SECURING NETWORK BY IMPLEMENTING A VPN ON RASPBERRY PI

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BACHELOR OF COMPUTER SCIENCE (COMPUTER NETWORK SECURITY) WITH HONOURS UNIVERSITI SULTAN ZAINAL ABIDIN

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DECLARATION

I hereby declare that the report is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Sultan Zainal Abidin or other institutions.

_____

Name: Nur Shahirah Binti Abu Hurera

Date:

CONFIRMATION

This is to confirm that:

The research conducted and the writing of this report were under my supervision.

<div style="text-align: right;">

_____

Name: Nazirah Abd Hamid

Date:

</div>

DEDICATION

In the Name of Allah, the Most Gracious and the Most Merciful.

Alhamdulillah, I thank God for His grace and grace, I can prepare and complete this report successfully.

First of all, I would like to thank my supervisor, Miss Nazirah Abd Hamid because with guidance, the advice, and the thoughtful ideas are given g me the opportunity to prepare this report successfully.

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May Allah SWT bless all the efforts that have been given in completing this report.

Thank you.

ABSTRACT

A VPN stands for Virtual Private Network which means it gives you privacy online and it is a secure encrypted connection between two networks that allows us to hide while surfing the Internet and eventually this is one way to fight vulnerabilities issues. Nowadays, VPN available in the market requires for subscription-based plans where mostly pricey and requires monthly payment for optimal security. There are also the issues involving the third parties to ensure valuable information. Hence, the purpose of this project is to create a safer and effective VPN as a network tool, especially for travellers to browse with privacy and secure from attackers. This project's objectives are to study how to use the VPN implementation technique for assuring network control. Besides, to design and implement VPN into Raspberry Pi to provide access for connected devices. When a device connects to the Pi, we can test all traffic routed through a VPN tunnel to reach the Internet. This device acts as a portable that can plug into any device and it has the capability of protecting the user from being monitored, and the sensitive information is hidden as needed because it can conceal user's Internet Protocol (IP). To avoid data interception from attackers, this innovation capable to encrypt end-to-end connection between a user's devices by implementing a VPN into a Raspberry Pi. To hide the user's IP address, we used OpenVPN server which is an open-source VPN where we can customize it. In conclusion, this portable network tool can help users to secure their network activities and minimize hacking attempts.

ABSTRAK

VPN bermaksud Virtual Private Network yang memberi privasi dalam talian yang merupakan satu sambungan yang disulitkan antara dua rangkaian yang membolehkan kita bersembunyi ketika melayari Internet dan satu cara untuk mengatasi kelemahan. Kini, VPN yang tersedia di pasaran memerlukan langganan yang kebanyakannya mahal dan memerlukan pembayaran bulanan untuk keselamatan yang optimum. Terdapat juga masalah yang melibatkan pihak ketiga dalam memastikan maklumat kita. Oleh itu, tujuan projek ini adalah untuk membina VPN sebagai alat rangkaian, terutama bagi pelancong untuk melayari dengan privasi dan selamat dari penyerang. Objektif projek ini adalah untuk mengkaji bagaimana menggunakan teknik pelaksanaan VPN untuk memastikan kawalan rangkaian selamat. Selain itu, merancang dan menerapkan VPN dalam Raspberry Pi untuk menyediakan akses bagi peranti yang disambungkan. Apabila peranti disambung, ujian laluan lalu lintas melalui terowong VPN untuk mencapai Internet dilihat. Peranti ini berfungsi sebagai alat mudah alih yang dapat dipasang ke peranti dan mempunyai kemampuan melindungi pengguna dari dipantau, dan maklumat sensitif tersembunyi kerana Protokol Internet (IP) pengguna tersembunyi. Untuk mengelakkan pemintasan data dari penyerang, inovasi ini mampu mengenkripsi sambungan dengan peranti pengguna. OpenVPN merupakan VPN open-source di mana kami dapat menyuntingkannya. Kesimpulannya, alat rangkaian mudah alih ini dapat membantu pengguna untuk memastikan aktiviti rangkaian mereka selamat dan meminimumkan percubaan penggodaman.

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LIST OF ABBREVIATIONS

VPN	Virtual Private Network
Wi-Fi	Wireless Fidelity
GPIO	General Purpose Input/Output
IoT	Internet of Thing
DoS	Denial-of-Service
IP	Internet Protocol
MITM	Man-In-The-Middle
OSS	Open-Source Software
GB	Gigabyte
RAM	Random-Access Memory
OS	Operating System
LAN	Local Area Network
ISP	Internet Service Provider
USB	Organization of Islamic Cooperation
HDMI	High-Definition Multimedia Interface
SD	Secure Digital
SSH	Secure Shell
PuTTY	Popular SSH and Telnet Client
GUI	Graphical User Interface

CHAPTER 1

INTRODUCTION

1.1   Introduction

In this modern world, access to data and info is only at your fingertips. Indirectly, data security is threatened by the hands of those who take advantage. Maintaining a computer network is a big step to prevent these perpetrators from breaking into our computers. Even the basic features require an internet connection as a shifter from file-to-file sharing, photo storage, messaging or video playback.

1.2   Project Background

Virtual Private Network or VPN is an encrypted tunnel between two devices that lets us access every website and online service privately and securely. A VPN can also give access to unblock streaming platforms, torrent safely and anonymously without speed throttling. Furthermore, in today's world, the popularity of VPNs as a preventative measure from being penetrated by attackers is on the rise. Majority students often use Wi-Fi connections as a conservative practice their limited allocated data. VPN is an easy and efficient solution to offers essential thing when online such as more security, online privacy and freedom.

As the main objective is to design and implement VPN into Raspberry Pi to provide access for connected devices, Raspberry Pi is a low cost, credit-card sized computer capable of doing everything you had expect a desktop computer to do.

People use Raspberry Pi to learn programming skills, build hardware projects and do home automation. The Raspberry Pi also provides a set of GPIO (general purpose input/output) pins that allows to control electronic components for physical computing and explore Internet of Thing (IoT). As the conclusion, this project is to create a safer and effective VPN as a network tool, especially for travellers to browse with privacy and secure from attacker.

1.3   Problem Statement

Setting up our own VPN at home sound impossible as some people do not like to hire a company to route our internet traffic. Mostly they are expensive and required monthly or yearly subscription plan. This is a huge disadvantage for those who need a budget yet reliable VPN. Relaying on a third parties of our valuable data and traffic connection is the most common option people do. This involves of the reliability of the company may carries risks where customers require to install VPN onto your system. Besides, accessing Internet using a public Wi-Fi especially for those who want to enjoy free internet while they are in the shop lead to DoS attempt by attackers. The hacker can intercept the data by positioning himself between our connection. This is known as man-in-the-middle attack where it they can eavesdrop or modify traffic travelling and plant malware to computer.

1.4   Objectives

The objectives of this project are:

a) To study a secure network using Virtual Private Network (VPN).

b) To design and develop a secure network by implementing VPN into Raspberry Pi.

c) To test the feasibility of VPN as a secure network tool.

1.5   Scope

This project involves a few phases, and the first phase involves understanding the working principle of Virtual Private Network in tunnelling the virtual connection through the existing networks. Meanwhile the second phase is to design and build a working portable VPN into Raspberry Pi especially for travellers who use free Wi-Fi and people that has router, computer or smartphone.

1.6   Limitation of Work

This project limitation is need to configure IP address for every new device.

1.7   Expected Result

At the end of this project, the expected outcome from this project will be:

a) Users able to secure the network of their internet connection from any vulnerabilities.

b) The Raspberry Pi VPN server is fully developed, installed and functional for the user use.

c) Well-hidden user IP and location successfully.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

This chapter discussed about literature review for the system that will developed. Literature review is a text of scholarly paper which includes some related function and terminologies including the theoretical and the methodological in proposed tool. this will show the comparison between the foregoing study and the current study after a process of studying, reading and understanding of related paper. There are a few of related work to the implementation VPN into a portable travel kit. This chapter will explore the concept of VPN which include hacker method of attack and technology of Raspberry Pi.

2.2   Virtual Private Network

Most of attack method are network based. Hackers know ways of exploiting vulnerabilities with objective of stealing data or perform malicious activity. Most commonly attack is Man-in-the-middle attack where attackers intercepting traffic to exploit the flaw within the router [1]. Figure 1 shows the MITM method of attack. Wi-Fi connection or public Wi-Fi can be secure with basic configuration with strong

encryption connection and strong combination of password. To secure the connection even further, VPN is well liked services provided.
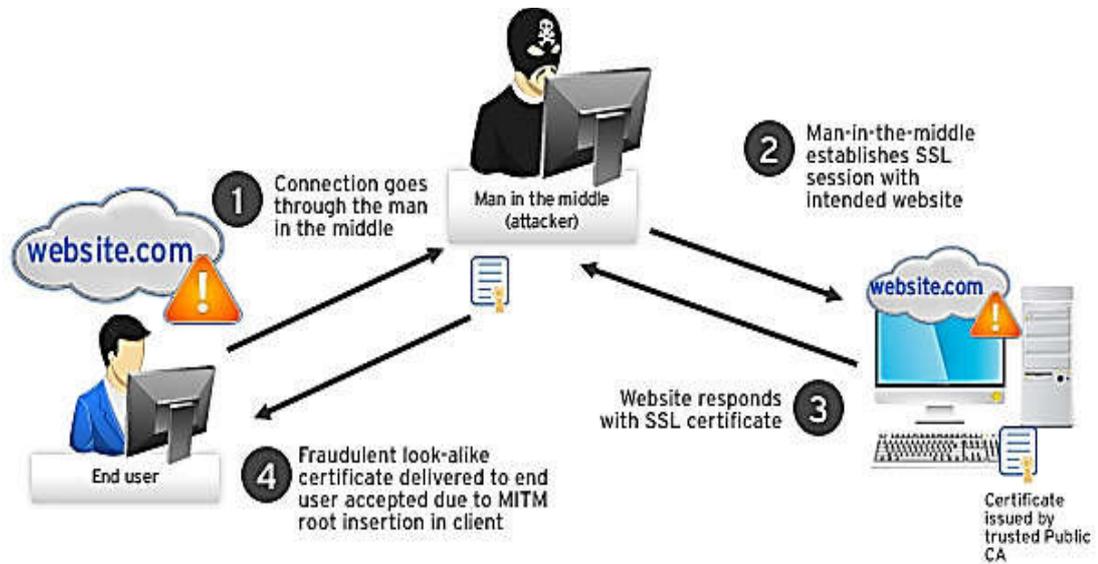

Figure 2.1: Man-in-the-Middle Attack Method

When using VPN, a tunnel is created to secure connection from a device that connected to the internet. As we know every device have personal identification code for internet connection called IP address. It can contain the location and information from internet provider. No matter what we do, it is recognizable and traceable online unless using VPN [2]. The best option of VPN to choose is open-source VPN as it customizable according the user's needs [3]. OpenVPN is open-source project that entirely a community-supported OSS project. This software applies VPN techniques between devices that are connected to the internet. OpenVPN also a software that operate both Windows and Linux OS. Creating your own VPN Is more efficient more beneficial in cost and reduce resources needed as that do not require special features [4] [5].

2.3   Raspberry Pi

A Raspberry Pi can turn into a server for this VPN project. This smaller device actually has a powerful performance at the cheaper price. This technology is well-known for general-purpose computer development especially for innovator and computer science students [6]. The latest version is Raspberry Pi 4 Model B has 8 GB RAM which is faster for a small computer. Securing network by using this tool is famous topic to be discussed and developed by many researchers. This proposed project is to create an alternative solution for security professional when using public Wi-Fi. As this tool kit has OS, a web configuration can be access by user to connect the VPN. The user did not need to configure the setting but simply entering the password you are connected to your own Raspberry Pi VPN [7]. This Pi can also add on more method to build multifunctional network tool.

2.4 Summary

No	Year	Title	Author	Objective	Methodology
1	2020	Security Network Using Raspberry Pi by Implementing VPN, Pi-Hole, and IPS (VPiSec)	Abidah Mat Taib, Mohammad Fikri Haniff Ishak, Nur Khairani Kamarudin, Mohammad Yusof Darus, Nor Azira Mohd Radzi	Develop a network tool that can secure the whole network environment from man-in-the-middle (MITM) attacks, adware and any suspicious packets using Raspberry Pi technology.	VPN, Pi-Hole, IPS (VPiSec)
2	2020	Budget Remote Access VPN & NAS	Dylan J. Simmons, Dr. Shirong Du	Develop a budget VPN service and allows remote management of networking devices	OpenVPN, Ubuntu Server (NAS)
3	2018	Securing Your Network with OpenVPN and Raspberry Pi 3	James Pak	Create an OpenVPN network using a small device	OpenVPN
4	2018	Securing a Home Network by Using Raspberry Pi as a VPN Gateway	Bogdan Jeliskoski, Biljana Stojcevska, Adrijan Bozinovski	Providing protection for IoT devices in a home network and their safe connection to the Internet.	VPN, Iot Gateway
5	2016	Raspberry Pi VPN Travel Router	Daniel S. Pierson	Provide secure VPN access for end user in a compact and easy-to-use package	VyperVPN

Table 2.1 Summary of Research Paper

CHAPTER 3

METHODOLOGY

3.1   Introduction

In this chapter we will discuss the understanding of the method used to undertake this study. The methodology explains a set of procedures of what and how we did it on the whole processes of this project. Additionally, the purpose of using methodology is to support the objectives that has been mention before and evaluate the reliability and validity of this project.

3.2   Framework

A framework can represent the whole situation of the problem and scenario for this project. Figure 3.1 shows the framework of securing network connection using the Raspberry Pi.
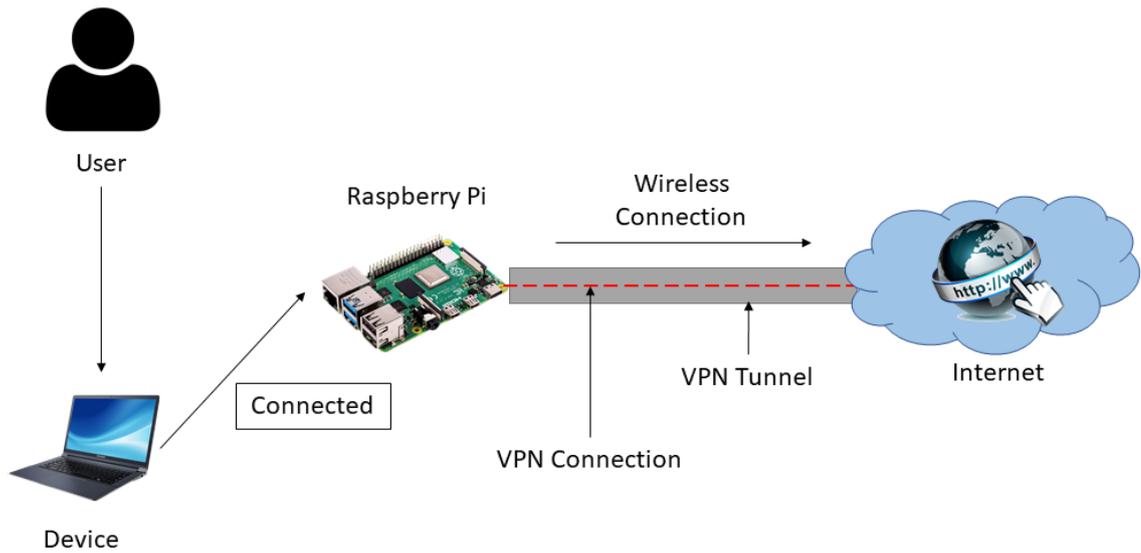
Figure 3.1: Framework

Based on Figure 3.1, the system required the user to connect the device with Raspberry Pi in order to have a connection of VPN. The Raspberry Pi needs to configure the default gateway for device can be sent to the Raspberry Pi that serves as the forwarding host to others network. After configuration, a VPN connection between the Raspberry Pi and the Internet access was created. The system will protect all data travelling through the VPN tunnel. User can safely browse without worrying the data leaks by the third party.

3.3   Pictorial Diagram

A pictorial diagram is the circuit diagram that use simple images to represent the components in the system. The diagram also shows the flow and the relationships between components in an electrical circuit. Figure 3.2 shows the pictorial diagram of the basic hardware configuration.
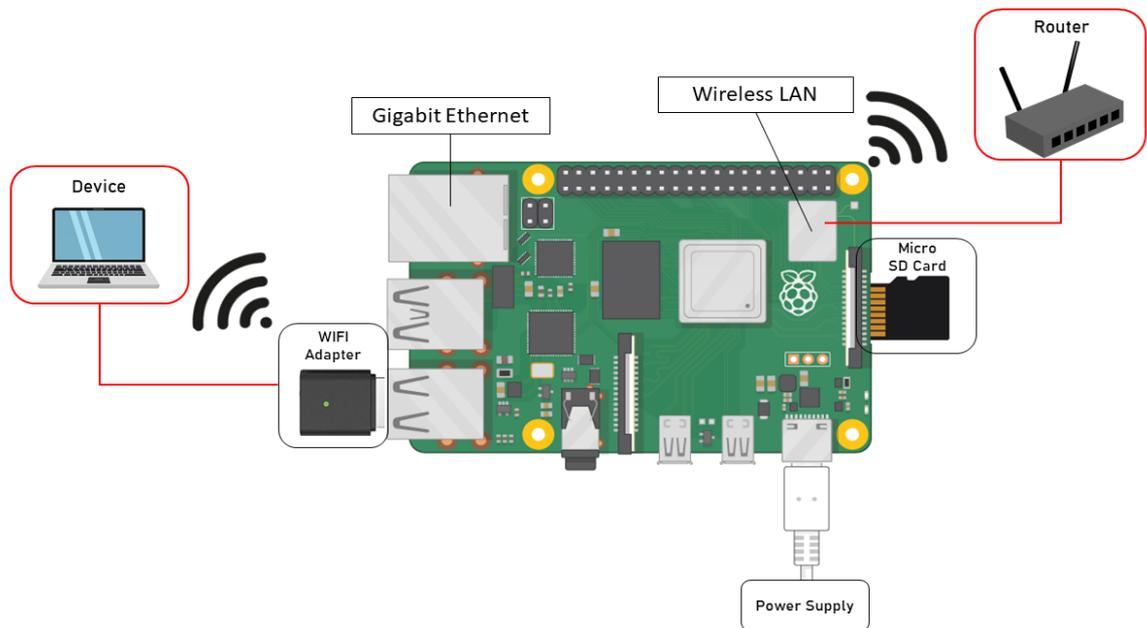
Figure 1.2: Pictorial Diagram

Figure 3.2 illustrate the Raspberry Pi VPN circuit connection. The device will connect via the Wi-Fi to the Raspberry Pi using Wi-Fi adapter. Then, the Raspberry Pi will connect through the embedded Wireless LAN to the public router. Here, two wireless adapters been used because one use to connect to the existing public Wi-Fi and another one for create a private wireless access point for the user to connect. There is another option can be used especially if we use home router, the Raspberry Pi can connect by wired using the ethernet cable. The benefits from this interconnection are when an attack happened and invaded the system the ISP will reveal from the Raspberry Pi and not the real ISP.

3.4   Flowchart of the Project

A flowchart is a conceptual model for mapping the flow of steps and decisions that need to be made in the process. It is a description that organize in a way that support the framework structures. By grouping, it makes it easier to understand who and what are responsible for every workflow. Figure 3.3 shows the cross-functional flowchart that used in this project.
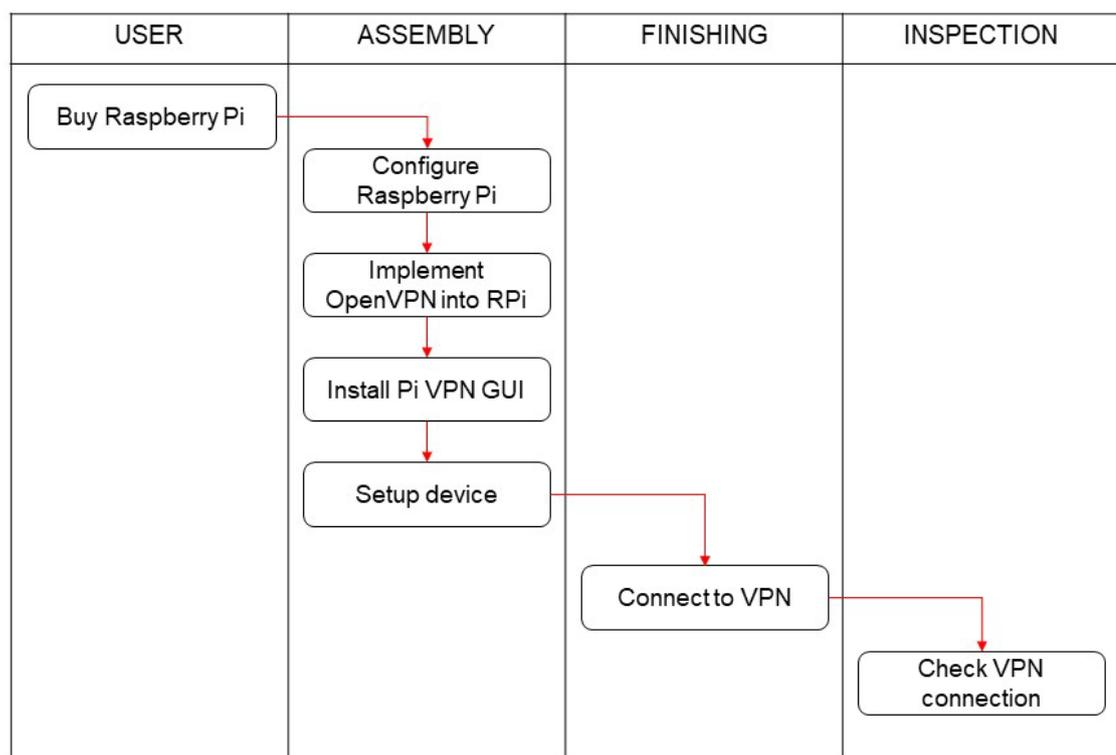

Figure 3.3: Flowchart of the Project

Figure 3.3 describes the subject and the phases included in the upper column contain the user, assembly phase, finishing phase and the inspection phase. The first phase, user involved in analysed all the requirements from the existing systems such as websites, videos and reading materials such as journals, articles, research paper or videos. Based on this collected information, the suitable hardware for this project is Raspberry Pi. The

Raspberry Pi that used in this project is Raspberry Pi 4 Model B that have 4 USB port, Ethernet port, HDMI port, Micro SD Card slot and USB type C for power supply. For the storage 16GB Micro SD card will operate the Raspberry Pi Operating System and any associated configuration data. This kit also consists of 4GB RAM which can handle the traffic load on both Wi-Fi connection.

Next, the first thing in the assembly phase is configuration of the Raspberry Pi to create a default gateway for the device. The Raspberry Pi need to connect to the VPN that has been configured. The configuration device needs to have the default gateway that aids as the forwarding host to others network. As Raspberry Pi is a stand-alone component system function like a computer, we choose to connect the Raspberry Pi into the device for easy monitoring between both devices. Enable SSH server in Raspberry Pi using PuTTY in Windows OS from device will gain access to the Raspberry Pi's command line. PuTTY is a free and open-source terminal emulator typically used for remote access to server computers over a network using the SSH protocol. Once PuTTY running, a profile for this connection was created. Secondly, implementation of OpenVPN into Raspberry Pi. Since we relying the Pi as network service, a static IP address need to be set. Next, installation GUI for PiVPN. To run the interface, a small web server was setup to show a webpage with current VPN IP address.

In the finishing phase is to connect the device with PiVPN to the wireless connection and test for errors so it functions well as a whole system. Lastly, in the inspection phase we test to check the VPN connection whether feasible correctly. We use IP Lookup to compare the real IP address or not. We also need to test the network activity encrypted and network performance using Wireshark.

3.5   Conclusion

In this chapter, all of the explanation before were methodology that apply to build the proposed system. The flow of this project is being shown in the flowchart and detailed view of the system works displayed in the framework with hardware configuration in pictorial diagram. Therefore, it was proven that the methodology used is acceptable based on the project's objectives in the previous chapter

CHAPTER 4

CONCLUSION

4.1 Conclusion

Securing network by implementing a VPN on Raspberry Pi is a convenient alternative with only a few tools and coding configuration. Besides, it is even cheaper and portable to use on any devices after a bit of setup. This low cost product also can give you an optimized internet speed during browsing and video streaming.

Furthermore, this system gives you full control over your private network allowing you to surf without risks or access data and files on your home network. So, it will be an absolute stability tool that can work fine on the devices since the server IP can change according to the ISP to assign a new one. Hopefully this system can help to prevent any vulnerabilities on our network connection.

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