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Analysis of Network Design and Management Using PPDIOO At SMA Labschool Unesa 1

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ABSTRACT

The development of computer network technology has significantly impacted global connectivity and technological innovation. Computer networks, which enable the seamless integration and expansion of network capabilities, have revolutionized communication, information access, and business operations. SMA Labschool Unesa 1, a digital-based school, requires robust network management to support its education delivery system. Government regulations also mandate the presence of a computer lab in educational institutions to support the learning process. Therefore, the research aims to analyze and design a computer network architecture using the PPDIOO model on Cisco Packet Tracer for implementation at SMA Labschool Unesa 1. As a result, the analysis of network design and management in this school has been done quite well. The use of the Cisco Packet Tracer application can create a good network design and successfully connect all network devices with ping testing that has been done. As well as for better network management, after being implemented in reality it is also necessary to optimize periodically.

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1. INTRODUCTION

The development of computer network technology has become an important aspect of broader technological progress. Computer network technology has broken through the boundaries of time and space, integrating information from around the world into a cohesive whole [1]. This integration has been the driving force behind interconnected experiences and the rapid pace of innovation in the technological landscape. The convergence of digital technology, telecommunications, and informatics has presented great opportunities for the development of network infrastructure and services [2]. Along with technological developments, the evolution of computer networking technologies plays a critical role in enabling and supporting these advancements. The seamless integration and expansion of network capabilities has facilitated the growth of various technology domains, including the Internet of Things, cloud computing, and artificial intelligence. These interconnections and advances in computer networking technology have laid the foundation for the modern digital age,

shaping the way we communicate, conduct business and access information.

A computer network is a collection of interconnected devices that communicate with each other to share resources and information [3]. The development of computer networks can be traced back to the mid-20th century when computer networks were first developed, which allowed computers to communicate with each other over long distances [1]. Since then, computer network technology has evolved rapidly, encompassing a variety of hardware, software, and communication techniques to develop and maintain networks [4]. Today, there are many types of computer networks, including local area networks (LANs), wide area networks (WANs), and wireless networks. The advantages of computer network implementation and management include better communication, increased storage capacity, and efficient resource sharing. Computer networks have revolutionized the way we communicate, access information, and conduct business, allowing us to access information, communicate with each other, and conduct transactions from anywhere in the world [5]. Continued advances in networking technology have made our lives simpler and more effective, and it is expected that these trends will continue to shape the future of communication and information sharing.

SMA Labschool Unesa 1 is one of the leading private schools in Surabaya which is under the auspices of the Dharma Wanita Foundation of Surabaya State University which has quality facilities and curriculum. The school with the slogan "School of Character" is located on Jl. Unesa Campus Lidah Wetan, Surabaya. SMA Labschool Unesa 1 or abbreviated as Smalabsa is a digital-based school and uses Semester Credit Units (SKS) in its education delivery system [6][7]. Digital-based Smalabsa requires schools to have good network management. Government Regulation Number 19 of 2005 concerning National Education Standards (SNP) Chapter VII concerning Facilities and Infrastructure Standards Article 42 Paragraph 2 explains that all school educational institutions are required to have infrastructure, one of which is a computer lab to support a regular and continuous learning process [8][9]. This supports good and correct network design and management in educational institutions. Therefore, this research was conducted with the aim of analyzing and designing computer network architecture using the PPDIOO model on Cisco Packet Tracer to be implemented at SMA Labschool Unesa 1.

2. LITERATURE REVIEW

2.1 PPDIOO (Prepare, Plan, Design, Implement, Operate, and Optimize)

Figure 1. PPDIOO Model [10]

PPDIOO is a network lifecycle approach developed by Cisco that defines the continuous service lifecycle required for robust network design and implementation [10]. The first step of this model is Prepare which includes setting organizational requirements, developing a network strategy, and proposing a high-level conceptual architecture that identifies technologies that can best support the business. Second, Plan involves detailed planning, such as creating a project plan, conducting a thorough audit of the existing infrastructure, and developing site-specific requirements. Third, Design

which focuses on creating a network design document based on the specifications and requirements identified in the previous phase. Fourth, Implement involves the actual implementation of the network design, including device configuration, cabling, and ensuring the network is built according to the design. Fifth, Operate is the longest phase where the network is actively managed, and day-to-day operations, fault detection, correction, and performance monitoring take place. Finally, Optimize focuses on refining the network design and operation, identifying and addressing operational issues, and ensuring the network meets organizational and technical requirements. The PPDIOO model provides a structured approach to network design and implementation, ensuring that the network is not only well designed but also effectively maintained and optimized throughout its lifecycle [11].

2.2 Cisco Packet Tracer

Cisco Packet Tracer is a powerful network simulation tool developed by Cisco Systems. It is widely used for education and training purposes, especially for individuals preparing for Cisco networking certifications such as CCNA and CCNP. This tool allows users to create, configure, and troubleshoot network infrastructure using a virtual environment, eliminating the need for physical network equipment. Packet Tracer supports a wide range of network devices, protocols, and features, including routers, switches, firewalls, and wireless access points, which makes it a comprehensive platform for learning and practicing various networking concepts. In addition, Packet Tracer is equipped with features to simulate IoT (Internet of Things) devices, so users can explore and understand network integration with IoT technology. This tool is available for free and can be downloaded from the Cisco Networking Academy website. It is compatible with a variety of operating systems, including Windows, Linux, and macOS, making it accessible to a wide user base. Overall, Cisco Packet Tracer is a valuable resource for networking students, educators, and professionals, providing a realistic and risk-free environment for network design, configuration, and troubleshooting practices.

3. METHODS

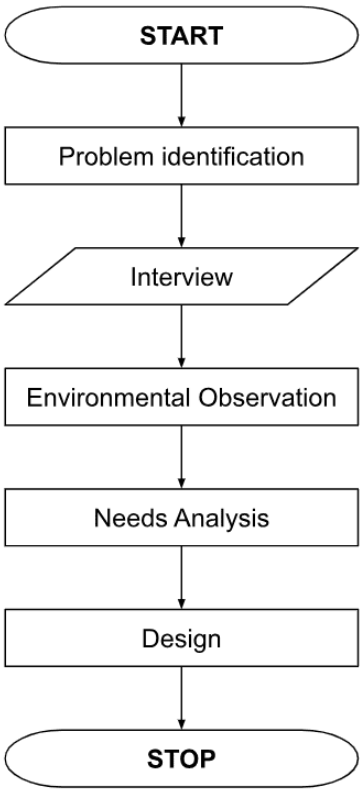

Figure 2. Data Collection Method [12]

The problem identification process is guided by the network analysis requirements document which can help to identify requirements, features, and needs. Interviews were conducted with the person in charge of managing the school network, students, and teachers and educators to collect data related to the school network. After the interview, an environmental observation was conducted to see the conditions in the field directly. Next, a needs analysis was conducted including user requirements, application requirements, device requirements, and network requirements. Finally, design is done on the needs that have been analyzed previously.

4. RESULTS AND DISCUSSION

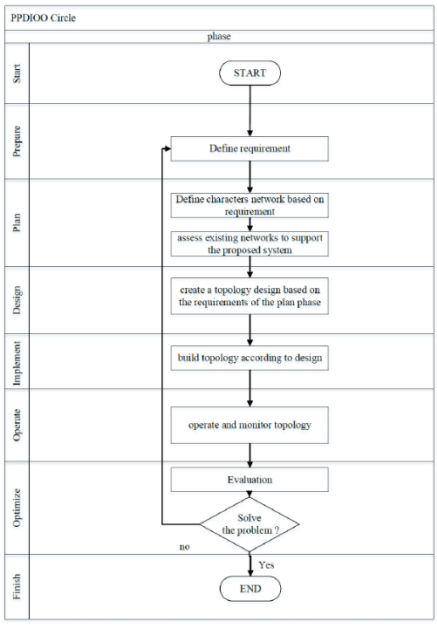

Figure 3. PPDIOO Cycle [13]

Based on the figure, the research conducted a PPDIOO model starting from the prepare to optimize stage completely and also explained the details of each stage. However, in some studies conducted using Cisco Packet Tracer, the main focus is limited to the "Prepare" to "Testing" stages [14]. Therefore, research using the PPDIOO model in Cisco Packet Tracer tends to provide insight especially in the early stages of the cycle, providing a solid foundation for possible further research or implementation in a real environment. In this research, the PPDIOO model is used with stages including prepare, plan, design, and testing. The following is the PPDIOO cycle model used in this research.

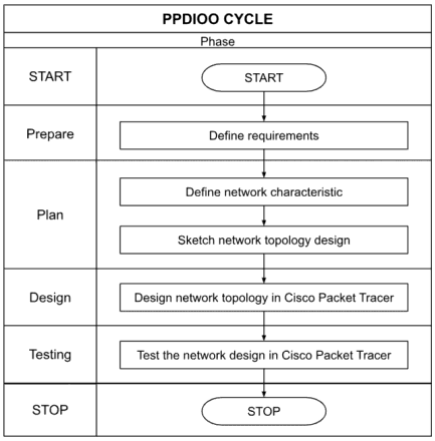

Figure 4. PPDIOO Cycle

Based on the Figure 4., there are four stages used in this research. The first stage is preparing which involves defining requirements such as user requirements, device requirements, application requirements, and its network requirements. After that, we define the network characteristic according to the requirements that we collected and sketching the initial topology design. In the next stage, we design the network topology in Cisco Packet Tracer. After the topology design is complete and it is confirmed that all network devices can be connected, testing is carried out. In the testing stage, we make sure that each network devices have been able to connect perfectly and can communicate with each other by performing a ping test. A fuller and more advanced discussion is carried out in the next section below.

4.1 Prepare

At this stage, obtained some data from interviews for network design requirements. Based on this, the following are some buildings and rooms that require a network to be installed.

Table 1. Data of School Building and Room

Building	Floor	Room	Number of Users
A	1st	Science Laboratory	36
		Classroom 12 IPA 1	25
		Classroom 11 SOEGEPBI 1	36
	2nd	Classroom 11 SOEGEPBI 2	36
		Classroom 12 IPA 2	25
		Classroom 11 SOEGEPBI 3	36
	3rd	Classroom 11 BIKIFIMAE 1	36
		Classroom 12 IPA 3	25
		Classroom 11 BIKIFIMAE 2	36
B	1st	Teachers and Administration	25
		Principal	12
		Library	12
	2nd	Classroom 10-1	36
		Computer Laboratory	30
		Classroom 10-2	36
	3rd	Classroom 10-3	36
		Classroom 10-4	36
		Classroom 12 IPS	25

Source: Interview

Based on the data in the table, the network devices needed for design and simulation on Cisco Packet Tracer are as follows.

Table 2. Device Requirements [14]

No	Device	Number of Device	Description
1	Router 1841	1	Located in the center of Unesa, the location and number are unknown.
2	Server-PT	1	Located in the center of Unesa, the location and number are unknown.
3	Switch 2960-24TT	9	One as a central switch, six as switches per floor in both buildings, and two in the computer labs.
4	Access Point-PT-N	6	For Wi-Fi connection and available on every floor in both buildings.
5	PC-PT	38	For computer labs and administration devices (in principal's room and library).
6	Laptop-PT	33	For teachers' room, principal's room, and library.
7	Tablet-PC-PT	468	For learning activities all students.
8	Smartphone-PT	8	For principal's room (in case for guests) and library.

Device requirements have many tablets as the school's learning activities are all digital-based.

4.2 Plan

The following is a network design plan in Figure 5.

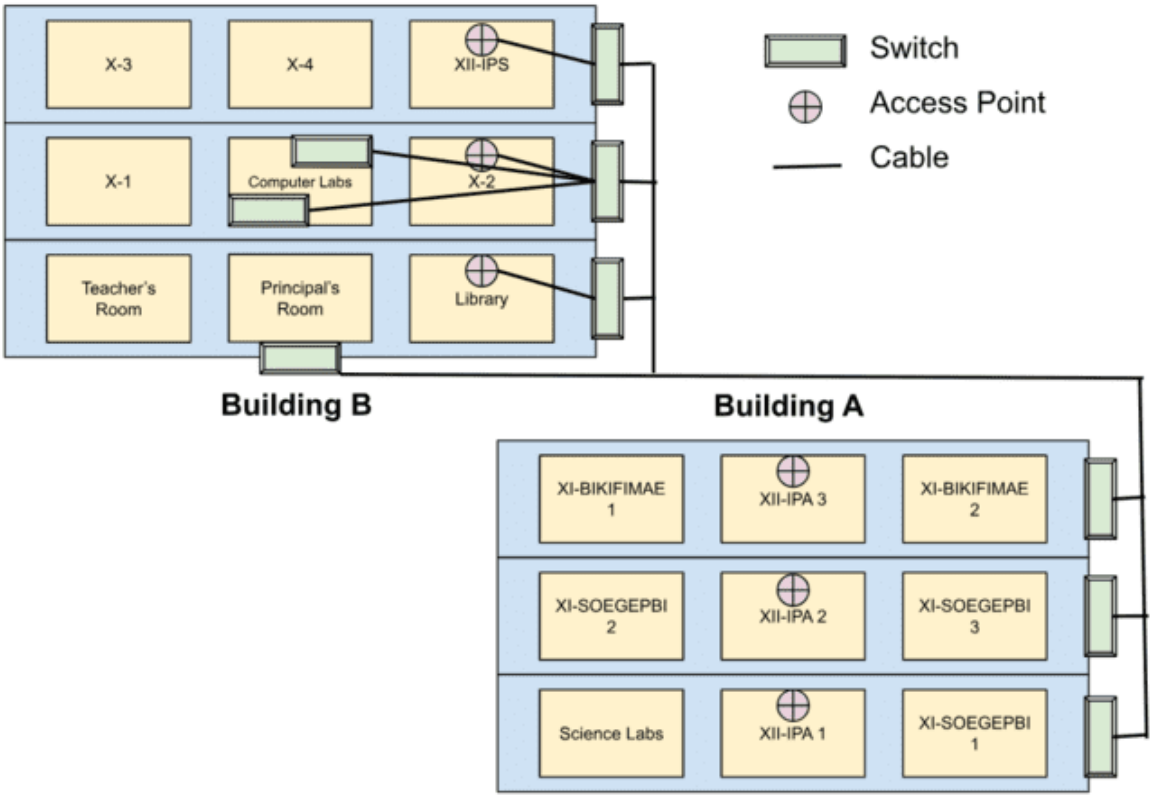

Figure 5. Network Topology Plan

4.3 Design

The network design plan that has been made is then applied in Cisco Packet Tracer as follows. There are two buildings, namely building A and building B where each building has three floors.

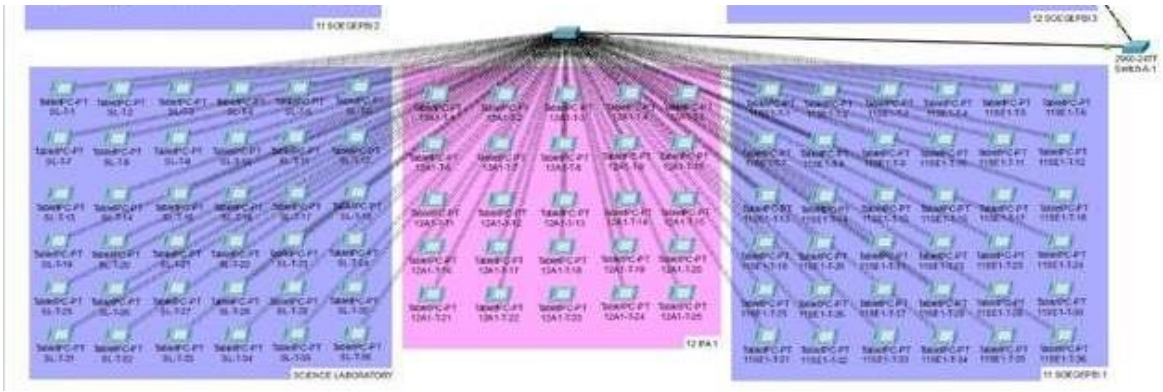

Figure 6. Topology of Building A on 1st Floor

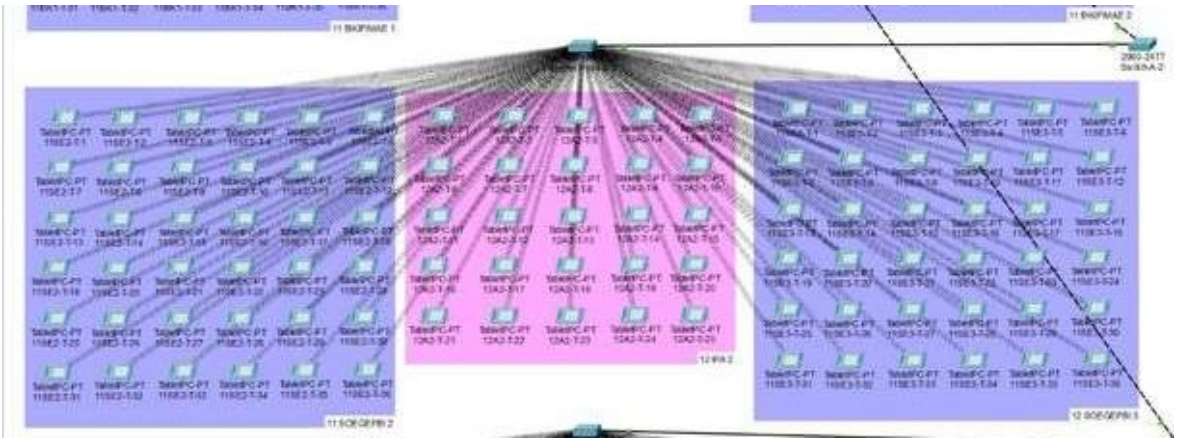

Figure 7. Topology of Building A on 2nd Floor

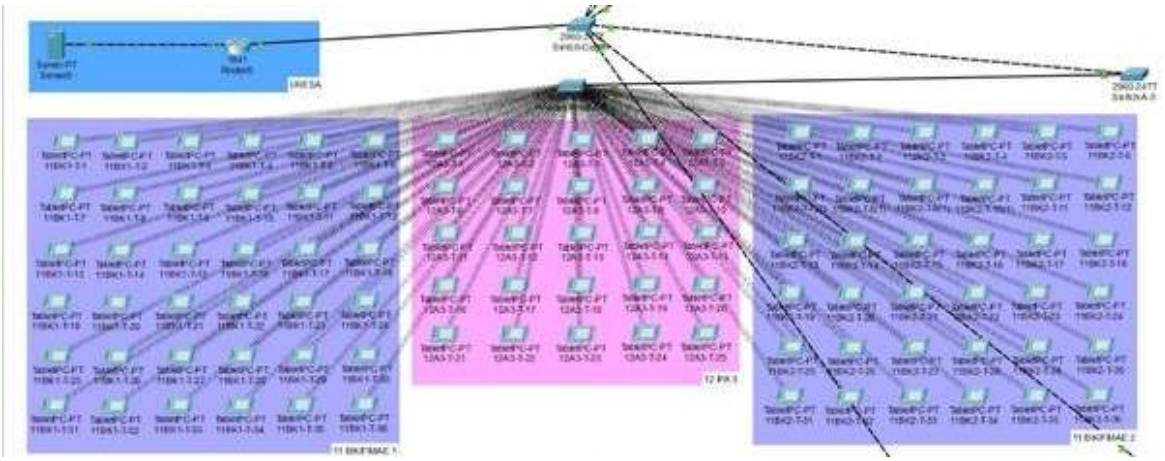

Figure 8. Topology of Building A on 3rd Floor

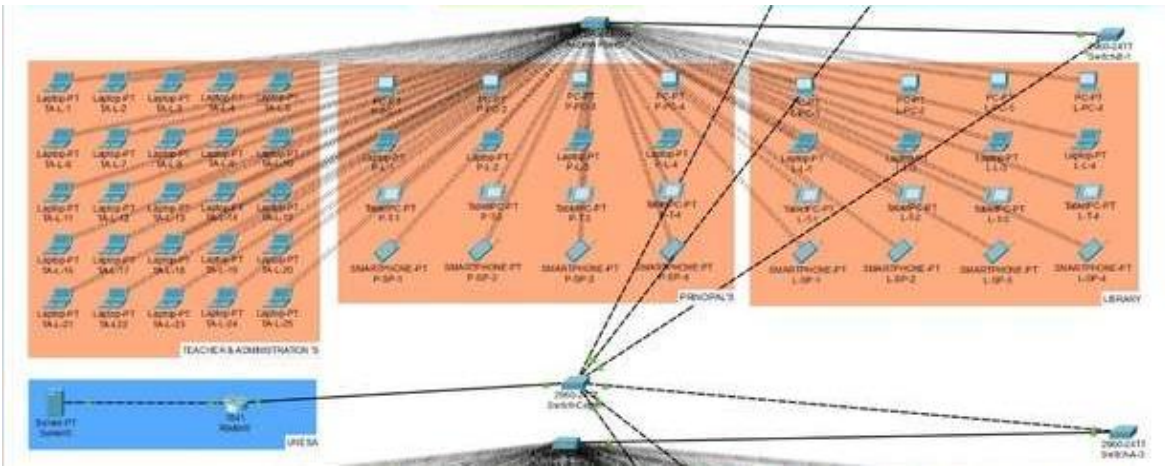

Figure 9. Topology of Building B on 1st Floor

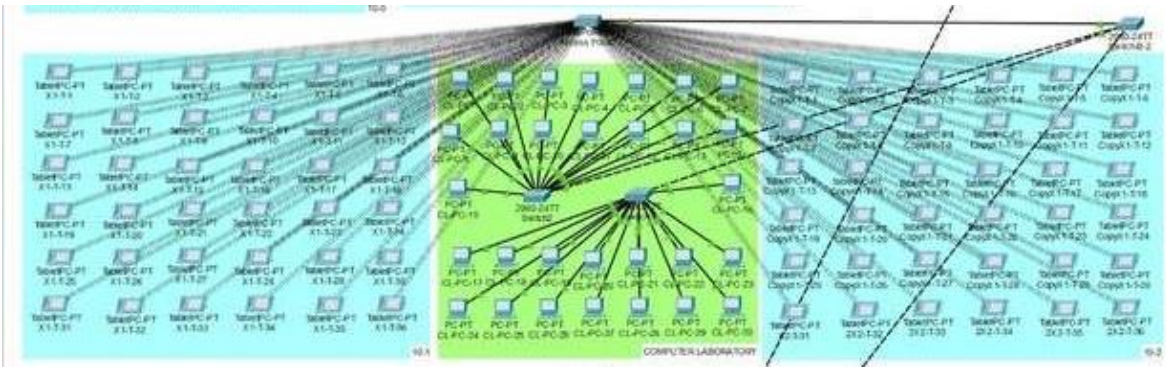

Figure 10. Topology of Building B on 2nd Floor

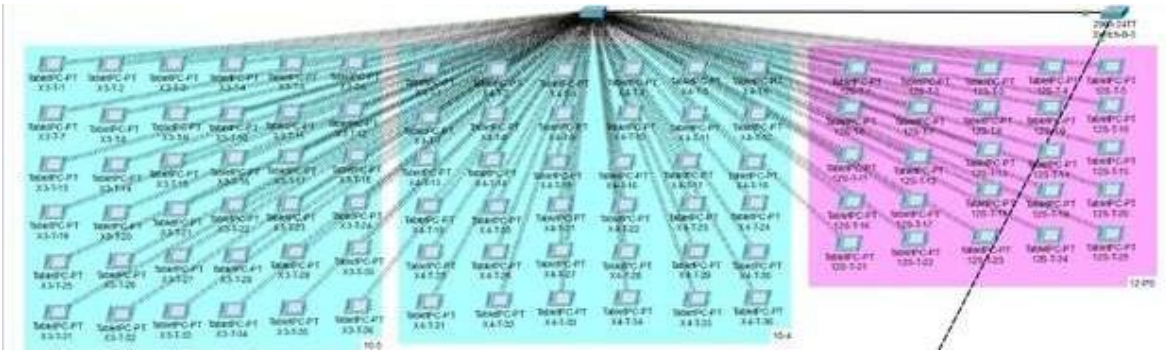

Figure 11. Topology of Building B on 3rd Floor

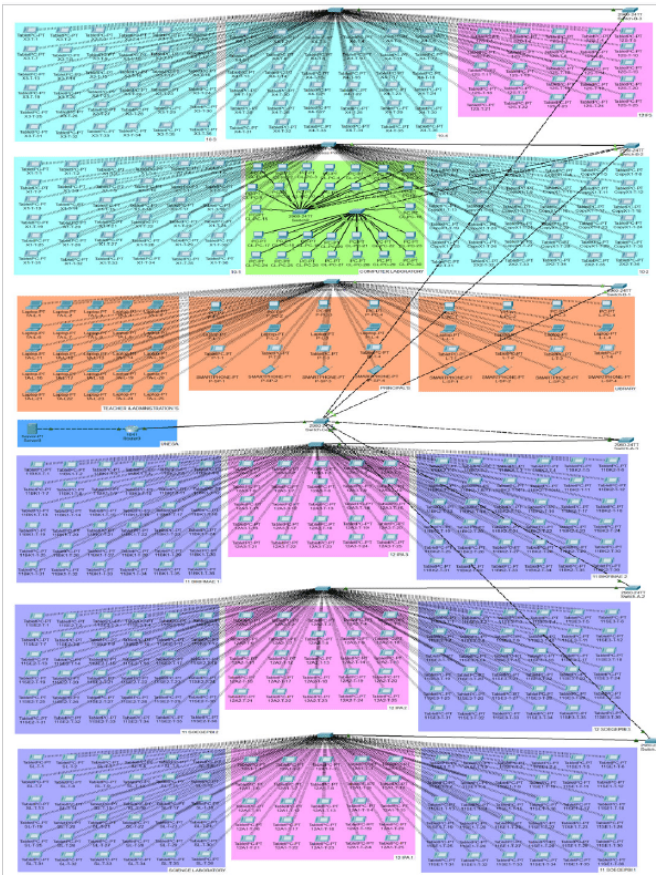

Figure 12. Complete Topology

4.4 Testing

In the last stage, testing, ping tests and sending simple PDUs will be carried out as following.

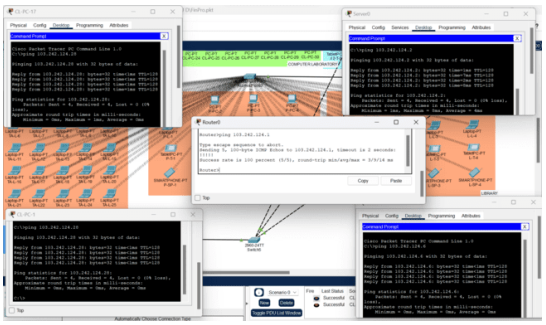

Figure 13. Ping Test

In figure 13 ping test it can be seen that the ping test was successful. On the router CMD (white) and on the server CMD (upper right corner), both ping tests have been successfully performed.

Figure 14. PDUs Test on Building A

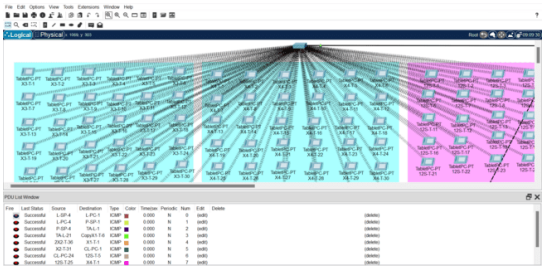

Figure 15. PDUs Test on Building B

Then on the PC in the computer lab (CMD upper left corner, lower left corner, and lower right corner) the ping test has also been successfully carried out.

5. CONCLUSION

The process of teaching and learning activities at SMA Labschool Unesa 1 is highly dependent on the network because all processes are digital-based that need to be accessed from a learning platform. Therefore, it is very important for schools to have good network design and management. In this research, an analysis of network design and management at the school has been carried out which has provided quite good results. The use of the Cisco Packet Tracer application can create a good network design and successfully connect all network devices with ping testing that has been done. The design of several network equipment devices in each place and room can be adjusted. The output in the form of design results based on the model from Cisco Packet Tracer needs to make real application in its development. As well as for better network management, after being implemented in reality it is also necessary to optimize periodically.

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