

Design and Implement a Secure Network Infrastructure for Private School Duroob Al Marifa

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Abstract. This research focuses on designing and implementing a secure and efficient network infrastructure for Duroob Al Marifa Private School in Seeb, Muscat. It addresses issues such as outdated equipment, network congestion, and insufficient security. Using the PPDIIO framework (Prepare, Plan, Design, Implement, Operate, Optimize), the study proposes a structured approach to deploying an upgraded architecture that incorporates advanced routers, high-performance switches, reliable servers, and modern firewall systems. Key goals include protecting sensitive school data, preventing unauthorized access, and improving overall network performance. The study includes a feasibility analysis covering technical, operational, and economic factors. It also examines the use of packet sniffing tools for security evaluation and explores open-source solutions for network monitoring and management to ensure cost-effective implementation. The project aims to offer educational institutions a practical model for achieving secure, scalable, and high-reliability digital learning environments.

Keywords: Firewall, Network, Infrastructure, Methodology.

1 Introduction

The project is about networks (secure infrastructure and in detail in the field of firewalls). This project can be implemented in any government building, company or any institution of learning. There is a network infrastructure that is made of parts such as basic services which are (DNS) Dynamic Host Configuration Protocol (DHCP), Network Time Protocol (NTP) among others; and the others are the backup, recovery, and monitoring [1], [2]. Since these components are used for collecting, exchanging and distributing information in the network, they are the most valuable assets to be targeted. Therefore, network infrastructure is the box in the system assembly that refers to all the software and hardware elements utilized by the application, middleware or other categories, but not included in the integration [3], [4].

2 Problem Statement

2.1 Define the Problem

The educational environment, including schools, is interested in the data of students and employees on their devices connected to the network, that is why the idea of working on this project, and this project will be devoted to the design and implementation of the network infrastructure of the private Duroob AL-Marifa School, and by accepting this development there will be a positive effect on the instructive organization and on the workers whether the organization is governmental or corporate. Also, some of the problems in the school are failure of the hardware due to age, wear and tear or environment such as temperature [5]. At times in some institutions there is no security on the network and this means that there are some who may steal data and engage in some unlawful activities that may lead to the device being infected with viruses and malware and sometimes leads to loss of the device and brings bad reputation to the institution, financially, politically and operationally and these operations are usually conducted by hackers [6].

2.2 Consequences of the problem

Network problems are multiple and one of the prominent problems in the Duroob AL-Marifa Private School is a slow network due to network congestion, bandwidth limitations or interference from nearby devices. Frequent interruptions to the network can also occur due to weak Wi-Fi signals [7]. Outdated drivers, configuration conflicts and hardware problems also lead to this problem. Weak passwords and unsecured networks also lead to network security issues (unauthorized access) [8].

3 Methodology

The PPDIOO model is most suitable for secure network infrastructure projects as this model is based on networking and security [9]. They can enhance the durability of big and small structures. The future of PPDIOO is to minimize risk and optimize the long-term performance, pay more attention to security and decrease the network exposure [10]. This methodology was developed by Cisco and is only applicable to Cisco tools [9]. Its most important feature is that it involves the customer in the development of the project through feedback, which is in line with the concept of a project as a network design, which has to be constantly developed and improved in the network, in line with the project [11].



Fig. 1. Methodology.

3.1 Prepare

This is the collect requirement step in order to organize all other steps such as what the step to develop the network is and which technique will be used [9]. The current project was selected based on specialization and the Initiation report was tendered and accepted.

3.2 Plan

This is the most important step; it consists of all parts of the network and what have been implemented as user's need [10]. In this project, there are many steps in the planning stage including: problem statement, time frame and cost estimates, major stakeholders, project goals and objectives, preliminary assessment of feasibility, system hardware and software requirements, major project strengths and weaknesses, and the most appropriate approach to the project.

3.3 Design

In this stage, all the components will be used to design the network. It is necessary to note all the details of the network [11]. In this project, the design can be changed and modified during the project, and it is one of the benefits of the chosen methodology.

3.4 Implement

This is the phase where work on the network devices begins and the link between these devices is created [11]. This makes sure that the network is well functioning and any vulnerability to the network. First, it must be configured on the network with the help of the Packet Tracer software, second, the configuration of the network in reality.

3.5 Operate

The operational phase deals with the health of the network, where daily usage has to be maintained with a high level of availability at low costs. The principal source of data for optimization comes from the detection, correction of faults, and performance monitoring in daily usage [9].

3.6 Optimize

Especially for the management of the network, this step aims at the detection of network problems and finding solutions to such [10]. In this stage, it is necessary to monitor the network first-hand and take immediate action concerning any fault that may be experienced on the network in real time.

4 Feasibility Analysis

Assessing the key issues in the project to determine whether the project is feasible and can be done taking into consideration factors. This is called feasibility analysis [12]. The most important of these points are the timetable, technical, operational, functional, Economic and Legal aspects. This evaluation helps determine the success of the project before starting implementation.

4.1 Schedule Feasibility

The feasibility schedule is for the whole period of the project, but the most important thing mentioned here is the timeline of the project. Project will be completed in two semesters started in October 2024 and it will be completed in June 2025.

4.2 Technical Feasibility

In this type of feasibility, it is established whether the technical resources required for the project include the right equipment, enough equipment, and the right technical skills to complete the project [13], [14].

Table 1. Function of Hardware and Software.

Hardware and Software	Function
Laptop (XPS 16-Laptop)	To make configurations
Server (Cisco ASA 5505)	To share data and resources
Switch (Cisco CBS350-8MGP-2X)	To connect network to each other
Router (Net gear Nighthawk RS700S WIFI 7 (BE19000))	To Bridge between two networks.
Access Point (TL-WA1201)	To create wireless LAN
ISP	To supply the school with the internet
Firewall (Cisco ASA 5505)	To protect and secure the networks
Pach Pannal	To organize large number of cables

4.3 Economic Feasibility

This type of feasibility determines the real cost for the project, it ensures the project is economically viable and capable of delivering financial benefits and knows the benefits for the project [15], [16]. It is assumed that the budget for this project is 3500 OMR, but the economic feasibility of the project is 2740 OMR. This means that the budget is larger, which makes the project successful.

Table 2. Cost of Components.

Component	Cost
Laptop (XPS 16-Laptop)	240
Server (Cisco ASA 5505)	1450
Switch (Cisco CBS350-8MGP-2X)	280
Router (Net gear Nighthawk RS700S WIFI 7 (BE19000))	150
Access Point (TL-WA1201)	180
ISP	105
Firewall (Cisco ASA 5505)	175
Pach Pannal	160
TOTAL	2,740 OMR

4.4 Operational Feasibility

It determines the project's facility to solve the problem in the organization, whether it is current or old problems in a previous project, as it includes the number of workers and the management of the structure and any applicable legal requirements [17]. It must also be known whether the project will be completed on time or not, depending on the resources available for the project and the skills of the employees in dealing with the project, some requirements for the project are router, switch, firewall [18].

4.5 Functional Feasibility

This type of feasibility is to decide if project idea is good for completion or not, whether it is good for success or not, and whether the project is good for investment or not that to Design and plan and implement the network infrastructure, and to Implement a security solution using a firewall, also to Configure advanced security using various tools [19].

4.6 Legal Feasibility

In this type of feasibility study, the conclusion is made that the project is legal and conforms to the existing legislation [20]. That entails exploring legal restraints and policies, the need for permits, licenses, or certifications and legal responsibilities or exposures and patents or trademarks among others.

ACKNOWLEDGMENT

More specifically, I would like to thank my project supervisor Jitendra Pandey, for their useful guidance, motivation and encouragement along the process of writing this project proposal on Design and Implement a Secure Network Infrastructure for Private School Duroob Al-Marifa. Their knowledge and suggestions were very useful in the accomplishment of the goals of this study. I am also grateful for the cooperation of the administration and staff of Duroob Al-Marifa Private School in providing the required data and information that helped in establishing the required network infrastructure in fulfilling its needs. It is important to thank my friends and colleagues for their support and help, as well as their input into my insights and the work done for this project. Last but not the least, I am more than grateful to my family for standing by me throughout the time I spent on accomplishing this work. This has been made possible by their belief in me all through time. This project is the result of the work of all the people to whom I am grateful for the help.

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