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# Application of Computer Systems in VPN Networks

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## ABSTRACT

The internet is a place to view any kind of information about almost everything present in the world. In present times, the internet is becoming more and more accessible to individuals all around the world. Once something is easily accessible to the public, it can be easily be violated and abused. In this sense, malware can be easily placed by hackers on the internet for an individual to stumble upon it and the viruses it contains can view significant files on the system of the user that has been infected. Hacking is an act where an individual tries to access another individual without their consent and usually steals information for their gain. A solution to this problem is the usage of a virtual private network (VPN). This academic research aims to present the basic information, significance, and applications of a VPN through various examples, and the computer systems related to it.

**Key words :** VPN, software, application, computer systems, Interconnected Network.

## 1. INTRODUCTION

Virtual Private Networks (VPNs) is a type of network used to secure communications between computers over a network [1]. By securing the link between computers, they are now under a private local area network. This greatly extends the reach of the network to other sites without the costs of creating a private network. Separate Local Area Networks can work together as a single LAN and can be connected to other computers for telecommuting without the risks of using an open network. Virtual Private Networks prioritizes the security of the devices connected to it. The encrypted connection with a public internet server will protect the device from any third-party device.

A computer system is the entire body of a computer that includes the hardware and software [2]. For a computer system to be called functional, it should have the ability to receive input from the user, process data and with that data, create information. The information created can be either used as an output or placed in the computer's storage. Computer systems can work as a single entity or can link itself to other external devices, i.e. smartphones and USBs.

This paper will further discuss the best VPNs available for File Transfer and security measures. The study will focus on the VPN: LogMeIn Hamachi and its companion FTP, FileZilla FTP.

## 2. BACKGROUND OF THE STUDY

The Virtual Private Network was created in 1996 by Gurdeep Singh-Pall, a Microsoft employee [3]. Initially, before the VPN was published, it started as a Peer to Peer Tunneling Protocol (PPTP) and was formally published as VPN in 1999. VPNs were originally supposed to be only used by mega-corporations to share files within their office space to allow employees to gather information without the risk of unauthorized users stealing confidential data. Virtual Private Networks kept on improving from that point as more powerful encryptions were used to secure communications among businesses. This service grew immediately into popularity because of scandals that arose in the past that pointed out that the government doesn't recognize out privacy when using the internet. Most users of technology in modern times know that their private data is vulnerable when using public services, so they turn to VPNs to lessen the risk of losing data. Currently, over a billion people are using VPNs daily and will keep growing as people realize how truly useful VPNs are.

The LogMeIn Hamachi Virtual Private Network is a cloud-based connectivity service that allows users to be part of a private network [4]. It focuses on web-based management which means that the VPN allows us to manage and restore virtual networks immediately with ease. The VPN also acts as a gateway for virtual networking that provides remote users with secure access to LANs. The security of this VPN is encrypted for both public and private networks which is further reinforced by passwords and a strict security system. The system is easy to use as it extends its LAN-like capabilities to mobile users.

FileZilla, the File Transfer Protocol, is a companion to the LogMeIn Hamachi VPN. The VPN allows a secure connection between machines and the FTP, FileZilla, allows the transfer of files for all machines.

## 3. STATEMENT OF THE PROBLEM

With the advancement of modern technology, the possibilities that can be done in VPNs continue to widen. Enabling a way to create a direct and private interconnection of machines, this type of software can be used to perform a variety of tasks that may involve, or require the use of other machines. The direct connection of one machine to another creates a variety of possibilities that can be done compared to relying on the use of one machine. Other activities can be done which require the interaction of one machine to another. For this research, the aim is to provide ways on how VPNs can apply the various computer systems.

Considering the vast space of possibilities found in computer science, there are bound to be ways that machines can make use of a VPN to perform various tasks. Tasks such as information exchange are one of the most basic yet essential features that can be done over a VPN. The interconnection of a great number of machines can enable the creation of an advanced database of information. There also exists the possibility of gaining control of another machine through VPN turning all inputs of one machine into inputs of another one. As the possibilities are vast, this paper aims to cover as much as they can on what computer systems can be applied in VPNs.

## 4. SIGNIFICANCE OF THE STUDY

Based on Betternet [5], A Virtual Private Network is an essential system that protects the user's privacy and increases the user's security on the internet. The system is designed to give users a secure, encrypted link to transfer data between several machines. Due to the security VPNs offer, the data being transferred by the machines cannot be read by anyone outside of the VPN. Both public and private networks have reinforced privacy and security when the device is running on a VPN.

Over 2.7 Billion people have smartphones as of 2019 [6]. All these smartphones contain personal information for each individual in that 2.7 Billion people. It is most likely synced with all your social media accounts and emails, which will make it a very valuable item for you. When connected to WiFi, your data in the smartphone can be accessed or can be shared with other people may the connection be secure or not. Your IP Address can also be tracked down by the service provider or other parties which can potentially be used to harm your well-being. But having a VPN enabled protects you from all the harm the internet has to offer.

## 5. DESCRIPTION OF THE SYSTEM

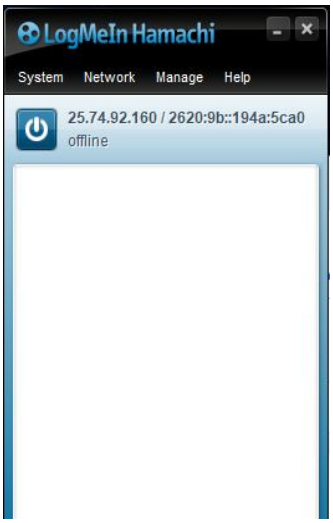


**Figure 1:** Hamachi Primary Window

LogMeIn Hamachi is a VPN client software design by LogMeIn [7]. This VPN client offers a variety of Web-Based Management options, Multiple Options for Instants and Managed Networks, and Embedded Security [8]. Its primary feature is enabling multiple machines to connect into one network with LogMeIn serving as the centralized gateway for the machines to connect interact. The acquisition of the program is readily available at LogMeIn Hamachi's official site vpn.net. The software is compatible with Windows, Mac, and Linux and is capable of allowing the mixed OS to be in one network.

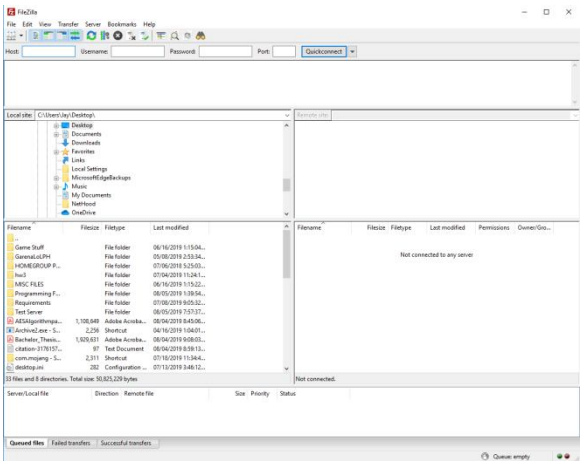

**Figure 2:** FileZilla Client Main Window

FileZilla [9,10] is an open-source FTP program designed by Tim Kosse. It is licensed under the GNU General Public License. The standard FileZilla offers support for not only FTP but also FTPS and SFTP. Along with the free client and server software, FileZilla can also be acquired as FileZilla Pro [11] which provides support for WebDAV, Amazon S3, Backblaze B2, Dropbox, Microsoft OneDrive, Google Drive, Microsoft Azure Blob and File Storage, and Google Cloud Storage [12].

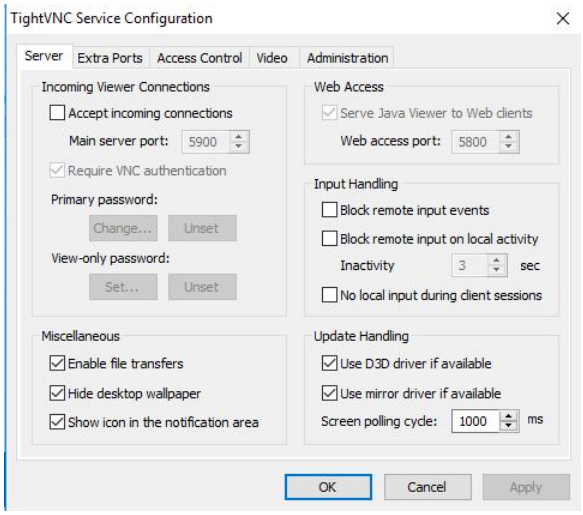


**Figure 3:**TightVNC Server Settings Window

TightVNC [13] is a free remote desktop software by Glavsoft. This software is compatible with Windows XP/Vista/7/8/8.1/10 and their corresponding Windows Server version [14]. The general use of this software is to allow one machine to connect to a host machine to gain control of the inputs of the host. This software is provided free of charge and can be used by anyone.

**Figure 4:** Minecraft during gameplay

Minecraft [15] is a sandbox video game that was developed by Mojang and was released last November 2011. It is a sandbox game where the players are capable of interacting with various blocks with some producing various responses. The game features two main types of gameplay: creative and survival. In creative mode, the player is given the freedom to place any blocks within the rules of the game. This serves as the playground for the user's imagination. On the other hand, survival mode challenges the player to survive in the world by limiting possible interactions. Minecraft also features the ability to generate a randomized world which can be tailored to the specifications of the player.

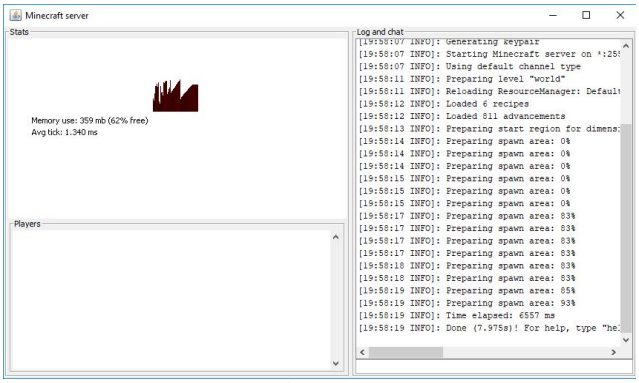


**Figure 5:** Minecraft Server Monitoring Tool

One of the prime features of Minecraft is its multiplayer component. The multiplayer feature allows other players with the same software and version to play in the same environment. Multiplayer in this software can be done either by one player opening their world to LAN connection or connecting to a dedicated server running the Minecraft Server software [16]. The software is a jar file that requires Java to run. To run this program, the windows command line is required. The command to run the file is "java -jar <server filename.jar>" wherein <server filename.jar> is the filename of the server jar file. The monitoring prompt is capable of logging down all actions done in the server including the loading of data and the number of resources consumed by the server. The monitoring tool is also capable of accepting commands for various functions.

## 6. METHODOLOGY

To observe the capabilities of VPN networks in applying various computer systems, a variety of researches will be collected and analyzed. Research made by other fellow researchers will be compiled and checked for evidence of the use of computer systems. Specifically, papers that cover the topics of Spatial Imaging, Rough Set Theory, Electronic Sensor, Logic Scoring of Preference, Neural Network, Database Monitoring, and Data/Information Transfer will be covered.

Furthermore, the actual use of VPNs will be conducted to see if other software are capable of using VPNs to perform certain tasks that encompass the topics listed above. For the trials, Hamachi will be the VPN client used to observe computer systems applied to VPN networks. Due to the limited time provided to the researchers, only a few programs will be tested for the use of computer systems. These programs are namely Filezilla and TightVNC.

## 7. REVIEW OF RELATED LITERATURE

In research [17], VPNs, by definition, is an extension of a private network across a public network to enable users to exchange information with one another. As a result,

applications making use of VPNs can benefit from the added functionality, security, and management provided by the private network. Following this information, it is then expected that the software that will be run through Hamachi should be able to benefit from the 3 benefits mentioned above. Namely, Hamachi should be able to serve as the foundation for the software to function, be secure against threats, and allow a form of management within the software involved.

Research [18] cited that VPNs are made to be private networks on a national or international level. This would make VPNs safe from threats such as hackers and viruses as VPNs are designed to be a highly secure network between the companies and the user through authentication and encryption. This would mean that in using VPNs, users are assured that their connections to and from the server are assumed to be safe from vulnerabilities. All the while, the security offered VPNs will not serve as a hindrance to the performance of the connection

In VPNs, its security comes in three different components [19]. These components are the Authentication Header (AH), Encapsulating Security Payload (ESP), and Internet Key Exchange (IKE). AH is an authentication system used for connectionless integrity through origin authentication of IP datagrams. It also features Anti-replay protection to protect against unauthorized packet retransmission. ESP is the protocol used to provide authentication, integrity, and confidentiality. Along with protecting data from tampering, ESP is also capable of encryption. Finally, IKE is a protocol for a security association. Before the secured data is exchanged, the two machines must establish an agreement.

One of the security features that Hamachi provides is AES 256-bit encryption. AES or Advanced Encryption Standards is a block cipher encryption algorithm designed to replace the outdated DES algorithm [20]. The number of bits represents the key sizes used to encrypt and decrypt data. For 256-bit, 14 rounds of the algorithm will be applied. Furthermore, research [21] comparing AES-128 and AES-256 was conducted to see each one's efficiency. AES-128 feature 10 rounds vs AES-256 14 rounds. By definition of the paper, the more rounds the algorithm does, the more secure the system will be. On measure the amount of time it takes for each key size to encrypt and decrypt data, AES-128 was faster in both encryption and decryption vs AES-256.

Among the ports that Hamachi will use to connect to the mediating server and peers, ports TCP 12975 and TCP 32976 are used as the initiator port and session port respectively [22]. As FTP used for file transfer between one host to another using a TCP-based network [23], FileZilla should be able to utilize Hamachi without much problem as FileZilla meets the requirements needed to run FTP.

In the realm of spatial imaging, it tackles with the possibility of storing spatial components as data [24,25]. In simpler terms, it is a topic that relates to storing spatial coordinates as data. The use of spatial data has continued to expand to various fields. One of which includes computer sciences. The capability of storing and handling spatial data in computer science allows for the creation of a great possibility of programs.

A program was created by a group of researchers that utilizes 3D plane positioning using a mouse and a haptic device for ergonomic evaluation. Upon doing trial runs for both devices, both were able to navigate the three-dimensional plane. The navigation within a three-dimensional plane is proof of computer programs utilizing spatial data as navigation was possible in a three-dimensional environment.

Rough set theory is an approach in tackling a set of data. The rough set approach is connected to artificial intelligence. Artificial intelligence uses this approach to make a machine more capable of self-thinking. The theory uses mathematical tools to uncover hidden patterns in the given data. With the use of approximation on the given sets of data such as functions and equations, pattern recognition becomes clearer to uncover for a machine with AI to learn [26,27,28].

To transcribe physical actions into data that can be used by computers, electronic sensors are required. Depending on how the system was configured, various physical interactions can be configured to be interpreted as a certain type of data [29,30]. The definition of the terms “sensor” and “transducer” is often considered as synonyms. By definition of The American National Standards Institute (ANSI), traducers are considered as devices that can provide a “usable output in response to a specific measurand.” This would mean that the device requires the ability to convert outside responses into data usable by the machine [31,32].

Biomedicalsensors not only capable of collecting data, but also the capability of processing signals and other miscellaneous features. Through these sensors, the research envisions the possibility of enabling a form of individualized healthcare. A kind of healthcare that tailors to the needs of the individual. All this is made possible by the capability of the sensor to detect biological changes within the body.

Logic scoring of preference is more complex reasoning compared to a "black and white" logic gate which either gives 1 or 0. Logic scoring is associated with fuzzy logic. Fuzzy logic is an accurate and precise observation when examining a given example. It is not as simple as a yes or no question because the answer could be maybe. There is a certain degree to each answer since different variables are considered in formulating an answer. This approach is complex due to the logical contradictions it possesses. There are different algorithms when using this approach to properly get what is required.

Neural networks concern itself with Artificial Intelligence (AI). Artificial Intelligence is the capacity of a machine to think and it is patterned to think like human individuals. Artificial Intelligence is also capable to understand different kinds of logic and is capable of deep learning. Going back, there are different kinds of neural network that utilizes artificial intelligence that specializes in different fields. These

algorithms are focused on creating a neural network capable of improving the Quality of Experience one has during network connections through adaptive bandwidth allocation. In simpler terms, it is an AI capable of adjusting the bandwidth of the connection to ensure that the quality remains excellent.

Database Monitoring is the tracking of the performance and resources of a database so that a high-performance level would be achieved. Databases serve as the center of most businesses. With the rise of application complexity, together with it, IT infrastructures are developing to be far more diverse than before. Overall, monitoring will help a system be more efficient in the tasks they handle may it be troubleshooting or capacity planning [33].

Data Transfer is any information that is transferred from a location to another. Data transfer comes in the form of displaying data on a webpage on the internet to the copying of files using a hard drive. The internet allows two types of data transfer, which is downloading from a source and uploading to a source. Another way to transfer data is to utilize peer-to-peer communication between machines [34,35].

## 8. THEORETICAL CONSIDERATIONS

Readers of this document might or might not have any general information about virtual private networks (VPN) or computer systems. With that said, the information found in the paper would be simplified for easier apprehension. Throughout this study, different academic research with regards to VPNs and computer systems that are available will be taken into context to give more clarity for the reader. A qualitative approach will be done to present significant information about VPNs and computer systems. A little bit of quantitative research will also be present to help support the claims of the paper.

## 9. DATA AND RESULTS

As FileZilla Server requires a web server where it will be hosted, XAMPP. was used to host an Apache webserver to serve as a platform for FileZilla. XAMPP comes preinstalled with its own FileZilla Server software running at version 0.9.41 beta. Before testing the connection, the settings of FileZilla were fixed to bind the server to the host's Hamachi IP address, along with directories being set for access, and user accounts being made. The home directory is set as a folder with 3 folders named "Test 1," "Test 2," and "Test 3" respectively.

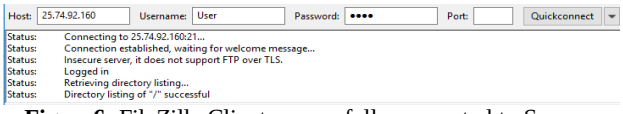


**Figure6:** FileZilla Client successfully connected to Server

With the Hamachi address as the host address, logging in with the generated account was a success. The File Viewer also successfully displayed the different directories found with the root folder (Refer to Fig. 7). As the directories contained no file whatsoever, no files were displayed. Navigating into the test folders would also result in no files displaying. A file titled "Minecraft.exe" was then inserted into the root folder of the FTP and one individual was selected to test out all the capabilities they can do in the FTP client.

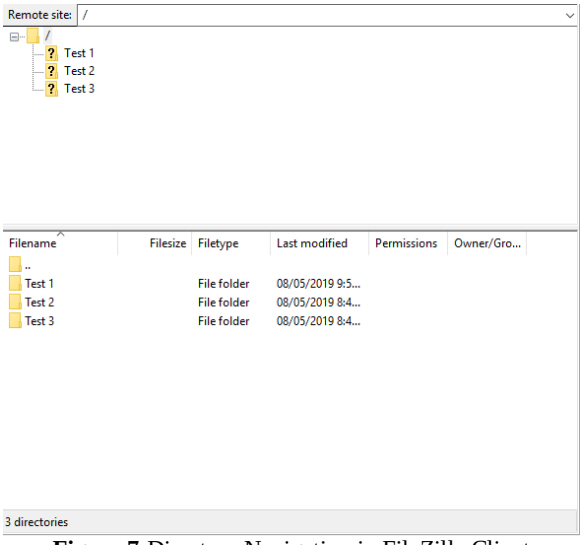


**Figure 7:**Directory Navigation in FileZilla Client

Ascertain actions were done by the connected user, FileZilla Server logged down all the actions that were done by the user which included directory navigation, directory deletion, directory creation, file uploading, file downloading, and file deletion. All changes are done in FTP Folder also reflected on the OS which can be observed in Fig. 8.

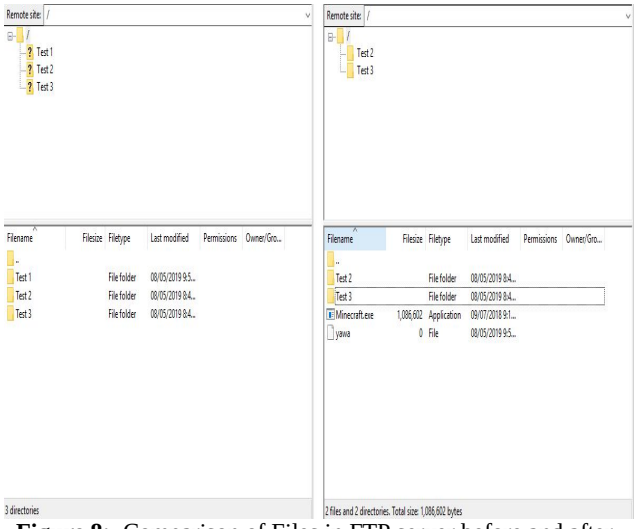


**Figure 8:** Comparison of Files in FTP server before and after

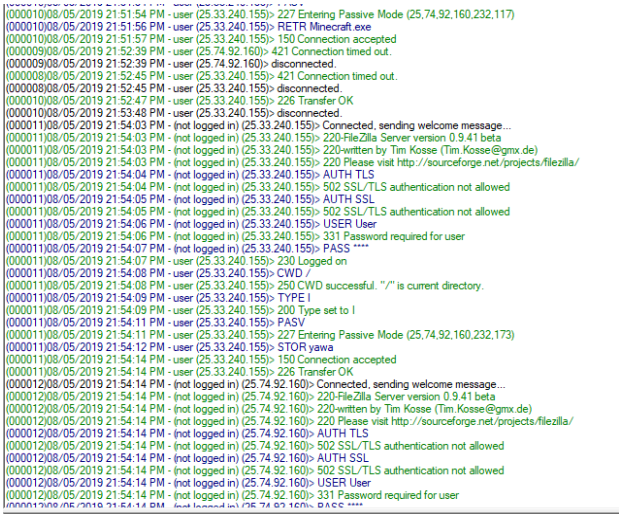


**Figure 9:** Server log of various actions

All actions logged down by the Server software with a timestamp and the name of the user responsible for the action (see Fig. 9). Furthermore, the status of file transfer can be seen at the bottom of the program, where all the connected users are listed. The progress and speed at which the file is being transferred are taken into account by the software (see Fig. 10). Throughout this trial, it can be observed that everything that occurred through FileZilla and Hamachi can be said to be a prime example of Data/Information Transfer.


**Figure10:** List of Connected Users with File transfer progress and speed

There was no problem during the setting up of TightVNC. After installation, there was no need for an additional setup to allow TightVNC to work with Hamachi. As the installer recommends that a password is to be set up, a password was placed to ensure the safety of the machine. After setting up the server on the other machine, TightVNC Viewer was opened up to access the machine. In the remote host field, the Hamachi IP address of the host was inputted. After inputting the correct password, the viewer then started to display the desktop of the host.

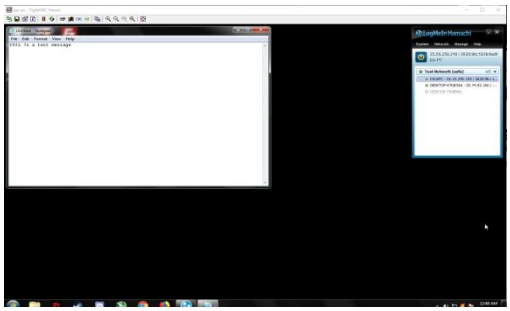

**Figure 11:** TightVNC used to connect to another machine to open notepad and write a message

Here, it can be observed that the mouse and keyboard inputs made by the client are being reflected in the host computer. To further test this, the notepad was opened using the mouse and the keyboard was used to write a test message. As seen in Fig. 11, all inputs were successfully accepted by the host machine. This demonstrates the capability of VPNs to transmit electronic inputs to another machine. A prime example of the use of electronic sensors.

Minecraft is a game where players navigate a 3D sandbox environment. The position of the player is defined by 3 sets of values, x, y, z. Similar to a three-dimensional cartesian plane, the position of the player is tracked based on what value is their xyz coordinates are at a given time. In this simple simulation, Minecraft was able to demonstrate the capability of using spatial imaging tracking down the position of a player in a 3D environment. About VPNs, the trials that will now be conducted will see if the movement and actions of a player will be sent over to another machine with VPNs as the medium of connection.

The setting up of the Minecraft server can be done in 2 ways. This can be through setting up a dedicated server or by allowing a player to open their play session to LAN. In testing this software, both will be considered to see if Hamachi can be used to connect to other machines for shared gameplay. For opening the play session to LAN, no technical setup was required. On the other hand, setting up a dedicated server requires quite a bit of work which will be elaborated on later [36]. This LAN Setup can use a Feedback Control operation [37].

In both scenarios, a world is needed to be generated before a session can be considered playable. For LAN sessions, the world is generated when the player chooses to create a new world in singleplayer. For dedicated servers, however, a world is generated upon starting the server and the same server will be used until either the original folder containing the world files was removed or the level-name setting in the server.properties file was changed to a world name that was never generated before. The generation of the world can be said to be a product of rough data sets as it creates a randomized world based upon certain parameters and mathematical equations to ensure that the world follows a certain structure/pattern while remaining unique to each player. Logic Scoring of Preference can also be evident during world generation for LAN sessions as the settings in which the world is to be generated can be edited to change the world randomization that could cater to the preference of the player.

Starting with opening the play session to LAN, the hosting player only requires to set the settings of how the game can be played. There is no option of selecting where to host the world. After opening to LAN, a message will be sent prompting the host player on what port is the game being broadcast on. To connect to the host, the other players must make a direct connection to the host by using the host's hamachi address and port as the server address for direct connection. After connecting to the session, the players are

then able to interact with the elements present in the host's world.

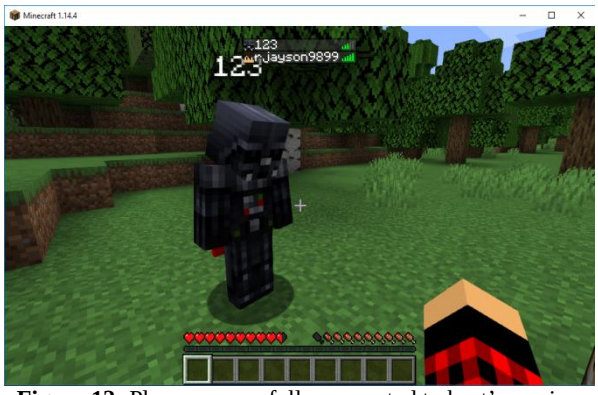


**Figure 12:** Player successfully connected to host's session

In setting up the server, the windows command line is a requirement to run it. The command to run the program is "java -jar <server filename.jar>" with <server filename.jar> being the directory of the server jar file. As the server will generate various files for its use, it is recommended for the server file to be placed in a dedicated folder. On first boot, the server will close and a txt file named eula.txt will be generated along with other files. For the server to run, the eula value in the txt must be changed to true. Afterward, the server can then continue to perform its operations. The first of which is to generate the files it would need to perform. Afterward, it would generate a world based on randomization. After this, the server can now serve as a Minecraft session where other players can connect to. But before any player can connect, the Hamachi IP address must be binded to the server by editing the server.properties file with a notepad tool. After this, the server can now be accessed by other players in the same network.

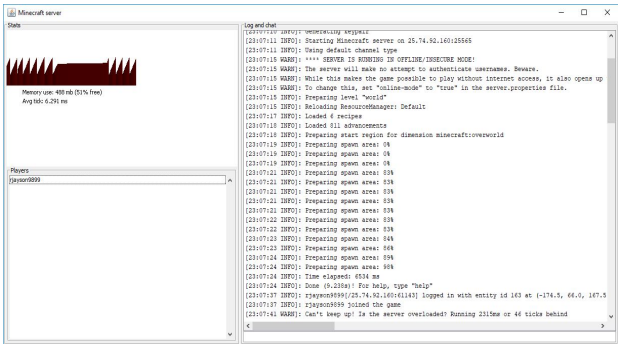


**Figure 13:** Server Dialogue box reporting the status of the server

The difference between opening to LAN and hosting a dedicated server is that the dedicated server is capable of logging down all activities done in the server by the players (see Fig. 13). It also logs down errors, warnings, and progress of actions being done by the server itself. It also logs down the number of resources being consumed by the server at a given moment. The players are also listed down by the program as a means of knowing who is connected at a given time. This is slightly similar to the FileZilla Server software which also provides means of tracking down activities and current users. These logging capabilities provided by both software can be considered a means of database monitoring as this software provide the means to monitor and manage activities done in a server.

## 10. ANALYSIS OF DATA

By the end of the trials, the programs were able to demonstrate some form of computer systems. In every program, the main computer system that is said to be common among all of them is data/information transfer. As the VPN is used as a medium for the software to connect to one host to another, VPNs serve as the channel for which information is sent and received from one host to another. After this, each program was then able to serve its primary function which also demonstrates other various forms of computer systems.

In the study, the researchers used a FileZilla server to bind with the host's IP address in Hamachi. Using FileZilla, it shows all the actions of the Hamachi server. It also shows the users that are connected to the Hamachi server. After using FileZilla, TightVNC was set up. TightVNC was paired with the Hamachi IP address of the host. This enabled remote use of a different machine that is connected to the Hamachi server. In figure 11, the image shows that the user with remote access opened notepad to write a message that would be visible to the machine of the other user.

Another use of VPN is creating a Local Area Network (LAN) or dedicated servers for playing games. A game application called "Minecraft" is used to show how VPNs could be useful. In the test of creating a LAN, the setup required was only in-game, though the machines must already be connected to the Hamachi VPN. The creation of the world in Minecraft is done before the making of the LAN since a player connected to it will just be joining the created world. Upon the creation, the world is randomized but can be catered to the preference of the player. The creation of LAN is successful if the other player connected to the Hamachi server can join the game in LAN.

## 11. CONCLUSION

With the advent of the internet, many things thought to be impossible can now be made possible. The internet has enabled the ability to connect a vast web of machines to enable actions such as long-distance communication. Due to this, the Internet is a need for individuals thanks to its ability to hastens the productivity of the world. Despite the wonderful things provided by the Internet, navigating it is not without its risk. While browsing the internet, an individual is at risk of getting malware that can harm the individual's personal computer, smartphones, tablets, etc. That is why the use of a virtual private network (VPN) is very significant in the current generation. One of the uses of VPNs is to secure a person's browsing data. The concept of browsing without VPN is that data requested from a computer is sent to the vast internet and data is sent back to the computer.

The possibilities that can be done in VPNs is expansive in itself. Being able to provide a means for machines to connect directly and securely, it is made possible for programs to utilize certain computer systems to deliver specific functions. These functions can encompass various computer systems.

Over this research, it has been evident that computer systems can be applied to VPNs. Most notably on how all three programs were able to utilize data and information exchange to manipulate certain aspects of the machine. These aspects include files present in the machine, inputs that can be done by one machine, and the ability to manage a server.

## 12. RECOMMENDATIONS

Throughout the study, most details and information found in this paper are based on present findings that were borrowed from journals and various websites. Most findings in the paper were proven to be true as the researchers had first-hand experience with the applications that were the focus of the paper.

To have a better understanding of how VPNs work or differ from each other, the scope can be improved by focusing on the other programs or files that VPNs can be used on. Currently, VPNs can only protect files that transfer between machines from hackers or other third parties. VPNs cannot protect the computer from viruses and malware sent by a trusted machine, as it is the job of the antivirus to do so.

The paper discussed the relationship of computer systems with the Virtual Private Network. The researchers focused solely on their relationship as a whole without any specifications. This can be improved by looking into the relationship of the Virtual Private Network with each computer system. Further studies can show how a VPN works within a supercomputer, mainframe computer, minicomputer, and microcomputer.

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