# Alternative VPN Solution Using Raspberry Pi as Router

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***Abstract*— Free Wi-Fi is exceptionally convenient to the public, but security can be a concern as such free access points are available at restaurants, hotels, airports, and cafes. Even though it has a router firewall, it does not mean that the network is shielded from certain network connections. It is incredibly easy to steal the username and password of others or see what they do by using the same network. The big challenge to free Wi-Fi security is the hackers' ability to position themselves between the user and the link point. The hacker steals information that you send on the Internet, such as valuable e-mails, credit card data, and personal information. The aim is to create a Virtual Private Network (VPN) Router using Raspberry Pi. VPN works to protect the Internet connection of the user's device to ensure that all data sent and received is authenticated and protected. The VPN router is based on the most popular Raspberry Pi 3 on the market, allowing people to avoid Wi-Fi attacks of this type without installing any program or application on their devices. This makes the router a link between the user and public network and allows the connection of several client devices to this router. The router has been checked to ensure that this VPN router provides the best speed and durable protection. Finally, we hope that the VPN router will help secure internet connections and protect their privacy.**

## I. INTRODUCTION

Private client data in an unstable system is easily presented to aggressors for information without client information. Usually, people did not realize that their security would be at risk when exchanging free WiFi on the Web, for example, over an uncertain system. Then some clients don't know VPN and don't have VPN programming preinstalled in their devices. If Pi can set up a VPN tunnel, the client can avoid these sifting restrictions.

The goal of this project is to secure Internet navigation with a Raspberry Pi Router for multiple devices and to compare OpenVPN's Internet speed with other VPN applications. Free unencrypted wireless services, for example, online banking on the public network, are accessible and not secure.

The VPN encrypts internet traffic to allow users to browse the web anonymously without having to track by hackers or spies. The benefits of this VPN router are lightweight and VPN plug and play. The VPN router is tiny and can be linked to WiFi devices anywhere that do not support VPNs such as Chromecast. This router acts as a bridge between a personal access point and an unsecured network. Every single device connected to this router is connected to a passive VPN.

## II. RELATED WORK

### *A. SOHO Remote Access VPN. Easy as Pie, Raspberry Pi*

This research paper presupposes that Eric Jodoin has certain confidence in Internet Service Providers (ISPs) which is routed in the presumption that they respect the laws of their respective countries concerning the illegal interception of private communication. This paper presents an alternative as a VPN solution and the associated server and client setup instructions. Eric Jodoin says, "Tandem with free available OpenVPN server and client applications, the low-cost Raspberry Pi (RPi) hardware is used" (Jodoin, 2013).

Once the VPN server and the client have authenticated, they must establish an encrypted tunnel to securely return all traffic via the Internet to the trustworthy network, where it will be relocated to its final destination.

### *B. The Virtual Private Network (VPN) Connection is Establishing Using Raspberry Pi*

This article investigates how the Raspberry Pi is used as a VPN server for a home network. The VPN connection was created with OpenVPN between a home network and the public Internet. The researcher concludes: "OpenVPN is a site to site or remote software application. Access links by custom use of the SSL / Transport Layer Security (TLS) security protocol "(Constadinos Lales, Aparicio Carranza). The customer is a laptop installed on Windows 7 Toshiba that is downloaded from the official website. The type of VPN connection is remote access, which ensures good security than fast installation. The customer has provided his keys and certificates.

### *C. Raspberry Pi VPN Travel Router*

This article recommended the Raspberry Pi router as a VPN router to ensure secure Internet connectivity for connected devices. Pi is Internet connected via a wireless or wired Ethernet interface and offers a wireless connection to the VPN. This article has a small web server on the Pi, which is available to customers on a protected private network. The researchers concluded that the wireless range and performance of higher power adapters will probably improve than the relatively small

USB adapters in Edimax. This could, however, reduce overall portability and make it less convenient for users to transport on their journeys "(Pierson, 2016). The server hosts a configuration / statistics page with information about network links established by the Flask web server. A web-based configuration page displays the existing network information and the wireless networks available.

## III. RESEARCH METHODOLOGY

The methodology provides guidance step by step to complete the project. To succeed in a project, an appropriate method is needed. This chapter discusses the decision on the method and how to use the technique in the project.

The model prototype states that a working version of the program is developed before the actual software is developed. This is primarily an iterative mechanism of trial and error. Prototyping is an appealing concept for advanced and broad systems, with no manual mechanism or infrastructure to assist decision-making.

### *A. Requirement Gathering*

At this point all future system specifications to be built are listed in the design specification document. For this project the Linux commands to create a VPN in Raspberry Pi will be defined. Requirements shall be subject to the objectives and scope negotiated with the supervisor. All sources of internet knowledge, books, newspapers, articles and previous research similar to this project or system are included in the data. The analysis will be carried out to determine the technology for this project.

### *B. Designing Prototype*

As in this process, research will be carried out to learn how to achieve a better result. This study was linked to other similar research papers, as you can see. On the other hand, a VPN router based on Raspberry Pi and its modules, hardware and software was also being developed.

### *C. Building Prototype*

In this step, the Raspberry Pi-based VPN router will build its prototype. The installation of the components studied earlier will start during the design process. The critical part of the program is the Raspberry Pi, which works as the computer brain. All other elements shall be suitable for the prototype construction.

### *D. Evaluation*

The evaluation process involves validating the prototype and including its parts such as the WiFi adapter and others. Raspbian will be the operating system for Raspberry Pi (OS). Various commands used to create a VPN connection in Raspberry Pi. Raspbian supports Linux installations to create a wireless router for Raspberry Pi. OpenVPN connections are made by commands to ensure that all devices successfully pass through the VPN. The security will be tested with any security tools to verify whether an attacker has a small chance of interrupting the network.

### *E. Refining Prototype*

The refining prototype is a process that the Raspberry Pi will evaluate. Post configuration for any defects or errors is checked. If the site answers, the data packets are returned to the Pi via the Internet, the Raspberry Pi must decide which WiFi client the answer is intended for and transmits the data packet to the Website. Finally, clients can access the Internet in VPN mode. All of these will be thoroughly tested to ensure that there are no errors during manufacturing. If this step fails or if it finds an error, a prototype can be developed to test hardware and compatibility.

### *F. Documentation*

Finally, all the information on this project will be documented and finalized during a report. Important information will be presented throughout this project.

### *G. Project Overview*

VPN offers a secure and authenticated network connection. In order to easily expose users, users must encrypt sensitive information. The Raspberry Pi VPN encrypts all devices with a simple AP connection. Figure 2.6 shows a project diagram for a more accurate project flow understanding.

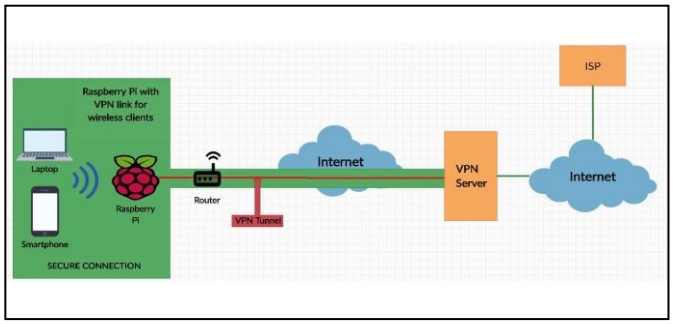


Figure 1: Flow of VPN Diagram Using Raspberry Pi

## IV. RESULT AND DISCUSSION

This section focuses on the data gathering, analysis and discussion. Tested after installation of the device, the system underwent comprehensive testing with different types of data, such as images and random files. The competing VPN provider chosen for this project is Nord VPN. Nord VPN was chosen as it has a Singapore server and has the lowest ping to fit our OpenVPN server. The tests were carried out to ensure the programme is problem-free and achieves its capabilities in hardware and software.

The results of this project are seen here at this stage. The testing was carried out by the Raspberry Pi connect to mobile hotspot and get the VPN connection that created after a few seconds. Figure 2 shows that Raspberry Pi established a connection successfully.

Figure 2: Connection Between Raspberry Pi and Mobile Hotspot

Figure 3 indicates the website used for measuring download and upload VPN speed test. This website is known as testmy.net and has more data, precision and easy interface than other speed test providers. This speed test will download randomly generated data to your browser, calculate the download or upload speed, and log all speed test results.

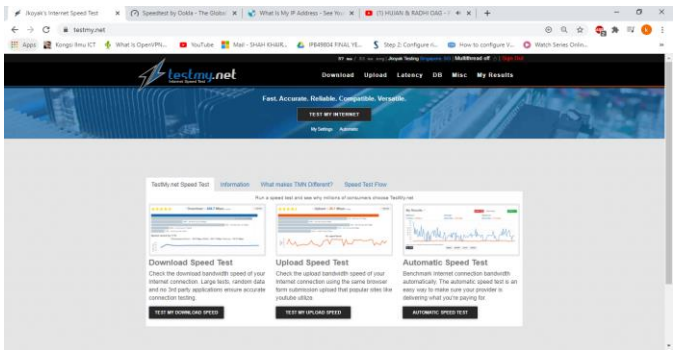


Figure 3: Webpage of Testmy.net

To be realistic in testing the speed comparison between the two VPNs, the external USB wireless adapter from the Raspberry Pi is being used to test the laptop to get the exact result according to the hardware specification. For example, dynamic data rate and frequency band. The frequency band used is 2.4Ghz and 802.11b / g / n, 150Mbps for dynamic data rate.

The test will make a comparison of speed between two VPNs which is Pi VPN and Nord VPN. A test without VPN has also been done for further results. It shows the result for Pi VPN, Nord VPN and without VPN to download response time in a few seconds for two different file sizes, 5 MB and 10 MB. During this test, two clients are connected to the router.

Based on figure 4 results, a connection without using a VPN, it's faster than others because the network doesn't have to encrypt and tunnel. The highlight of this result is that Pi VPN is having longer response time than Nord VPN for both file sizes. The result is therefore still acceptable in time for normal daily use.

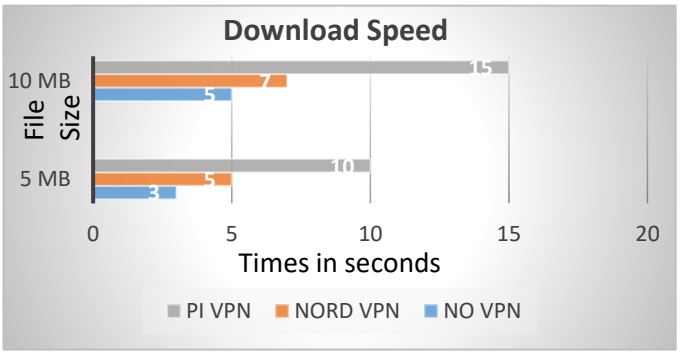


Figure 4: Download response time with 2 clients

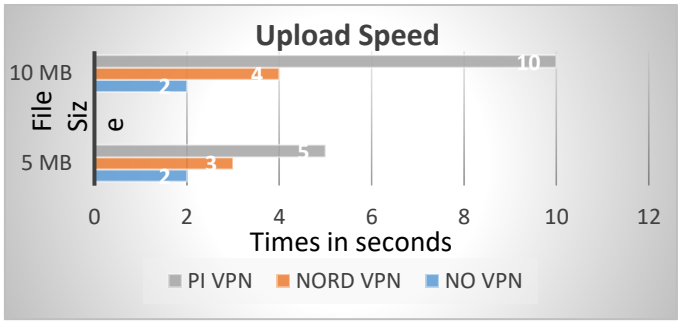


Figure 5: Upload response time with 2 clients

Based on figure 4.4, the results are shown in seconds in response time between Pi VPN, Nord VPN and without VPN, the two file sizes are 10 MB and 5 MB. Based on the results, Nord VPN is faster than the Pi VPN for both file sizes. According to this result, it is because of the hardware capabilities, Raspberry Pi has a slow upload rate.

For the next test, there are two more clients to perform the stress test. Added to the Pi router, currently being used by four clients. The connection between the VPN and the Pi shows a different performance than before. The two speeds indicate a different time to complete the tasks.

Figure 6 shows the results of Raspberry Pi's download speed VPN is slightly slow compared to Nord VPN. The results are according to this data is still acceptable for normal daily use in time response.

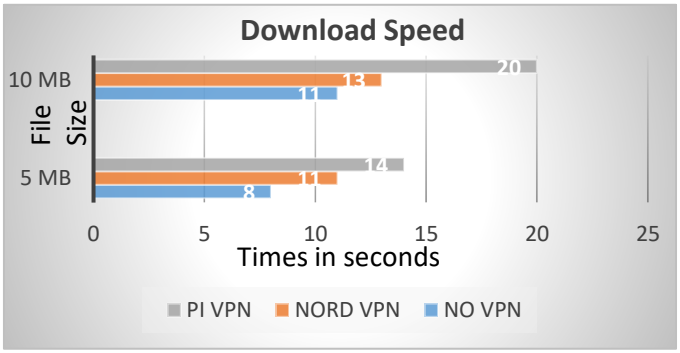


Figure 6: Download response time with 4 clients

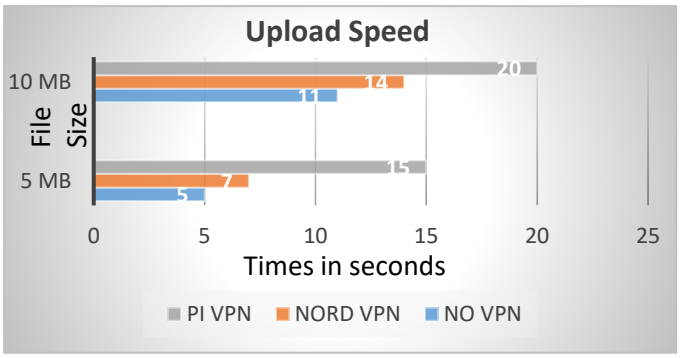


Figure 7: Upload response time with 4 clients

According to figure 7, Nord VPN results are shown beat the Pi VPN in the upload of larger files completely. Pi VPN will take more longer upload time and the internet connection is intermittent. The problem would mean that it's more about hardware and network tunneling makes the internet connection unstable.

Figure 8 indicates the website used for check the IP and DNS leak before connected to VPN while Figure 9 shows the result of IP after connected to VPN. This website is known as ipleak.org and has more data, precision and easy interface. This website will give an information of your IP address and DNS data to your browser. If VPN connection is established and the detected DNS detected your ISP DNS, then your system is define as DNS leaking.


Figure 8: Before connect VPN

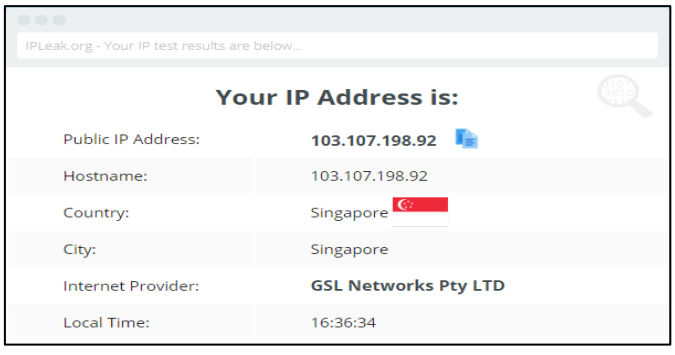


Figure 9: After connect VPN

## V. Conclusion

This section addresses the description of the project and the possible suggestion. Knowing the overview of a project is important; we can then see what the project has succeeded or not.

The Raspberry Pi VPN router project has been successful with a huge amount of testing, growth and monitoring, all the targets being met to establish passive VPN communication while linked to the Raspberry Pi VPN router and to protect the internet surfing. Although it is a small-scale prototype, it can be a VPN router, it has certain limitations because of its small form factor. The inference on the study performance is that Raspberry Pi VPN router displays a positive download speed test performance relative to the Nord VPN which is premium market VPN provider. At the end of the project Raspberry Pi VPN Router is a plug-in system that allows the public to protect all data from hackers and maintain their privacy.

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