**Secure VPN & Cloud Storage**

**Final Report**



**Maciej Chudy / C00247467**

**Supervisor: Joseph Kehoe**

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# Introduction

The main focus of this document is to provide the reader with an overview of the journey that was the development of a Secure VPN & Cloud Storage project. In this final report, I will cover my personal experience of the development of this project, the extra features that I have implemented, the issues that I’ve encountered throughout the development, the things that I have learnt from this project and how they will help me in the future when working in the industry. This report will also cover the technologies that I have used or tested throughout the project and finally, I will discuss my achievements which I have gained upon completion of this project.

# Project description

My project was to develop a low-power secure VPN & cloud storage server, but first, what is a VPN and cloud storage?

A VPN, or virtual private network is a fully secure encrypted tunnel that is created between a peer, or client and a server. A VPN allows the client and the server to communicate privately on a public network without the ability of a malicious actor to interfere their conversations. A VPN server works like a relay, the user connects directly to the server and forwards all their traffic through the secure tunnel to the server, which then the server passes on the traffic to the web server or application that the user was trying to access in the first place which in return makes the user untraceable since the IP address of the client gets changed to the IP address of the server once it gets relayed forward.

Cloud storage is a computing model that allows users to store their data and files on the internet, or the “cloud”. It allows users to have 24/7 access to their files without having to store them locally on their devices, which in return allows the users to free up storage on their devices and have all their files stored on a server as well as

# Functional specification vs finished project

Comparing the project, I described in the functional specification to the project that is going to be submitted, the design was only upgraded as I went along with the development.

## PiVPN / Wireguard

Originally, I intended to use PiVPN as an easy way to create the VPN functionality of the project which was then later scratched, and I began implementing WireGuard without the addition of a UI that was provided by PiVPN. This allowed me to understand the process of how WireGuard functions as a VPN and how the handshake between the client and the server is made.

## Nextcloud

The implementation of Nextcloud went as planned and as predicted, the installation of this cloud document management system.

Nextcloud has since gotten an update from Hub 3 to Hub 4 which added the implementation of AI assisted image generation, text as well as overall enhanced performance which only helped the project get better with the additional features.

## Bitwarden

Once the implementation of Nextcloud was complete, I looked further into how I could make this project better and BitWarden was one of the features that I implemented that wasn’t in line with the functional specification. BitWarden is a secure password manager that is accessible from anywhere, it allows the users of the server to keep their password secure in a vault that only they have access to.

## PiHole

Pi-Hole is another addition to the project that I implemented, it is a DNS based ad blocker and it also provides a dashboard that is accessible only by authorised users which gives insight into the number of ads that are being blocked, the amount of users that are connected to the server as well as, it adds the ability to create changes to your local DNS settings as well as domains.

## COCKPIT

Cockpit is simply a server management dashboard that gathers information about the server and displays it on a website that, once again, only authorised users have access to. This allows the admin to have a deeper understanding of what is happening on the server to further help with server monitoring.

# Issues encountered

There were lots of issues encountered when developing and implementing this project, they put me behind schedule by a lot. In this section, I will cover the main issues that I have encountered and how I tackled them.

## Pi

The first issue that I encountered was at the very start of the project, the idea was to have a Raspberry Pi running at home, or in the college that would act as the server for all the features that I wanted to implement. The Raspberry Pi that I was provided with wasn’t strong enough and I was afraid that with the features that were going to be implemented, it would slow them down a lot and make the VPN and CDMS hard to use.

This issue was first tackled by getting a virtual server running on the SETU campus network which provided me with all the resources needed to implement the features that were planned to be implemented.

## Nextcloud

An issue that I encountered when implementing Nextcloud was the fact that it needed a valid domain that was pointing to the server. When the server was running on the campus network, I was put behind schedule whilst working with the I.T Services team as they were completely busy and couldn’t create a sub-domain for my project so that Nextcloud could run on the website.

Nextcloud was developed to be secure, which meant that a lot of the features on the server didn’t work over HTTP which I was first using for testing purposes which led me down another alley way of figuring out how to create SSL certs for a webpage that wasn’t public to the internet.

## Campus network

Another issue that I encountered around halfway through the project was the campus network being extremely restricted in terms of port forwarding and other firewall rules that were in place. This created another massive issue because I couldn’t connect to the virtual server via the VPN which I initially first thought it was an issue with the configuration of the server.

After close inspection of all the packets, I realised that the client when trying to communicate with the server was sending a lot of packets, which in response the campus network was dropping them because there was simply too many of the same packets, from the same IP address trying to communicate.

This issue was massive, and I had to come up with a way to try and resolve it, but after a lot of research about this issue and a lot of going back and forth with the I.T Services team, I had to step away last minute from the campus network and rent out my own virtual server which I was able to do from Linode.com.

This server allowed me to have full control over the server without any limitations since the network that the server is running on is fully unlocked which in return left me with a big task of figuring out the correct firewall rules to use in order to completely isolate the server from the outside network but still allow a connection to be made via the VPN.

Graphical user interface

Description automatically generated with medium confidenceThis wasn’t as easy as I thought it would be, the firewall rules that I thought would work, didn’t work which left me in a loop of trying to figure them out, which then I came across an Apache Restrict Access by IP module which allowed me to block any IP other than the server IP. This allowed me to connect to the server via the VPN, mimic it’s IP address and allow me to view the websites as planned.

# what have i learned?

Starting this project, I didn’t have an idea of how Linux worked, this was by far my biggest achievement. This project allowed me to learn Linux and get quite comfortable with it even though I have never properly used it as an operating system.

Another thing that I learnt during this project was how to implement features to the server I never even knew existed in the first place. This allowed me to strengthen my knowledge on the topic of open-source applications that are out there.

This project has also taught me the importance of the security measures as I done more research about each of them as well as how to prevent them on an actual live server.

# Conclusion

In conclusion, I’d like to think that this project was a great success on my side, I am finishing this project a lot more knowledgeable about the topic of servers than I ever thought I’d be. This project was an amazing learning experience which also gave me insight into how much work goes behind setting up a server that has the full functionality and security.

My expectations weren’t high when I started this project, but I am finishing it with a lot of new skills that will be extremely useful for me when I enter the industry working full-time.

# Acknowlodgements

I’d like to thank all the lecturers that I have spoken to about my project and that gave me insight on how I should do some things differently to which I have planned initially but most importantly I’d like to thank Joseph for guiding me with this project, his help was extremely necessary because as first I was quite lost and didn’t know where to start but he led me in the right direction which allowed me to end up in the position that I am in right now as well as the I.T Services team for having to deal with the issues that I was encountering along the way which they helped me with even though they were busy with their own work a lot of the time.