



Redesign and Simulation of Computer Networks in IoT-Based Medical Records Laboratory

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ABSTRACT

The medical record laboratory has a very important function, one of which is in serving patients using electronic medical records or often referred to as hospital management information systems. A computer network in a medical record laboratory in an educational institution is a very important infrastructure in carrying out learning activities, without exception on the computer network in the medical records laboratory at Dian Nuswantoro University. The current condition of the computer network still has shortcomings such as inappropriate network management, network devices that are not configured and features on the server that are less than optimal. The purpose of this research is to redesign and simulate computer networks with simulators to design a more optimal network and add network features that do not yet exist including the application of the internet of things (IoT) for maximum medical record laboratory services. The expected results of the redesign and simulation are that in order to run properly, there are changes to the design and needs of network devices that can be adjusted to the conditions they should be. Network devices that have been configured have DHCP server, NTP, FTP and Web server facilities. The addition of a motion sensor to turn on the laboratory room lights before use can also work well.

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1. INTRODUCTION

Almost every medical record study program has a medical record laboratory for learning activities. There are sections in the medical record laboratory such as for services that have TPPRI, TPPRJ, TPPGD, and Assembling Services. In addition, there are other spaces for the learning section of health administration such as INA-CBG'S. The laboratory also has an office space to control every activity of the laboratory activities (Temesvari & Tiyardi, 2021).

Dian Nuswantoro University has a medical record laboratory facility with various services as mentioned above. Currently the laboratory is already using a computer network in these learning activities. but in learning activities several times encountered

problems on the computer network. The problems found include: internet network disconnection, web server disruption, complicated network maintenance. In addition to this, laboratory personnel need some time to prepare the laboratory before activities in the medical record laboratory begin. So that sometimes there is time cut off when the initial learning begins. the conclusion of some of these problems is the need to redesign the computer network in the medical record laboratory and conduct testing in the form of simulations before any network repairs will be carried out(Gwangwava & Mubvirwi, 2021).

The application used in the redesign and simulation is the Cisco Packet Tracer 8.1 application. The author uses cisco packet tracer in doing redesign and simulation, because by using cisco packet tracer redesign and simulation can be done simultaneously more easily than other simulation applications(Andriani & Ghozali, 2019). The use of the cisco packet tracer application is used to obtain redesign and simulation results in the form of information that identifies that the network can work as expected. In this case, the medical record laboratory currently uses an unstructured network topology in its network communication process. Therefore, the network often experiences problems such as disconnected internet connections, disruption to the web server, and complicated network maintenance. So that this causes services in the use of medical record laboratory to be disrupted, especially when they are about to start activities.

In a study entitled Design and Simulation of IoT Systems Using the Cisco Packet Tracer by Norman Gwangwava (2021). The research discusses a case study on the management of factory fertilizers. The simulation only focused on process parameters for monitoring saturated steam temperature, converter head temperature, and neutralization temperature respectively. The model could be extended to include key process parameters—fuel flowrates, CO and SOx emissions, NOx emissions, evaporator steam pressure, and other broad industrial applications. The simulation carried out can work well, this is shown by the performance of the IoT-based device system that can be accessed from several PC networks in the office including using mobile devices(Gwangwava & Mubvirwi, 2021).

Then the research conducted by Ria Andriani (2019) on Performance Analysis and Redesign of School Lab networks Using Cisco packet tracer. Researchers designed with the concept of a star topology in a predetermined room. parameters used are delay, packet loss and throughput. the conclusions made in the performance analysis and design get good results because there is no role based on the results of the analysis of these parameters(Andriani & Ghozali, 2019).

The next research with the Waterfall Method Using Cisco Packet Tracer Software by Singgih arif widodo (2019). Researchers conducted research with the aim of designing a suitable and usable computer network topology design. so that its implementation is expected to assist the management in developing, repairing, and improving the quality of computer network infrastructure so that the vision and mission of the institution can be achieved. The conclusions of this study are expected to provide a network system design that can be used in the future(Widodo & Jumasa, 2019).

Further research was carried out by Rahmat Novrianda Dasmen (2022), Researchers conduct research with the aim of optimizing and improving services to the community. The conclusion of this study is that the Local Area Network (LAN) network is further optimized in its use and it is better to add several computers to improve performance in each polyclinic(Rahmat Novrianda Dasmen et al., 2022).

2. RESEARCH METHOD

In this study, the authors first analyzed all the existing network conditions in the medical record laboratory. Next, determine the topology used previously, this is done to determine

the research method that will be used. The research method and software used in this study is to use the waterfall method and Cisco packet tracer software. The reason for using software using Cisco packet tracer is because the software can simulate computer networks in sufficient detail as needed.

2.1 Waterfall Method

Waterfall method is one method in the System Development Life Cycle (SDLC) that has the characteristics of working on each phase in the waterfall that must be completed before proceeding to the next phase. This means that the focus on each phase can be maximized because there is no parallel workmanship (Heriyanti & Ishak, 2020). The steps taken in the waterfall approach are illustrated with the following images:

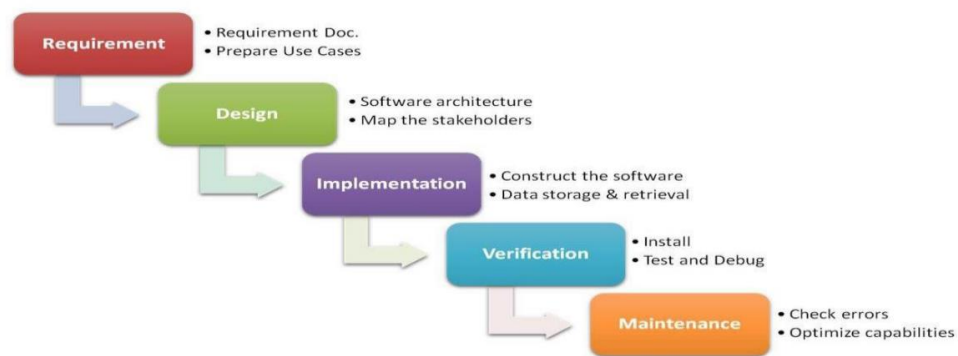


Figure 1. stages of the waterfall method

The work process flow in redesigning and simulating computer networks in the medical record laboratory is as follows:

- a. Requirement
In this first stage, the authors conducted a survey, analysis and identification of the overall needs of the computer network model that is currently running to find out the technicalities in the use of the medical record laboratory and the technology that will be used in the redesign.
- b. Design
In this second stage, the authors redesign the entire computer network and design a computer network model using a star topology which will be made using the waterfall method using Cisco packet tracer software.
- c. Implementation
After the redesign of the computer network has been completed, the next step is to configure the entire infrastructure that has been designed. The results of the configuration in accordance with the redesign produce a computer network that is in accordance with what is needed by medical record laboratory users.
- d. Verification
Testing is done by testing network connections, testing services on the server and designing the IoT system that has been made in accordance with the redesign plan (Susanto et al., 2020). In addition, ensuring that all computer network functions can be used properly without any errors as expected when simulating the use of medical record laboratory.
- e. Maintenance
After all redesigns and simulations can run well, it is necessary to test with real conditions to ensure the design can be implemented without any errors.

2.2 Star Topology

Network topology is a way of connecting several computers to create a computer network. Network topology has various forms of computer arrangement with various types of cables, connectors and different specifications (Anas et al., 2018). The focus of this research is to use a star topology. Star has a hub/switch in the middle of the topology as the center of this topology. The hub/switch is the center of this topology so its function is very vital, all network devices are connected to the hub/switch. This topology is a topology with the easiest maintenance so it is widely used (Anas et al., 2018). This topology has more advantages, including maintenance that is quite easy and does not require many devices because the network center is in the middle.

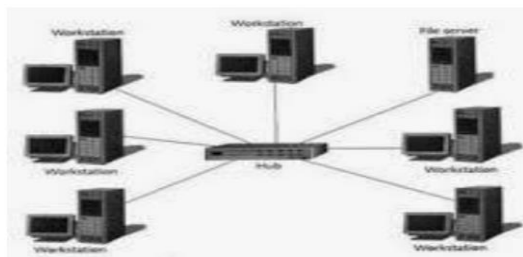


Figure 2. Star topology model (Widodo & Jumasa, 2019)

2.3 Cisco Packet Tracer

Packet Tracer is an application that can be used as a simulator. Cisco Packet Tracer is a software used for designing a system or network topology that will be applied to the real world, if you want to design a computer network topology without using the Packet Tracer application, it can cost a lot of money. So the benefits of Cisco are used so that people can learn without using expensive fees (Andriani & Ghozali, 2019).

3.4 Network Performance Parameters

The test model in this redesign and simulation is to use a test bed. This test bed is a model that can be used to test the performance of the system, topology, configuration or certain hardware of a product to be tested. As for what will be tested in this study are as follows:

a. Packet Loss

Packet loss or Request Time Out (RTO) (Bayu et al., 2019) is the failure of data packet transmission to reach its destination. The failure of the packet to reach its destination can be caused by several factors, for example, there is traffic overload in the network, or collisions in the network, as well as errors that occur on the physical media. Table 1 is the category of packet loss based on the percentage of delay.

Category	Big Delay
Excellent	0%
Good	3%
Poor	15%
Unacceptable	25%

To calculate packet loss can be seen by using the formula (Andriani & Ghozali, 2019):

$$\text{Packet Loss} = \frac{a-b}{2} \times 100$$

Where:

$$a = \text{Data packet sent} \quad || \quad b = \text{Data packet received}$$

b. Service test

This service test will test several parameters that will be tested on each client in the network redesign. These parameters are taken based on conditions that are already running and the need for future medical record laboratory planning.

Table 2. Test Type

Parameters	Source	Destination	Test	Results
Internet Connection	Node-1	Node-2	ISP IP Address	Successfull / Failed
Web Services	Node-1	Node-2	DNS	Successfull / Failed
DHCP Services	Node-1	Node-2	Request IP Address	Successfull / Failed
NTP Services	Node-1	Node-2	Show clock	Successfull / Failed
FTP Services	Node-1	Node-2	Transfer file	Successfull / Failed
IoT System	Node-1	Node-2	Motion Sensor	Successfull / Failed

In the 5 parameters above, each has a different function, an internet connection is used to connect to a wider public network. Then on the web service, the medical record laboratory is used to get medical record system application services in the form of website-based applications. The third is the DHCP (Dynamic Host Configuration Protocol) service, it is used to get the IP address automatically from the configured router. Next is the NTP (Network Time Protocol) service which is used to synchronize time between the server and client on the network.

Then FTP (File Transfer Protocol) is used to transfer files of a certain size on a special data transfer path in several clients at once, so that the files sent can be received by clients more quickly and efficiently. The last is the IoT system, Internet of Things (IoT) is a concept where certain objects have the ability to transfer data over a network without requiring interaction between humans or between humans and computers (Pratama & Laksana, 2021). In this case by using light automation using sensors. The reason is to make it easier for lab staff when starting activities in the laboratory when the laboratory conditions are in a state of off light. The devices used for this IoT system are Sensors, Home Gateways and lights that support wireless networks.

3. RESULTS AND DISCUSSIONS

3.1 Requirement

The results of the survey, needs analysis, and identification are needed. It aims to analyze the network that is already running by studying the problems that arise and determining the need for network usage to solve problems that often arise. At this stage it can be functioned as the decomposition of information that is separated into component parts, the aim is to find out the problem and analyze the problems that are expected so that improvements can be proposed by redesign and simulation. So that the proposed redesign and simulation can be a solution for future improvements.

3.2 Design

Furthermore, at this stage the results of the redesign made for the medical record laboratory are attached as shown in Figure 3. The network model was created using the Cisco packet tracer application. The first room is called the Registration Room which is used for services such as TPPRI, TPPGD, TPPRJ and Assembling. There are 4 computers with a centralized computer model or often called thin clients. Statistic room with 7 computers used for practical activities such as form design and health service learning. The last room, used for laboratory office space which contains several network devices such as routers, servers, computers, laptops, mobile phones, access points and printers. The switch used in the network redesign is 1 unit.

be obtained because there is a service source that provides the IP automatically, namely on the Router device. This is shown in Figure 5 as follows:

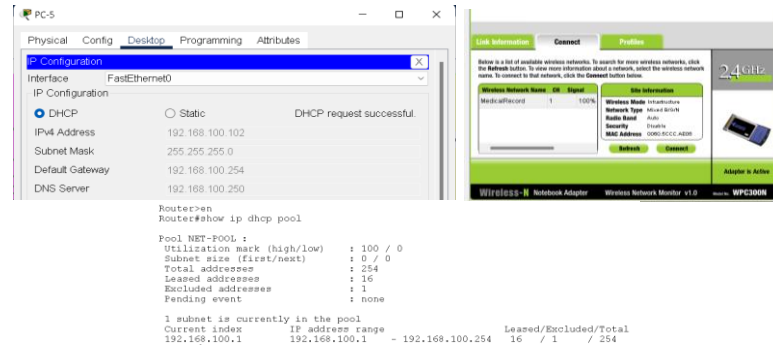


Figure 5. DHCP IP Configuration using simulator

c. Service on server

a) Services on the server to be configured are web services, NTP and FTP.

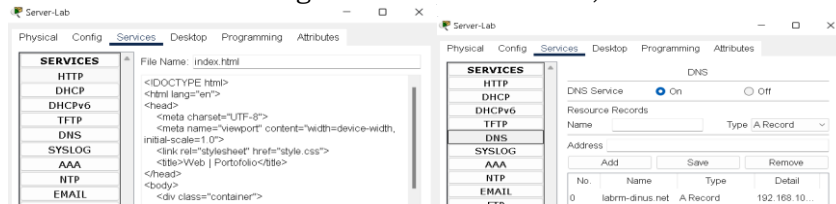


Figure 6. web service configuration using simulator

In web services, things to consider are settings on the server and setting up a domain name (DNS) on the web application that will be used.

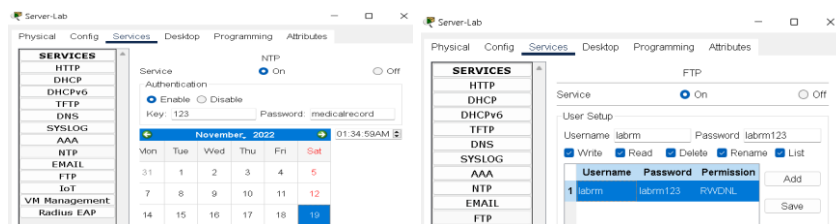


Figure 6. Configure NTP and FTP servers using the simulator

In NTP, NTP server activation is required and FTP access rights are required to get FTP services on the client.

d. IoT configuration

a) Next step is to configure the home gateway to adjust the automation of the lights based on the motion sensors that have been prepared.

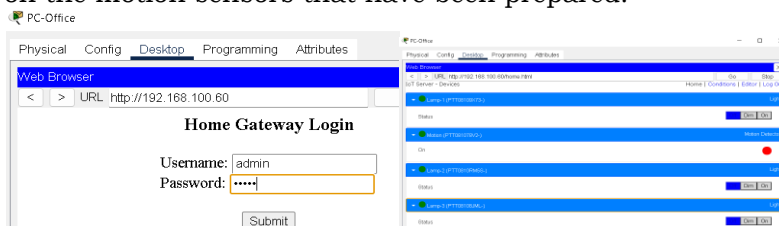


Figure 7. IoT based automatic light configuration using simulator

3.4 Verification

a) Packet Loss Results

The test results use network performance parameters with the results in tabular form as follows (Suhanda et al., 2022):

Table 3. Packet loss simulation results

Parameter	Source	Destination	Results
Packet Loss (%)	Router-Lab		0%
	Server-Lab		0%
	TPPRI		0%
	TPPRJ		0%
	TPPGD		0%
	Assembling	Router-ISP	0%
	PC-1 to PC-7		0%
	PC-Office		0%
	Laptop-Office		0%
	Smartphone		0%
Printer-Lab		0%	

Table 3 above is the result of the Ping Test Simulation using a Cisco packet tracer, based on the simulation, the packet loss result is 0%. That the packet loss value is included in the Excellent category based on Table 1, this is evidenced by the test in the image as follows:

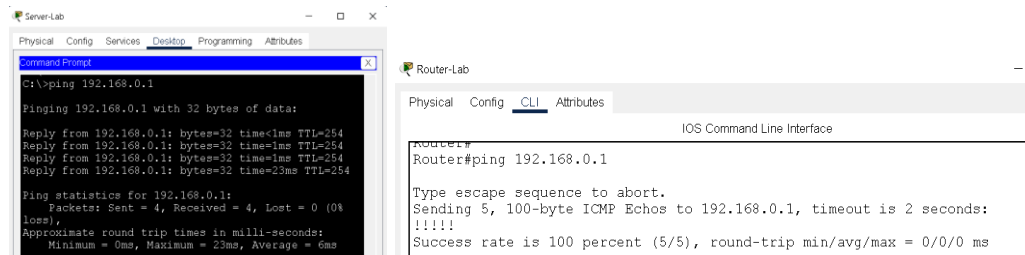


Figure 8. Network test results


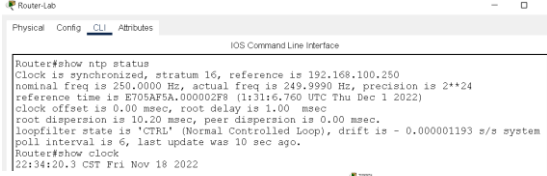
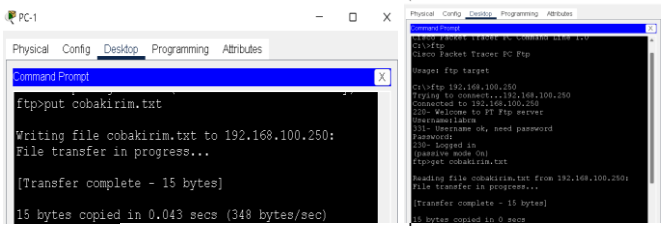
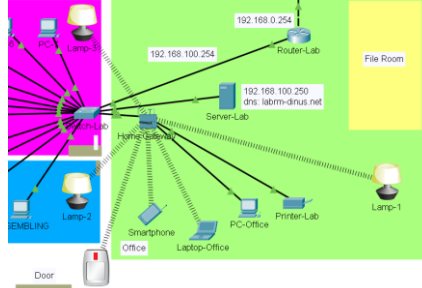
b) Service Test

Table 4. Service test results

Parameters	Source	Destination	Test	Results
Internet Connection	All Clients	Router-ISP	ISP IP Address	Successful
Web Services	All Clients	Server-Lab	DNS	Successful
DHCP Services	DHCP Client	Router-Lab	Request IP Address	Successful
NTP Services	Router-Lab	Server-Lab	Show clock	Successful
FTP Services	Registration	Statistic		
	Room	Room	Transfer file	Successful
IoT System	Computer	Computer		
	Motion Sensor	All Lights	Light Automation	Successful

Based on the results of service testing in the table above, all services can work well without any problems. The results of Internet connection services and DHCP clients can be seen in Figure 5 and Figure 8. To prove the results of testing Web Services, NTP, FTP and IoT systems as follows:

Table 5. Test Indicator

Parameters	Results	Indicator
Web Service		URL: http://labrm-dinus.net can be accessed
NTP		Clock is Synchronized
FTP		Transfer File Complete
IoT System		The light is on when the sensor is working

3.5 Maintenance

There are several things that must be considered in the maintenance phase. There needs to be a special schedule to implement the redesign on the actual network conditions. Then the network needs to be added bandwidth management and monitoring is done regularly. Preparing officers who understand network administration, so they can manage the network better.

4 CONCLUSION

The conclusion that can be drawn from this research is that the redesign and network simulation in the IoT-based medical record laboratory with the Cisco packet tracer application has been successful. Furthermore, the results of the measurement of the packet loss category get excellent results, this is indicated by the results when testing the network connection. All network services studied in this study can run well. Through redesign research and simulations in this medical record computer laboratory, this research can analyze strategies using simulators to ensure business continuity and the computer laboratory life cycle(Liu et al., 2021).

Suggestions that can be developed in this research by adding monitoring and bandwidth management systems in redesign and simulation.(Ardiansa & Primananda, 2017). Then, it is necessary to have an automation system on the server and backup so that it can turn on automatically including the services that are run(Ledonio, 2021). The

final stage of development needs to add a module to the IoT system to adjust the working time of the motion sensor, so that the length of time the lights can turn on and off can be adjusted. (Prahastian, 2019).

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