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Research Article

Implementation And Optimisation Of Tree Network Topology For Computer Network System Efficiency

Nazarul Bagus Riyadi[1], Naufal Azhar Suhendar[2], Suci Rahmadhani[3], Lukman Medriavin Silalahi[4], and Hayadi Hamuda[5*]

[1-4] Informatics Department, Univesitas Siber Asia;
e-mail : nazarula589@gmail.com [1], lukmanmedriavinsilalahi@lecturer.unsia.ac.id [4]
[5] Department of Computer Systems, Universitas Pamulang e-mail : dosen02886@unpam.ac.id
* Corresponding Author : Hayadi Hamuda

Abstract: Nowadays, the need for fast, stable, and easy-to-manage computer networks is increasing, especially in environments with many devices such as offices, schools, or data centres. One attractive solution is the tree topology, due to its organised structure and ability to handle large-scale networks. However, its implementation often faces obstacles, such as the risk of interference in the main network devices and the challenge of maintaining data transfer efficiency. Through this proposal, we would like to explore how tree topology can be better and more effectively implemented. We will use one method, which is to perform network simulation. From there, we hope to find ways to optimise this topology, so that it can be used in various modern network requirements. The targeted result is a simple yet practical guide that can help anyone from technicians to network managers to build a more robust and flexible network, in accordance with technological developments and needs. flexible network, in accordance with technological developments and future needs.

Keywords: Config dhcp server on router; Config dns server on cisco packet tracer; VLAN (Virtual Local Area Network); Device Connectivity

1. Introduction

Computer networks are the main backbone of the digital world, whether in homes, educational institutions, offices, or industries. Along with the increasing need for fast and efficient data communication, good computer network design and implementation is very important [1]-[2]. However, the reality in the field shows that there are still many computer networks that are built without careful planning and not in accordance with applicable standards. This often leads to various problems, such as unstable connections, wasteful bandwidth usage, and difficulty in managing devices in the network [3]-[4].

One of the important factors in building a computer network is the selection of an appropriate network topology. Tree topology is an attractive option because it combines elements of both star and bus topologies, and allows for a multilevel network structure. This topology is very suitable for various systems that require hierarchy, such as schools, universities, offices [5]-[6]. In a tree topology, network devices can be grouped based on certain levels, making it easier to manage and develop in the future [7]-[8]. However, the implementation of tree topology in the field is often not optimal. Some implementations exhibit inefficient network design, causing problems such as bottlenecks on the main line, high latency, or even devices that cannot communicate with each other effectively [9]. These conditions not only impair network performance, but can also increase operational costs due to the need for additional devices or repeated repairs [10].

Therefore, this research focuses on the implementation and optimisation of tree topology to improve the efficiency of computer network systems [11]-[12]. The methodology used includes an in-depth literature review to understand the basic concepts and recent developments in tree topology, as well as theoretical analysis of the implementation of this topology in various relevant network scenarios[13]-[14]. By utilising simulation software such as Cisco Packet Tracer, this research aims to provide guidance for network designers to select, imple-

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ment, and optimise tree topologies appropriately[15]-16]. Hopefully, the results of this research can provide proper insight into the effectiveness of the tree topology and provide recommendations for optimal implementation in the future[17]-[18]. Problem Formulation

1. How to implement a tree topology with high scalability to support the addition of devices or replacement of devices in a network system.
2. How to effectively implement a tree topology to support a computer network system with a hierarchical structure.
3. What are the obstacles that are often encountered in the implementation of tree topology, and how can they be overcome.
4. How can optimisation strategies be performed on the tree topology to improve network efficiency in terms of speed, stability, and resource utilization.

The purpose of this research are:

1. Implementation analysis: Study the existing tree topology-based network design to identify its advantages and disadvantages.
2. Simulation and testing: using Cisco Packet Tracer application to simulate the implementation of tree topology in different network scenarios, such as offices and schools.
3. Optimisation strategies: developing practical steps to improve the network design, such as setting up more efficient data paths, reconfiguring devices, or implementing additional technologies such as firewalls and load balancers.

2. Proposed Method

This section describes the methods used in the development of this research. The following are the stages of the research methodology for this research figure 1 [19].

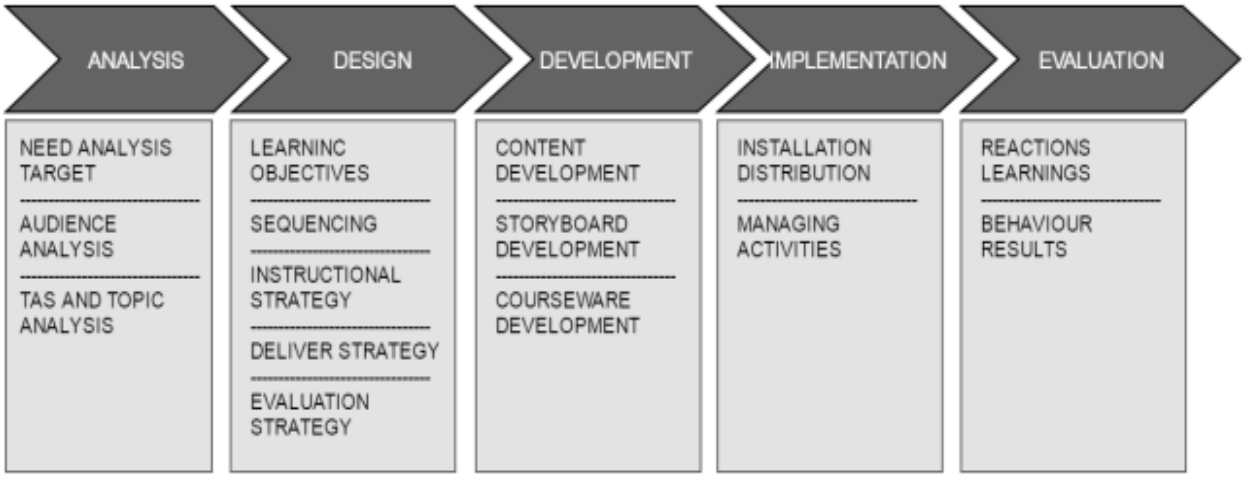

Figure 1. Addie Method

The Addie Method

As illustrated in Figure 1, ADDIE stands for Analysis, Design, Development, Implementation, and Evaluation. When creating educational and learning programmes, designers and developers can use ADDIE instructional design techniques as a reference (Aldoobie, 2015). This paradigm offers a dynamic and adaptable framework where the results of assessing each phase can influence the previous phase. Information regarding the knowledge, abilities, or attitudes that need to be taught to learners to achieve learning objectives is collected during the analysis phase through surveys, questionnaires, and interviews. The design phase follows, where the designer develops a comprehensive blueprint for the delivery of the educational programme. To select the best delivery method, the designer must create an educational strategy. During the development phase, the designer combines technology with real learning resources that will be used during the course. The process of turning all the planning into action is known as the implementation stage. This stage includes setting up the learning environment, training teachers, and training students. The evaluation stage is the last stage. To ensure that the learning programme meets the learning objectives, it is crucial to assess each step during this phase [20].

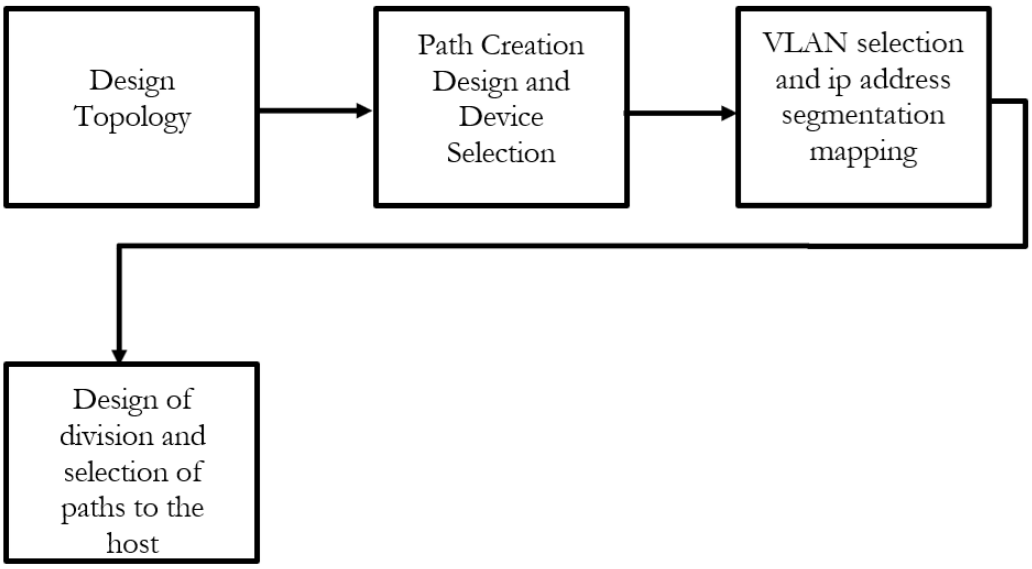

Figure 2. Flowchart Agile Development

System design contains planning steps that can fulfil the needs analysis that has been done. To meet these needs to produce a network system that divides the path evenly with a tree topology system, the planning steps can be seen in the picture above [21]:

1. Functional Requirements
   a. This system uses network paths and groupings to reach the destination of the host specified in the network topology (tree topology).
   b. This system selects and divides paths based on the vlan route paths on a switch that is distributed from the core switch on the network.
2. Non-Functional Needs
   a. Operating System: Windows/Linux/macOS as per Cisco Packet Tracer compatibility.
   b. Cisco WS-C2960-24TT-L (Distribution and Access Switch).
3. System Design
   a. System design contains planning steps that can fulfil the needs analysis that has been carried out.
   b. produces a network system that distributes paths evenly with a tree topology system.
4. Implementation
   a. Software installation: router, switch, server, pc-client.
   b. Configuring ip, dhcp server, vlan on cisco ISR4331 router.
5. Implementation
   a. Deploy the application on the server and test connectivity in educational and industrial environments.
   b. Provide technical documentation to assist with the installation process and user training.
   c. Construction of vlan management on Cisco WS-C2960-24TT-L switches according to the predefined topology design.
   d. Implemented path division on one of the distribution switches in charge of dividing the network segmentation.
6. Testing and Analysis
   a. system in performing path sharing of Cisco WS-C2960-24TT-L switches.
   b. The first test is a functional test covering the success of the system in dividing the path by looking at the packet flow in all paths on each network segment.
   c. he second test is performance testing including routing between networks, routing testing is carried out to ensure that the connections on both network segments are well connected

3. Results and Discussion

DNS Server and WEB Server Testing:

a. DNS server testing is done to test the dns resolver to ensure that the client pc can resolve the domain name server.
b. Web server testing is done to test the local web server that runs on the network is running properly.
c. User Device Configuration.
d. Data Simulation.
e. Network Tree Topology

Enter the following configuration

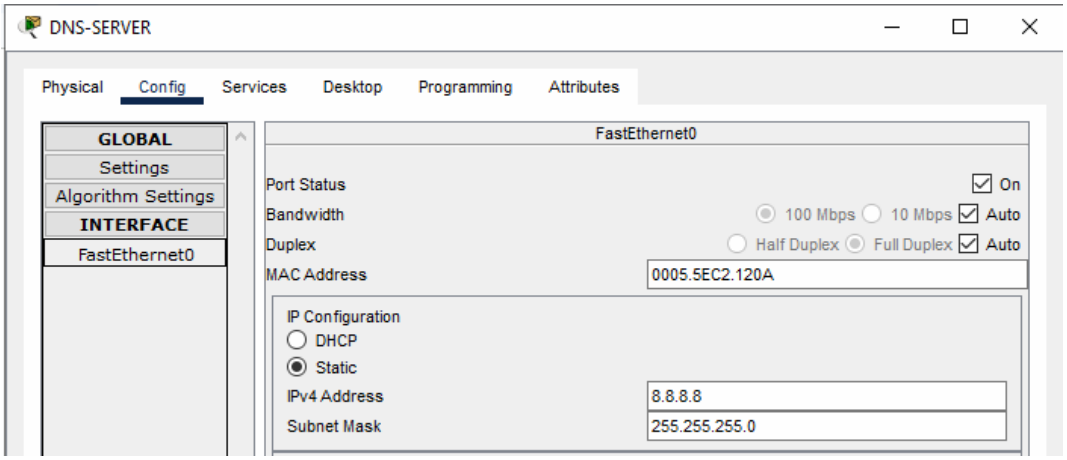

Figure 3. ip configuration on DNS Server

The next step is to configure DNS Service and A Record in DNS. Seen in Figure 3, the configuration server pointing domain 'tesweb.arkom.id' is directed to ip 172.10.5.10 which is the ip of the WEB server.

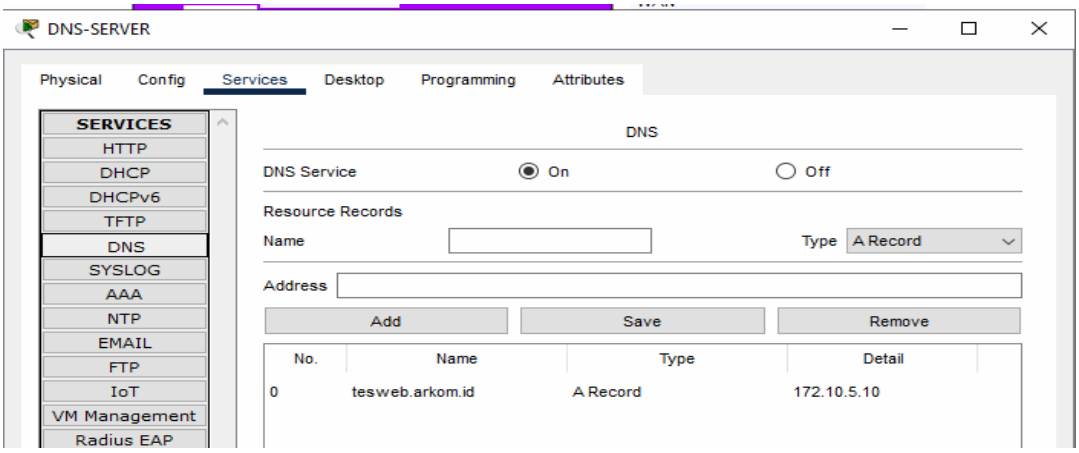

Figure 4. A record configuration on DNS Server

Access the network settings, find the DNS options, and select the DNS server you want to use, configure a device or system to use specific DNS servers

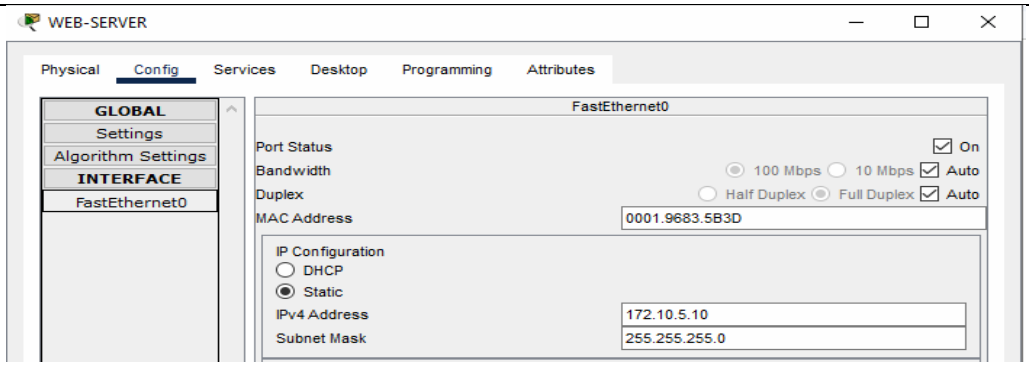

Figure 5. ip configuration on the Web Server

IP addressing involves assigning a unique IP address to a server, which serves as the server's identification and location within the network. With the right IP address, the server can receive requests from clients (e.g., a device that wants to access a website), process them, and send a response back.

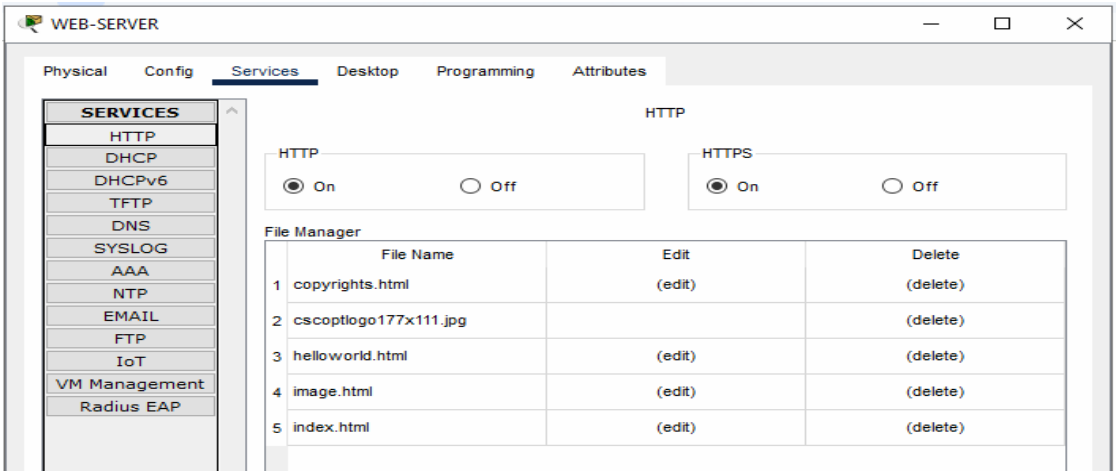

Figure 6. Web Host Configuration On The Web Server

Select IP Configuration, Enter the IP Address, Subnet Mask, and Default Gateway according to the following

Table 1. IP Addressing on PC

Device	tipe konfigurasi ip	IP Address	Subnet Mask
PC-1	static	192.168.10.10	255.255.255.0
PC-2	dynamic	192.168.10.21	255.255.255.0
PC-3	static	192.168.20.10	255.255.255.0
PC-3	dynamic	192.168.20.21	255.255.255.0

Each device connected to a computer network that communicates over the Internet Protocol is assigned a unique number. On the internet, this address functions similar to a physical address for your machine. You can check your network settings or use Command Prompt to find the IP address of your computer.

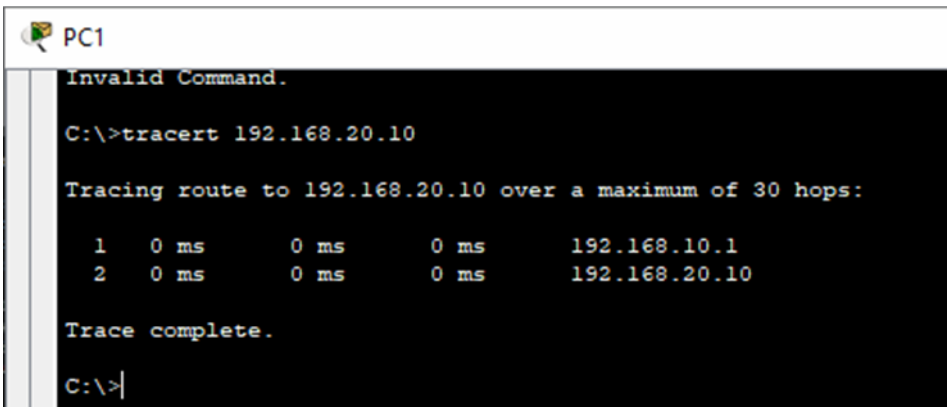

Figure 7. application simulation from PC 1 to PC 2,3,4

The process of simulating an application running on PC 1 so that it can be used on other PCs (PC 2, 3, 4) without the need to reinstall the application. This can be done through networking or virtualisation.

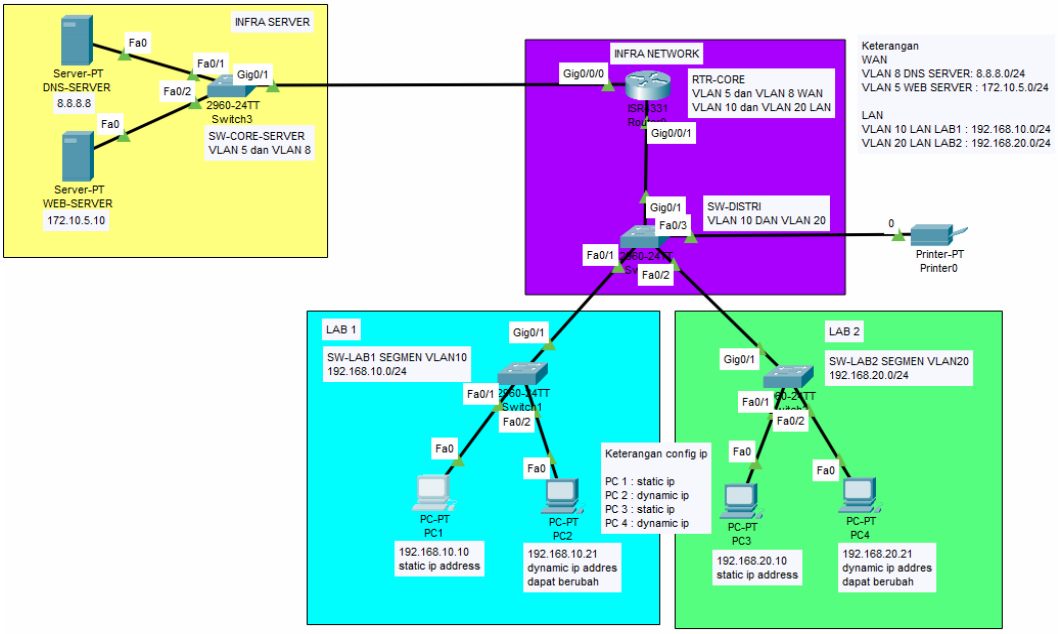

Figure 8. the overall design of the infrastructure.

This network topology implements segmentation using VLANs to improve communication efficiency and security. A router is used as a link between VLANs, enabling communication between devices in LAB 1 (VLAN 10) and LAB 2 (VLAN 20). The use of static and dynamic IP helps in network management, where critical devices use static IP while clients get dynamic IP. Servers are placed in separate VLANs to increase isolation and security, while printers can only be accessed by devices in VLAN 20. With this configuration, the network is more structured, secure, and efficient in managing data traffic.

4. Conclusions

Conclusions are drawn based on testing and analysis of the effectiveness of the implementation of tree topology with path separation on the WS-C2960- 24TT-L switch. Based on the test results, it can be concluded whether the application of tree topology gets optimal results.

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