Local Area Network (VLAN) so that no division can access any other division that has no interest in it.

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